Miami University

Department of Engineering Technology

ENT 498 Senior Design

Automated Livestock Barn System

5/6/21

**Campus:** Zane State College

**Advisor:** Mert Bal

**Team Members:** Gabryella Law, Michael Wengard, Joshua Hashman

## Executive Summary

The objective of this project is to provide monitoring of livestock, automated animal care, and user safety. It has several systems to meet these objectives: fire detection, watering system, feeding system, temperature control, dusk to dawn indoor lighting, video monitoring system, and a WIFI enabled web page or application for alarm and monitoring system data. This project does not encompass every need a customer may have in the farming industry for livestock due to the time constraints of one semester. This project was designed to build upon and redesign a past project students did during their senior year in a PLC class at Zane State College.

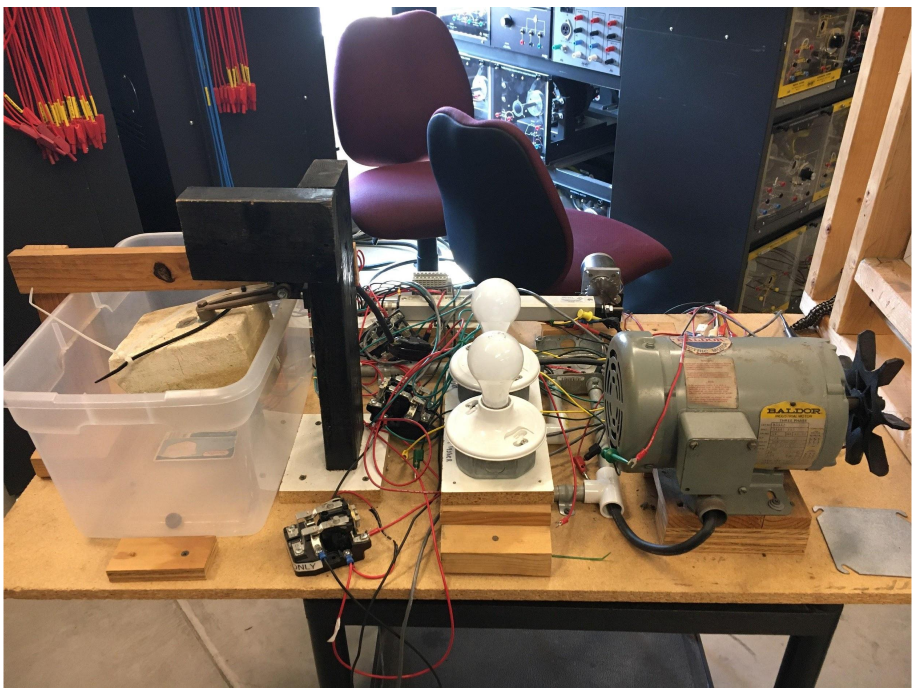


Figure 1. Zane State PLC Project

Ideally, the group is planning for this project to perform the specific functions listed below. To complete the project, the group has laid out specific milestones for the following semester, listed below the project goals.

**Project Goals:**

1. Open louvers during hot temperatures for temperature control
2. Refill water troughs once water level reaches a certain point
3. Refill food troughs at certain time each day (or once food level reaches a certain point)
4. Provide dusk to dawn indoor lighting for customer's safety, as well as the ability for a manual switch to still activate the indoor lighting
5. Provide video monitoring on demand
6. Provide fire detection alarms through web page or application. Detection of a fire prompts a protocol to initiate to alarm the customer as follows:
    a. Text or application notification of fire detection
    b. Link or notification directs customer to temperature readings and prompts user to view video feed
    c. Any open louvers will automatically be closed
    d. Any initiated automated systems (i.e. food, water, etc.) will be suspended
7. Provide additional monitoring and alarming system data through web page or application as follows:
    a. Extreme temperatures (defined in Scope and Methodology section)
    b. Low water: water sensor activation for more than 30 minutes
    c. Low food: food sensor activation for more than 30 minutes
    d. Count of times watering and feeding system have been activated each day
8. Provide additional protocols for alarms as follows:

a. A low water or food alarm will shut off the water or food system to prevent wasted water or food in case of a leak or equipment failure. A reset button will stop this protocol through the web page or application
b. An extreme temperature alarm will automatically open the louvers and alert the customer to abnormal temperatures through text or a notification from the application

**Project Milestones:**

1. Determine final physical layout of the model
2. Calculate current and power consumption
3. Build model and wire power
4. Set up Raspberry Pi with power and WIFI
5. Wire temperature control circuit, lighting circuit, food and water systems, security camera system, and fire detection system
6. Test wiring of systems
7. Program systems in Raspberry Pi Python code
8. Test systems and make adjustments to code
9. Test all systems and test communication with web page or application

**Table of Contents**

## Table of Figures

## Scope and Methodology

### Current Products

Looking into the scope and methodology, the group did some research to see if there were similar systems available on the market today. They found that a budget-friendly automated farming system for smaller scale farms is hard to find. There are large systems for industrial farms on the market, but they are way too expensive for many smaller farms to be able to acquire. There are also individual components such as feeders on the market that would work well with smaller farms, but complete systems of these more affordable components are not really available yet. If small scale farmers are not able to afford buying an automated system, they will either need to hire more workers to constantly keep the animals fed and watered and to ensure that the barn is safe for animals to dwell in. So, the goal of the team is to create an affordable automated control system that can do this with any sized farm.

While a system similar to the one being proposed is not available right now, there are some similar concepts being developed. One such conceptual system that was researched uses sensors and microcontrollers and has the ability to control lights, fans, valves, and emergency sprinklers. It has smoke detection and automatically locking doors, and even does feeder control along with the ability of the entire system to be accessible via cell phones [6, para.3]. This conceptual design has a target market in India. India is booming with many smaller family-owned farms and this affordable system would thrive there. Automation has already started changing the way people farm in the region [6, para 1, 2]. Incorporating a system like this could help revolutionize small scale farming here in the United States as well.

**Justification**

There is a need in the market for a product like the one that is designed in the project. In fact, the United States Department of Agriculture has said that "slightly more than half of U.S. farms are very small, with annual farm sales under $10,000" [3, para. 1]. Many households like these depend on off-farm income. Farms that receive their primary form of income outside of farming are called off-farm occupation farms. In 2018, the United States had approximately 819,000 off-farm occupation farms [4, Tables]. This system will help a part-time farmer maintain and monitor their livestock while they are at their primary workplace. Since the part-time farmer is not able to devote all his attention to his farming business, maintenance and care of animals could be compromised. This product could help ensure the care of livestock easing the burdens a part-time farmer may face.

Not only would it help a part-time farmer, but a full-time farmer could also benefit from this product. In 2018, there was a total of farming occupation/lower-sales farms of approximately 640,000 in the U.S. These farming occupation/lower-sales farms are defined as farms that get their primary source of income from farming and that make a gross income less than $150,000 annually [4, Tables]. This system would allow the full-time farmer to harvest crops and keep up on maintenance needs. But also, the project, as designed, has room for expansion. So as a full-time farmer's operation expands, the system can accommodate it. In addition, the system is designed to be cheap and efficient. The system is so inexpensive that the farmer could purchase a separate system for another barn location at very low financial risk. While farmers face several risks, this project could help minimize those financial risks that are associated with livestock care and maintenance of barn systems.

**Past Experience/Project**

This kind of system is not the first that members of this group have designed. At Zane State College, two people of this group participated in the design of a small-scale automation project for a livestock barn application, as seen in Figure 1 in the Executive Summary and in Figure 2 below.

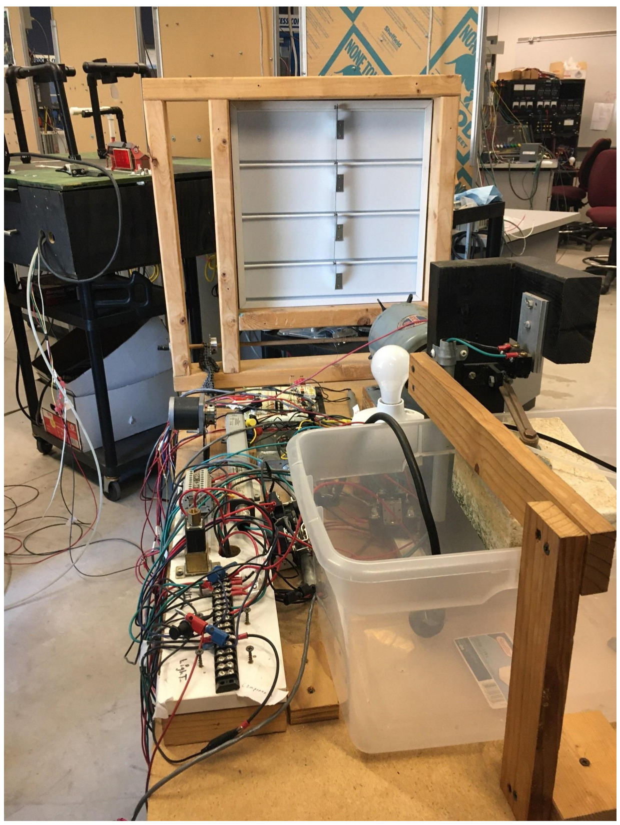


Figure 2: Zane State Project with Wiring

The project consisted of three systems: lighting, watering, and temperature control. It utilized a SLC 5/04 PLC, an industrial grade PLC, to control the different systems using ladder-logic coding. The lighting system utilized a few light fixtures and a photoresistor. It functioned as a dusk to dawn light, so that when it got dark the light would turn on. The watering system consisted of a float switch to detect the level of the water in the container. Once the water gets low enough, the PLC would activate an electromechanical coil to simulate the water container being filled back up. Finally, the temperature control system was the main focus of the project. Four thermocouples were wired to simulate temperatures in different locations of the barn. As the temperature rose at any location of the barn, the 3-phase motor would activate, and the stepper motor would open the louvers. There were four stages of operation for the step motor and 3-phase motor, as detailed in Appendix I. While this project has these three systems, these systems have been redesigned and other systems have been added, as described later in this report.

**Design Considerations**

Since the goal of this project is to design a product for farmers to use, there are several design standards to consider. First step is to understand your customers. Most people will not know anything about coding or circuit design. This product will have to be easy to install and maintain. To compete with large scale automation devices or individual systems, the product would need to be cheap, $100 to $400 for the control devices.

To maximize the user compatibility, a GUI (graphical user interface), a website, or an app should be designed to allow the farmer to change feeding time(s), watering operation, and temperature control parameters. In addition to these design considerations, environmental hazards should be considered. The group referred to the Engineering Code of Ethics for other design considerations: “II-1. Engineers shall hold paramount the safety, health, and welfare of the public.” [11, Section II]. Therefore, the equipment must be carefully designed to ensure the safety of the farmer and the animals in the barn.

**Main Control Device**

*Initial Research*

The group decided upon three different main control device options: an ACE PLC, an Arduino UNO, and a Raspberry Pi. The group discussed important characteristics of the main control device for the optimal performance of the project: networking capabilities, input/output options, external compatibility, and cost. A decision matrix was made to score the different options, as shown in Figure 3.

| Guidelines | Importance Multiplier |
|---|---|
| Cost | 3 |
| Network Capabilities | 4 |
| Input/Output Options | 3 |
| External Compatability | 4 |

| | Guidelines | | | | |
|---|---|---|---|---|---|
| Options | Cost | Network Capabilities | Input/Output Options | External compatability | Total |
| ACE PLC | 3 | 1 | 3 | 2 | 30 |
| Arduino UNO | 5 | 3 | 4 | 3 | 51 |
| Raspberry Pi | 4 | 5 | 5 | 4 | 63 |

Figure 3: Control Device Decision Matrix

Each of the options are cheap. However, network capabilities, input/output options, and external compatibility were very decisive factors. Some models of the ACE PLC have communication in the form of RS232 and RS485 utilizing Modbus [9, p. 16]. While ACE PLC does not have much for communication, Arduino UNO can offer more communication options with a board that has built in WIFI communication, such as the Arduino UNO WIFI [10, para. 10 & 11]. The Raspberry Pi has built in WIFI and Bluetooth capabilities, unlike the two other options [5, p. 3]. With network connectivity, the main control device would be able to receive input from outside sources. This would enable the use of a web page or application for the farmer to receive alarms and monitoring data. This web page or application would also have a settings page to allow the farmer to set variables for the alarms, such as extreme temperatures or the temperature in which the louvers should be opened.

The Raspberry Pi 4 Model B+ has 40 GPIO pin - ground, power, input, and output pins [5, p. 3]. The project will be utilizing the following pins:

- 3 Linear actuator circuits - 6 outputs in total
- Photocontrol sensor circuit and lighting circuit - 1 input and 1 output in total
- Temperature sensing circuit - 1 power, 1 ground, and 1 input in total
- 2 Level switch/sensors circuits - 2 inputs in total
- Water pump circuit - 1 output in total
- Source water and food level circuits - 2 inputs in total
- Fire alarm system - 1 input in total

In fact, this system will only need to utilize 17 pins of the 40 GPIO pins available on the Raspberry Pi 4 Model B+, shown in Appendix G schematics. While the Raspberry Pi provides input and output requirements, the coding will enable the group to set protocols in relation to input data. The farmer will be able to receive alarms for low water, low food, and fire detection. When there is a low water or food alarm, all automated water or food operations, such as filling the troughs, will be suspended until the alarm is cleared. In addition, the fire detection alarm will prompt all systems to be suspended other than the video system. The temperature control circuits will be overridden; the louvers in the barn will be closed to reduce air flow that would fuel the fire.

*Project Developments and Testing*

The group did a few calculations to limit the voltage and amperage to the control device, limits shown in [13, Fig. 4]. The group used voltage divider and the given voltage output on the control device to determine the resistance needed to maintain a safe amperage. For the 3.3 volt output and the 5 volt output, the circuits needed to maintain 16 milliAmps, which required at least 206 ohm and 312 ohm resistors minimum respectively.

Raspberry Pi 4 Model B Datasheet
Copyright Raspberry Pi (Trading) Ltd. 2019

| Symbol | Parameter | Minimum | Maximum | Unit |
|---|---|---|---|---|
| VIN | 5V Input Voltage | -0.5 | 6.0 | V |

Table 2: Absolute Maximum Ratings

Please note that VDD_IO is the GPIO bank voltage which is tied to the on-board 3.3V supply rail.

| Symbol | Parameter | Conditions | Minimum | Typical | Maximum | Unit |
|---|---|---|---|---|---|---|
| $V_{IL}$ | Input low voltage[a] | VDD_IO = 3.3V | - | - | TBD | V |
| $V_{IH}$ | Input high voltage[a] | VDD_IO = 3.3V | TBD | - | - | V |
| $I_{IL}$ | Input leakage current | TA = +85°C | - | - | TBD | $\mu$A |
| $C_{IN}$ | Input capacitance | - | - | TBD | - | pF |
| $V_{OL}$ | Output low voltage[b] | VDD_IO = 3.3V, IOL = -2mA | - | - | TBD | V |
| $V_{OH}$ | Output high voltage[b] | VDD_IO = 3.3V, IOH = 2mA | TBD | - | - | V |
| $I_{OL}$ | Output low current[c] | VDD_IO = 3.3V, VO = 0.4V | TBD | - | - | mA |
| $I_{OH}$ | Output high current[c] | VDD_IO = 3.3V, VO = 2.3V | TBD | - | - | mA |
| $R_{PU}$ | Pullup resistor | - | TBD | - | TBD | kΩ |
| $R_{PD}$ | Pulldown resistor | - | TBD | - | TBD | kΩ |

[a] Hysteresis enabled
[b] Default drive strength (8mA)
[c] Maximum drive strength (16mA)

Figure 4: Raspberry Pi Voltage and Current Limits

*Coding the Raspberry Pi*

This project is the first time any members of the team worked with the coding language used in the Raspberry Pi 4, Python 3. Due to this, the learning curve was steep and learning the language took days of research. During this time the team came across hurdles such as reading the needed inputs from the different sensors. Another challenge came from the logic of a function. Because of how the logic works in Python, the set up for the water function would have not worked the way the team intended, as stated in the water system section. After a long discussion and some logic graphing, the team arrived at a work around. However, the team experienced a catastrophic catastrophe when the GPIO board of the Raspberry Pi was shorted out. The final code the group developed for the Raspberry Pi 4 is shown in Appendix J.

*Coding the Arduino*

As a temporary fix to shorting out the Raspberry Pi, the team moved on to programming an Arduino UNO they already possessed. This turned out to be quite a challenge as it did not come with a lot of the features the Pi had. The Arduino has no internal clock. While this was a setback for this project, an internal clock could be available with an add on that is on the market. So, the team progressed by tying the activation of the food function, which was based on time of day, to when the water function would run. To prevent spills or food overflow, the team programmed the code with a shortened feed time. The final code the group developed for the Arduino UNO is shown in Appendix K.

**Temperature Control**

*Initial Research*

While this project will address temperature control for animals, the ideal thermal conditions for livestock may differ between different species. In addition, ideal thermal conditions may even depend on the age of the animal. For example, cattle that are less than 1 month old generally have a thermal comfort zone between 59 degrees Fahrenheit and 77 degrees Fahrenheit; in contrast, a mature beef cow has a thermal comfort zone between 41 degrees Fahrenheit and 68 degrees Fahrenheit [7, p. 61]. However, pigs have a different thermal comfort zone. As seen below, pigs can be maintained in temperatures as scorching as 100 degrees Fahrenheit with a solid, wet concrete floor with a moderate draft [8, Table 1].

**Table 1. Ideal temperature for pigs of different body weights as impacted by ventilation rate and flooring type. It is assumed that growing pigs are fed *ad libitum*[1].**

| Weight of pig | Deep bedded, no draft | Deep bedded, moderate draft | Solid, wet, concrete floor, no draft | Solid, wet, concrete floor, moderate draft |
|---|---|---|---|---|
| Nursing pigs | | | | |
| < 4 lb | > 90 °F | > 100 °F | NA | NA |
| < 12 lb | 85 °F | 96 °F | NA | NA |
| < 25 lb | 70 °F | 79 °F | NA | NA |
| Growing pigs | | | | |
| 20 - 35 lb | 65 °F | 73 °F | NA | 100 °F |
| 35 - 65 lbs | 60 °F | 68 °F | 90 °F | 100 °F |
| 65 - 130 lbs | 58 °F | 65 °F | 85 °F | 96 °F |
| 130 -280 lbs | 55 °F | 62 °F | 78 °F | 88 °F |
| Gestating sows | | | | |
| feed restricted, individuals | 58 °F | 62 °F | 83 °F | 93 °F |
| in groups | 53 °F | 60 °F | 75 °F | 84 °F |
| Lactating sows | 55 °F | 62 °F | 78 °F | 88 °F |
| Boars | 58 °F | 65 °F | 83 °F | 93 °F |

[1]Adapted from Whittemore's Science and Practice of Pig Production, 2006.

Taking the ideal thermal conditions of these two animals, the extreme temperature alarm for the project will be set at 100 degrees Fahrenheit. While the temperature ranges will be pre-set, the customer can change the settings for the temperature operations to their specifications through a settings page in the web page or app.

For the sensor, the group is using the DHT11 temperature and humidity module that comes in the Arduino kits that were bought by the students in previous classes. This sensor was chosen because it is inexpensive, easy to acquire, easy to wire, and the team is familiar with it. If the sensor reads too high of a temperature, the louvers in the barn will open to allow airflow to lower the temperature.

A stepper motor was used in the Zane State College project that some of the group members are familiar with. Stepper motors are useful because they can open and close the louvers in set increments. They are very complex and expensive, though. To avoid the cost and complexity of a stepper motor, the group is using linear actuators to open and close the louvers. They are planning on using an actuator with a three-inch stroke for this. The group will need to adjust the leverage of this depending on how much linear movement it takes to open and close the louvers.

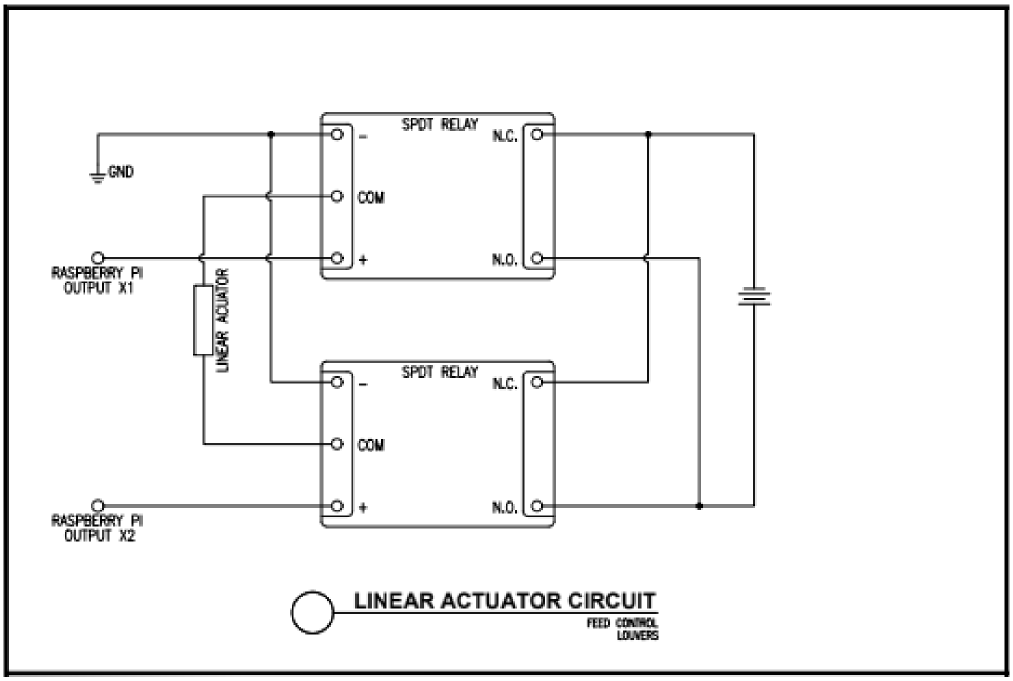
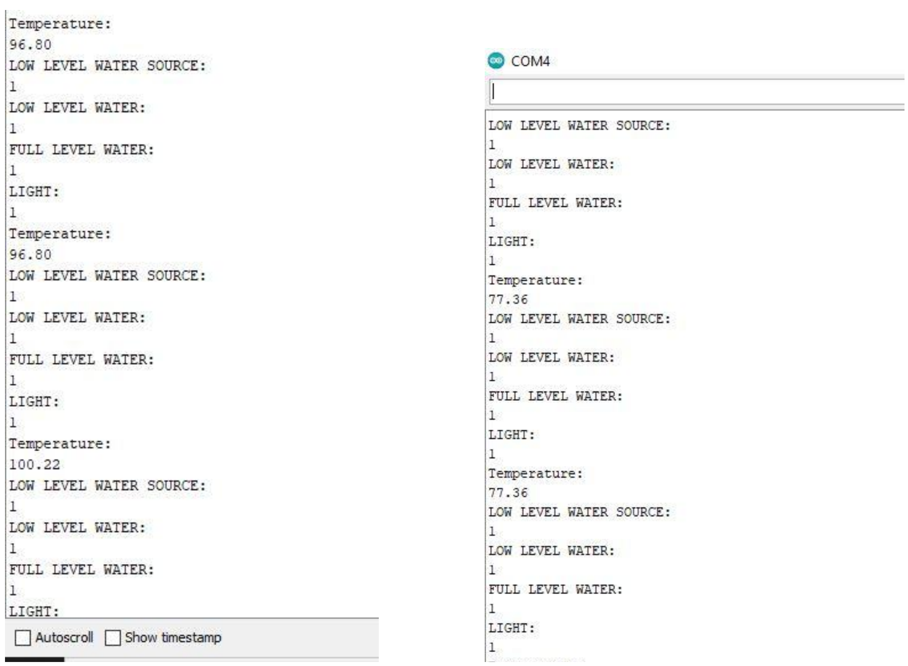



Figure 5: Linear Actuator Circuit

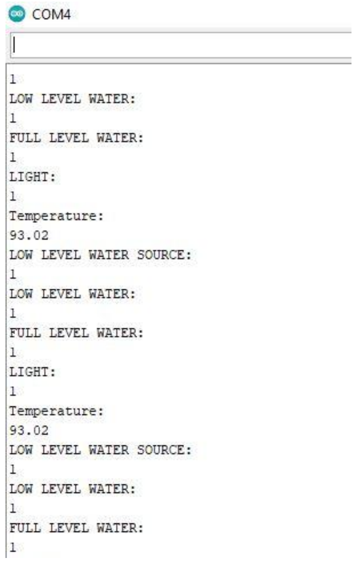
For the actuator to open or close the louvers, the polarity of its supply voltage needs to be reversed. The group did some research and found that two SPDT relays can be used to reverse the polarity supplied to the actuator. This circuit only uses 5VDC from the output of the Raspberry Pi module to energize one of the relays depending on whether the louvers need to open or close, as shown in Figure 5.

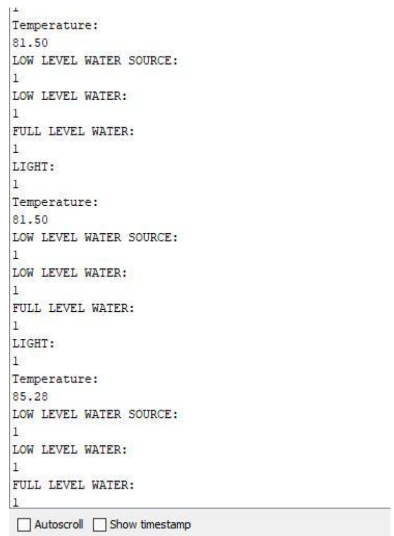
## *Project Developments and Testing*

During design and testing, the group faced the challenge of installing the appropriate libraries. The Raspberry Pi and Arduino UNO each required different libraries. During testing, it was determined that the temperature readings were consistent. However, the group was unable to get an output from the Arduino UNO when the temperature reached the preset operation level of 80 degrees Fahrenheit. To test, a hairdryer was used to raise the temperature. Figures 6a-6d below show the progression, as the DHT11 temperature module detected the rise in temperature.




Figures 6a-6d: Temperature Readings Part 1-4 (left to right, top to bottom)






The readings started at approximately 77 degrees and read up to 100 degrees in the figures. For the mechanical design, the linear actuator was fitted with a hook on the end to push against metal brackets that were added to the metal lever arm of the louvers, as seen in Figure 7.

Figure 7: Mechanical Design for Louvers

During opening operation, the linear actuator retracts and pushes against the metal brackets of the louvers to open them. During closing operation, the linear actuator starts to extend and the louvers begin to close on their own due to their weight and gravity. However, the louvers require the linear actuator to fully extend to close them completely.

**Fire Detection**

*Initial Research*

The next system included in this project is the fire detection system. It consists of a 120-volt wired smoke detector with a battery backup. The group wants the farmer to receive an alert from the program whenever smoke is detected. The group wasn't able to find much information so far on the internal circuitry of the detector; so when the group receives it, the detector will need to be disassembled. The group will then tap into the alarm status and run it back as an input to the Raspberry Pi module.

*Project Developments and Testing*

As one of the least planned out systems of the project, the group quickly started testing the fire detector. The fire detector that was purchased was a 120VAC fire alarm. Before purchasing, the group determined this particular fire alarm had an interconnect wire. The way this alarm would work in a home or business setting is as follows:

1. Interconnect wire connected to other alarm inconnect wires
2. Fire is detected at one of several alarms
3. Interconnect wire sends a signal that sets off all alarms that are connected

The group found this to be the easiest and safest way to send a signal to the microcontroller, instead of tearing apart a basic alarm at the risk of disabling it. However, it was not certain what kind of voltage or signal would be sent through this wire.

Upon testing, it was discovered the interconnect wire would emit a 7VAC signal, but only when fire was present to set off the alarm. The group then developed a schematic showing the conversion of the AC voltage to a DC output using a bridge rectifier circuit, as seen in Figure 8 below.

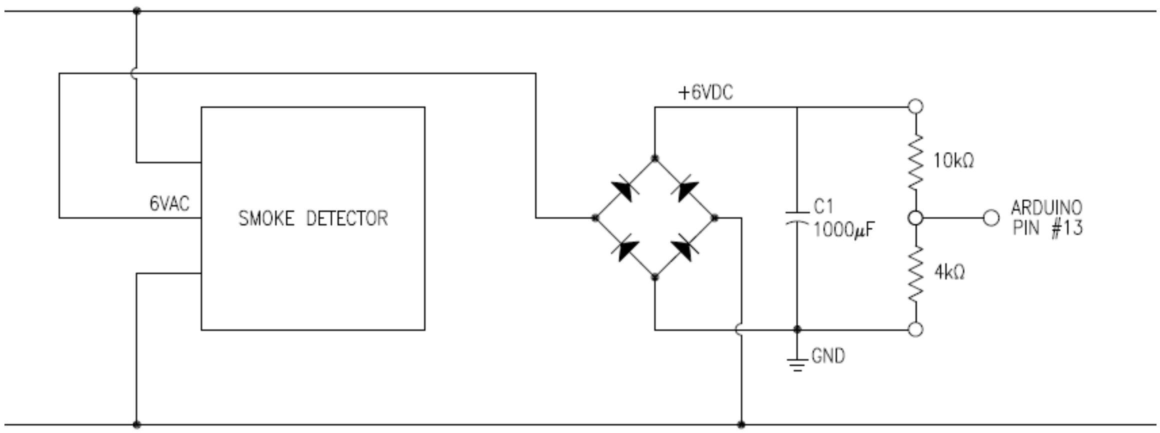



Figure 8: Smoke Detector Circuit

In order to connect the DC output to the microcontroller, a voltage divider circuit was calculated as such:

$$R = \frac{7V}{16mA} = 437.5\Omega \qquad \frac{3.3}{7} = 0.47 = 47\%\ of\ total\ resistance\ in\ circuit$$

It was calculated that the resistance in the circuit needs to be at least 437.5 Ohms in total. Also, the larger voltage of 7V needed resistance calculated so that the voltage of 3.3VDC would not be exceeded at the microcontroller. It was determined that the resistance would need to be at least a 53/47 ratio. However, the group decided to design the circuit with a resistance ratio of approximately 75/25 to ensure voltage and current limits were met. This was done by using a 10 kilo ohm resistor in series with a 4 kilo ohm resistor.

After initial testing, it was discovered the test button did not initiate a signal on the interconnect wire. To find out the voltage emitted, the group lit a controlled fire. Due to the need for real fire, testing presented a concern, but the group took precautions by keeping it away from fuel sources and flammable objects. The group was able to receive an input at the microcontroller that matched the fire alarms operation, as shown in Figure 9 below.

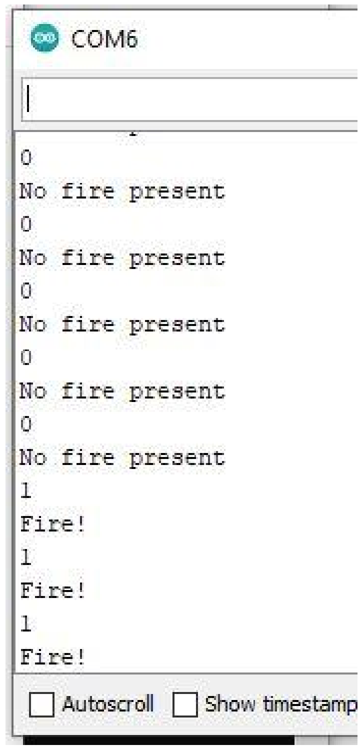



Figure 9: Fire Detection State Change

**Lighting System**

*Initial Research*

The lighting system for the project is very simple. Its main purpose is to provide safety for the farmer. As a farmer is working in the dark, the automated system will allow for the farmer to see into the barn without having to work with a flashlight or trying to find the light switch for manual operation. This will help the farmer avoid tripping hazards with more reliability and range than a standard flashlight. While the lighting system is also for safety, the light will facilitate video monitoring at night while using a camera that does not have night vision capabilities. The lighting system will operate as a dusk to dawn automated indoor light, but the farmer will be able to manually turn on the lights at any time with a light switch. The dusk to dawn operation will be made possible by using a ST-15 photosensor that would be mounted on the outside of the barn near the roof. The ST-15 photosensor will be connected to the Raspberry Pi through an electromechanical coil to isolate the Raspberry Pi from 120VAC, shown in Figure 10.

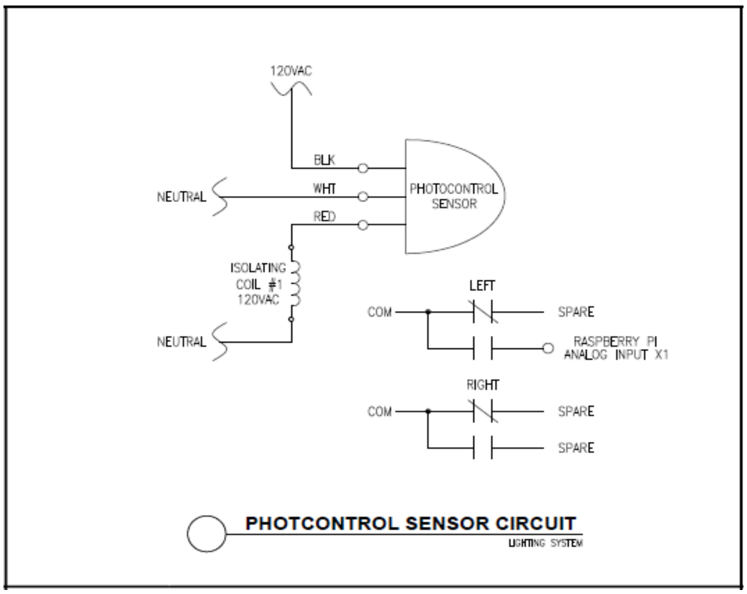



Figure 10: Photocontrol Sensor Circuit

*Project Developments and Testing*

Upon initial wiring, changes were made to the schematics.These changes were improvements that ensured correct operation and helped to keep current and voltage limits for the microcontroller, as shown below.

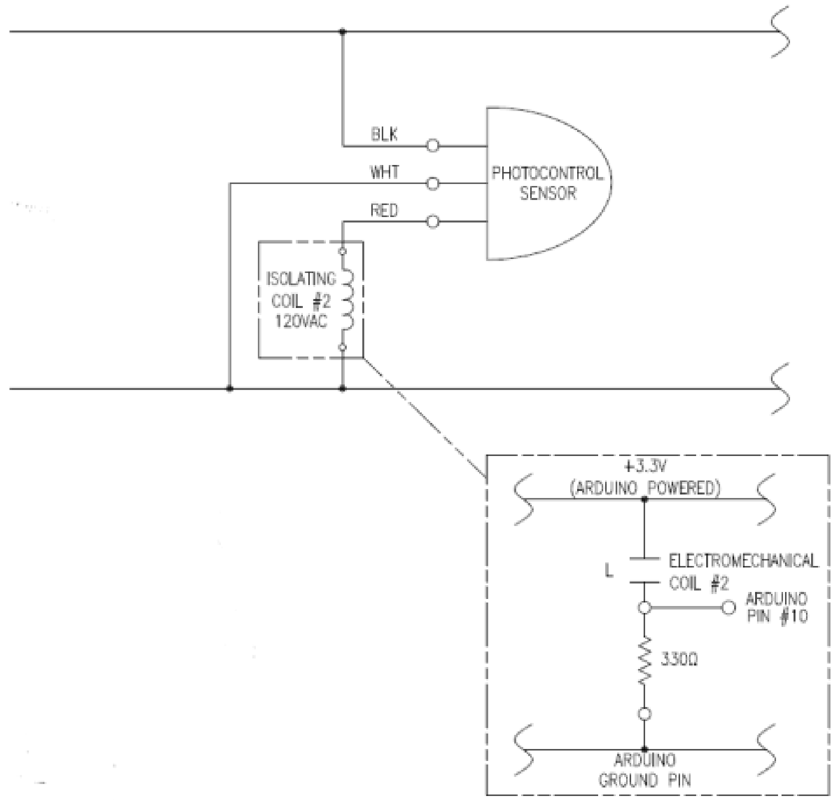



Figure 11: Photocontrol Sensor Circuit Revised

During testing, a flashlight was shined directly on the sensor to ensure the photocell would be inactive. Lighting in the garage area, where the testing was completed, was not bright enough to be detected by the photocell. According to the photocell data sheet (Appendix F), activation of the photocell could take up to 2 minutes. While this was a hindrance for testing, this operation helps improve the functionality of the lighting circuit. It ensures the light will not be turned on every time a shadow is cast over the photocell, a functionality change the group would have included in the coding if not already accounted for.

## Video System

### *Initial Research*

The video system will connect to the Raspberry Pi through a USB port. The camera the group is using is an AUKEY 1080p Live Stream Camera. The intent of this system was to allow the farmer to view the animals or condition of the barn at any time, any place through a web page or application. The Raspberry Pi will send the video feed through WIFI to a web page or application. In an emergency, the farmer would be directed to view the video stream through URL that would be sent through a text message or a notification from the application.

### *Project Developments and Testing*

During the development of the video application, the group researched the code needed to make the application work. The group came up with a preliminary plan to use the OpenCV library. This library is used to detect a video camera connection and decode the data to display the images on a pop-up window [12, para. 1]. During the testing phase, the group still needed to download this library onto the Raspberry Pi 4. This turned into an issue, when the group was not finding consistent instructions on how to download the library. In the end, the group was unable to install the OpenCV library due to dependent libraries missing. The group gave up trying to get this library after experiencing issues trying to find the missing libraries, limit internet access, and shorting the Raspberry Pi during testing.

## Food and Water Systems

*Initial Research*

The food and water systems will be a simple design that is meant for smaller farms. The food will be gravity fed with a gate that opens and closes to allow the food to drop into the trough. The water system will be fed by pump to allow for a fast fill from a clean source. Both systems can be run on a timed dispense or set to fill when the troughs become empty. These settings can be controlled from the webpage or phone application. The troughs and the sources will be monitored by sensors that detect water depth or if there is food, as seen in Figure 12 below. The webpage or phone application will also alarm the user if the sources become lower than the sensor placement.

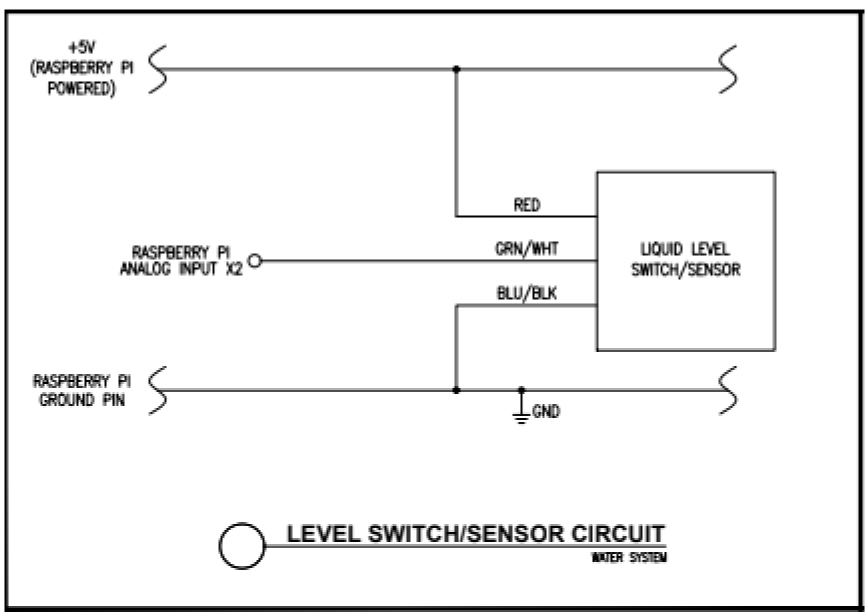



Figure 12: Level switch/sensor circuit for food and water systems

*Project Developments and Testing*

The feeding system consists of a linear actuator controlled by an Arduino using a SPDT (single-pole, double-throw) H-circuit shown in figure 13 below. Some of the challenges that came up with this circuit came up when the group had to switch from the Raspberry Pi to the Arduino Uno. The Raspberry Pi had time capabilities, but the Arduino didn't. The group wasn't able to use time delays because of the effect they have on other code, so instead, the feeding system actuator was programmed to be activated when the low water sensor input was Hi.

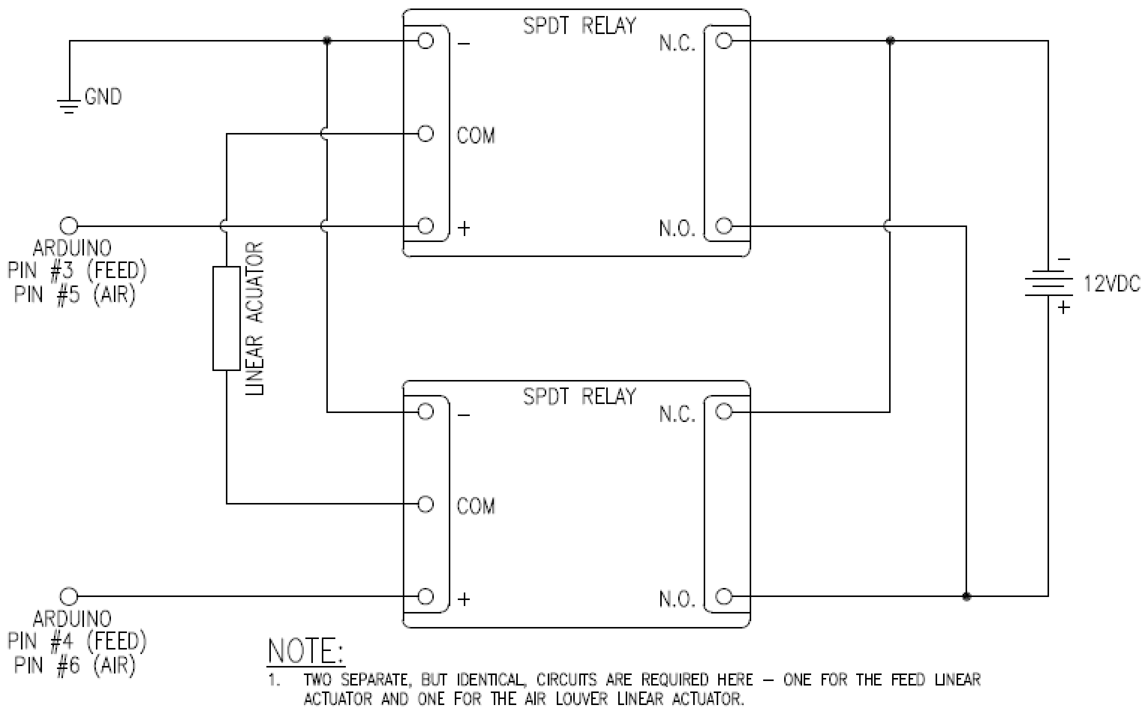



Figure 13: H-Circuit for linear actuators

The design for the food shut-off was a metal piece in the PVC pipe used to block the food from dropping into the trough. The actuator is used to retract and insert the metal piece out of and into the PVC when activated. This is shown in Figure 14.

Figure 14: Feed shutoff/activation design

Originally, the PVC was designed to have a straight drop from the source bucket to the trough. However, the model was redesigned to show all display items on the front side, while leaving most wiring and hardware on the back of the model. When it was redesigned, it was decided that two 45 degree PVC angles should be used to position the feed chute above the trough (Figure 15). The group ruled out using two 90 degree angles because they could possibly cause the food to lodge at the bottom of the first 90 degree pipe and result in a backup that would prevent food from dropping into the trough.

Figure 15: PVC pipe design

In the watering system, the group utilized liquid level sensors from Adafruit. These sensors acted as a smart switch that would be active when water is not present. There were a total of three sensors used. One sensor was used to ensure the submersible water pump did not run dry. This helps protect the pump and ensure it does not burn up during operation. The group wanted the water circuit to operate as follows:

1. Source water bucket is full; water is sensed at source water sensor (input = 0)
2. No water sensed for low level and full trough sensors (input = 1)
3. Pump activated (output = 1) through microcontroller and solid-state relay
4. Pump turned off (output = 0) until until one of the following conditions is met:

a. Water sensed at full trough sensor (input = 0)

b. Source water bucket is low on water; no water sensed at source water sensor (input = 1)

During testing, the group gathered data from the inputs by utilizing the Arduino serial monitor. When water was not present, the sensors would output 5VDC. This would show up as a digital input of 1 on the Arduino. Figures 16 through 18, below, show the transition between water not present and water present as water was added to the system.

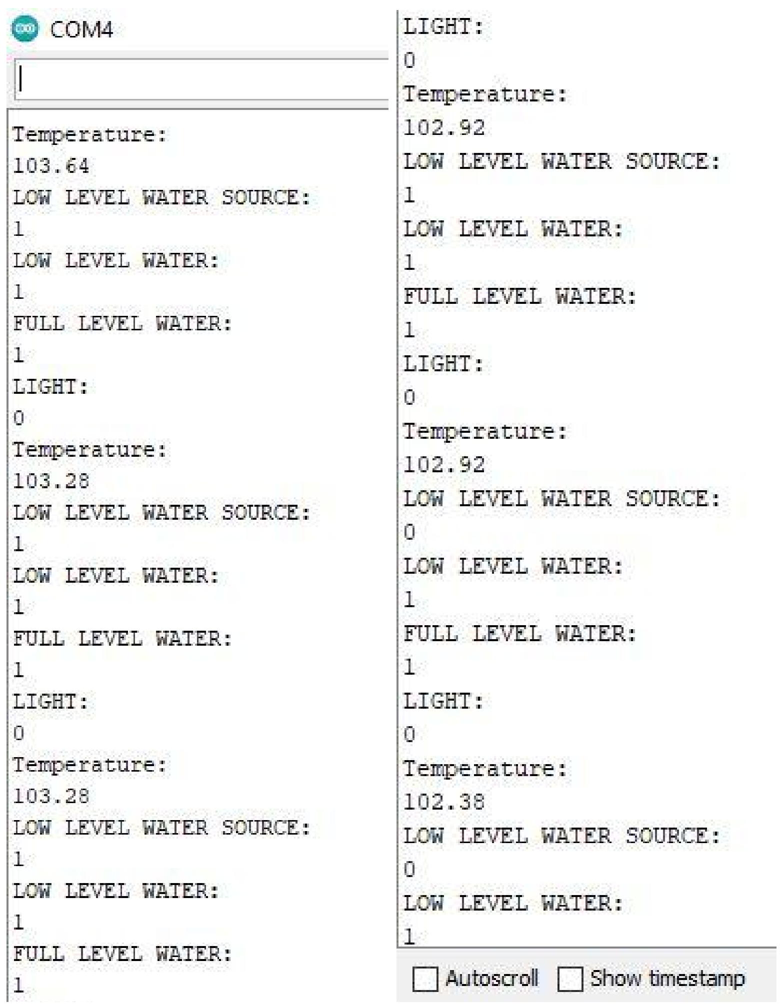



Figure 16: Water Source Sensor Deactivation

Initially, all of the water level sensors show a value of 1, as seen on the left screenshot of Figure 16. The group filled the source water bucket that contains the pump. As the water rose above the water source sensor, the water level sensor for the source bucket changed to 0, as seen on the right.

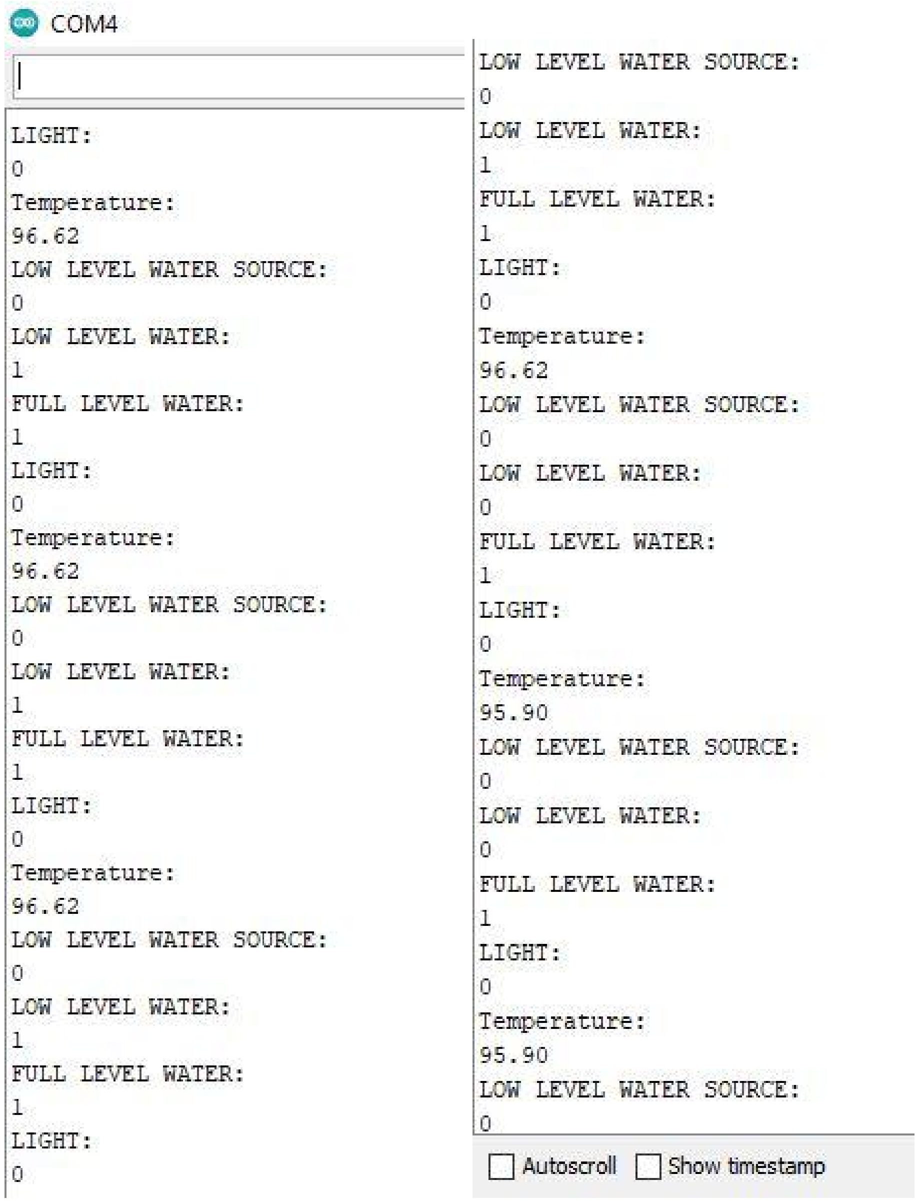



Figure 17: Low Level Sensor Deactivation

Now, the group is filling the trough. As the water goes above the low level sensor, the value changes to 0, as seen on the right screenshot of Figure 17.

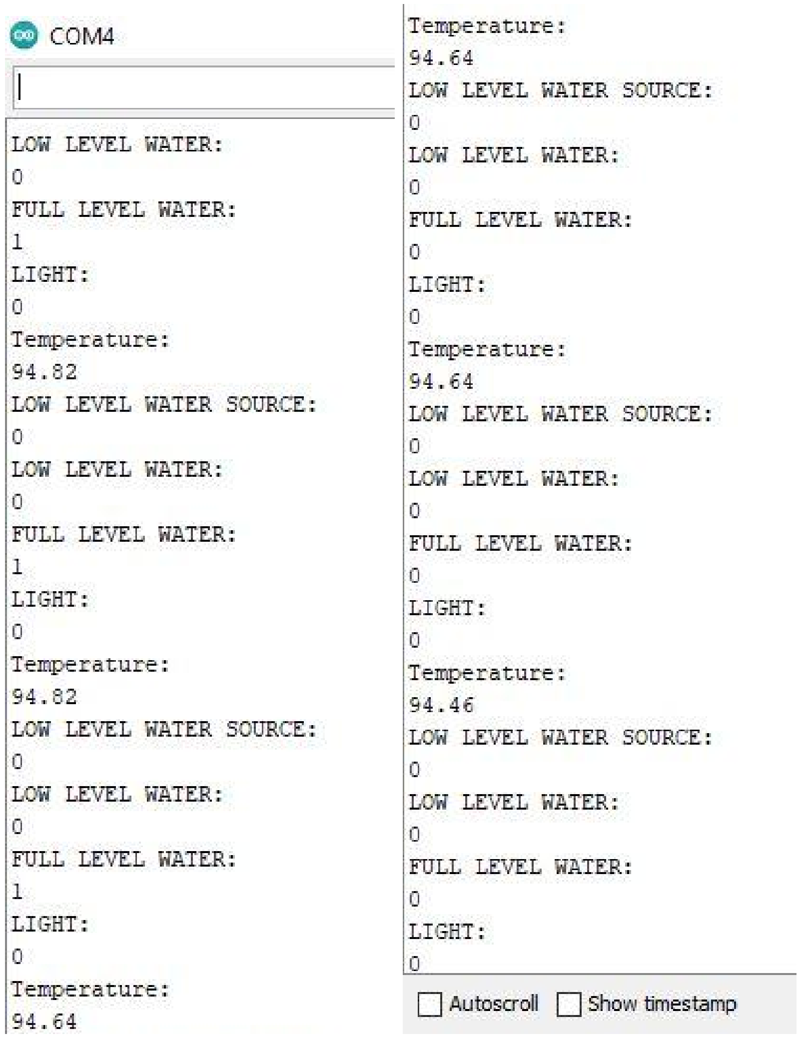



Figure 18: Full Trough Sensor Deactivation

Finally the water level reached the full trough sensor; a value of 0 is shown for the full trough sensor, shown on the right screenshot of Figure 18.

## Expected Findings and Results

The team was expecting to make a display showing how an integrated automatic farm system for the monitoring and care of livestock might work. The team expected the display created to show a simple version of the idea for small farm monitoring and food and water distribution. The display contained the following automated systems: light, surveillance, water, food, and fire detection. The team planned for the display to monitor and report any alerts to a URL website or a phone application for easy monitoring. However, this website or app was to be designed by Austria students. This partnership with the Austria students did not happen. The group had planned on making a simple GUI to allow for monitoring data to be viewed. However with building and testing, the group was not able to build a simple GUI.

The team was expecting the display to show how a simple system would operate. The display should have filled a water trough when the low level water sensor didn't sense water. In addition, the food trough should have been filled at a specific time(s) of day. By the end of the project, the group was able to receive inputs from the water sensors. The mechanical design of the water circuit worked, but the electrical circuit with and without the microcontroller did not work. Also, the food system did not work as intended due to switching microcontrollers. The food system could no longer work on time. So as stated before, the operation was to be activated with the water circuit, which didn't work.

The display was expected to light up when it gets dark and then turn off when there is enough light and manually by switch if needed. However while the input worked, the output for the light did not. It was also expected to monitor temperature and open louvers to simulate the addition of air control or an increase in airflow. Just like the other circuits, the inputs were received correctly, but the outputs were not working as expected. While testing, the Start button was pressed and the water pump and light would automatically turn on. The group was unable to determine if this problem was due to a coding error or a wiring circuit error.

While the outputs didn't operate as expected due to the possible coding and wiring issues, the mechanical design worked flawlessly. The Arduino outputs in relation to the inputs were not working properly. When the Raspberry Pi was deemed inoperable, the group had to use an Arduino Uno. Even after this substitution, the Arduino Uno did not solve all the problems.

In all, the team experienced several challenges with the wiring and testing. The inputs of all the circuits were being received correctly, but none of the outputs were working. The group finished initial building, wiring and testing on March 17th. They had insufficient time to complete troubleshooting of the project.

## Conclusion and Recommendations for Further Study

As stated before, the project was not operational as designed at the end of the semester. The initial work of mounting, wiring, and code writing was completed. As the group moved onto the testing phase, some issues arose with reading the inputs and operation of the outputs. The mechanical circuits worked well, but could be improved on as described later in this section.

With materials being delivered later than expected, the group had a late start on building the project. The model was not completely built and wired until March 17th. It also took longer to build the project than originally planned by the group. The group started testing on March 17th and continued to test and code until the end of the semester. The group had a budget of $1021.34, in which the group was left with $346.

In the future, more testing, preferably in stages system by system, should be performed in order to get the project working as planned. Due to this microcontroller change, the group then had to scrap a few systems and functions, such as the video surveillance and alarms. Without the support of the Austria students, the group did not have a website or app for all the monitoring data and alarms.

In addition to the completion of the project, the group put together a list of improvements and goals to redesign or build upon this project. These improvements and goals are listed as follows:

- redesigning the feeding system to use a solenoid valve instead of a linear actuator;
- motion detection;
- database or server to view past system operation data;
- heater circuit to adjust for cold temperatures;

- prefabricated soldered breadboards for inputs and outputs to ease installation;
- separate power supply to reduce load on microcontroller.

These recommendations for future study will help bring the product closer to mass production and sale.

## References

[1] Fancom, *About Fancom,* Fancom Forward Thinking. Accessed on: October 28, 2020. [Online]. Available: https://www.fancom.com/about-fancom

[2] Fancom, *Total Automation for Sows,* Fancom Forward Thinking. Accessed on: October 28, 2020. [Online]. Available: https://www.fancom.com/pigs/total-automation-for-sows.

[3] K. Kassel, *Most Farmers Receive Off-Farm Income, But Small-Scale Operators Depend On It,* United States Department of Agriculture, November 27, 2019. Accessed on: October 28, 2020. [Online]. Available: https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=58426

[4] USDA, *Tailed Reports,* United States Department of Agriculture, December 10, 2019. Accessed on: October 28, 2020. [Online]. Available: https://my.data.ers.usda.gov/arms/tailored-reports.

[5] *Raspberry Pi 4 Model B+,* Raspberry Pi Foundation. Accessed on: November 18, 2020. [Online]. Available: https://static.raspberrypi.org/files/product-briefs/200521+Raspberry+Pi+4+Product+Brief.pdf.

[6] Drishti Kanjilal, Divyata Singh, Rakhi Reddy, Prof Jimmy Mathew, *Smart Farm: Extending Automation To The Farm Level,* International Journal of Scientific & Technology Research, July 2014. Accessed on: November 14, 2020. [Online]. Available: http://www.ijstr.org/final-print/july2014/Smart-Farm-Extending-Automation-To-The-Farm-Level.pdf.

[7] American Dairy Science Association, American Society of Animal Science, and Poultry Science Association, *Guide for the Care and Use of Agricultural Animals in Research and Teaching,* American Dairy Science Association, American Society of Animal Science, and Poultry Science Association, January 2010. Accessed on: November 18, 2020. [Online]. Available: https://www.asas.org/docs/default-source/default-document-library/ag_guide_3rded.pdf?sfvrsn=c4ed43d1_4.

[8] P. J. Lammers, D. R. Stender, M. S. Honeyman, *Environment Needs of the Pig*. Accessed on: November 18, 2020. [Online]. Available: https://www.ipic.iastate.edu/publications/210.environmentalpigneeds.pdf.

[9] *Ace PLCs,* Velocio Networks, Inc, June 2019. Accessed on: November 21, 2020. [Online]. Available: http://velocio.net/AceDatasheet.pdf.

[10] *Getting Started with the Arduino Uno WiFi,* Arduino, February 2018. Accessed on November 21, 2020. [Online]. Available: https://www.arduino.cc/en/Guide/ArduinoUnoWiFi.

[11] *NSPE Code of Ethics for Engineers,* NSPE National Society of Professional Engineers, 2021. Accessed on April 30, 2021. [Online]. Available: https://www.nspe.org/resources/ethics/code-ethics.

[12] *How to Capture and Display Camera Video with Python on Jetson TX2,* JK Jung's blog, October 2017. Accessed on February 21, 2021. [Online]. Available: https://jkjung-avt.github.io/tx2-camera-with-python/.

[13] Raspberry Pi (Trading) Ltd. "Raspberry Pi 4 Model B," Raspberry Pi 4 Model B, June 2019.

# Appendix A: Meeting Journals

MIAMI UNIVERSITY
REGIONAL LOCATIONS
Hamilton - Middletown - West Chester

Meeting Journal
Department of Engineering Technology
ENT 497/498 - Senior Design Project
Project Title: Automated Livestock Barn

| | | Present |
|---|---|---|
| Advisor: | Mert Bal | [ No ] |
| Student: | Joshua Hashman | [ Yes ] |
| Student: | Michael Wengard | [ Yes ] |
| Student: | Gabryella Law | [ Yes ] |
| Student: | | [ ] |

Meeting Date: 4/21/21
Meeting Locatio Remotely via Zoom

**Topics Discussed**

presentation

poster

**Responsibilities/ Actions Taken**

Team finished presentation slides

Josh is going to work on copying presentation information/figures to poster

Team did a practice run using zoom and going through slides. Team will meet Thursday to record final presentation (couldn't during meeting due to running out of time)

**Next Meeting Date:** 4/22/21 **Locatio** Remotely via Zoom

MIAMI UNIVERSITY
REGIONAL LOCATIONS
Hamilton · Middletown · West Chester

Meeting Journal
Department of Engineering Technology
ENT 497/498 - Senior Design Project
Project Title: Automated Livestock Barn

| | | Present |
|---|---|---|
| Advisor: | Mert Bal | [ No ] |
| Student: | Joshua Hashman | [ Yes ] |
| Student: | Michael Wengard | [ Yes ] |
| Student: | Gabryella Law | [ Yes ] |
| Student: | | [ ] |

| | |
|---|---|
| Meeting Date: | 4/10/21 |
| Meeting Locatio | Remotely via Webex |

**Topics Discussed**

testing
project operation
presentation

**Responsibilities/ Actions Taken**

Team is working collectively to finish up presentation slides to record during weekend or early next week

Gabryella and Michael worked on testing project.
Inputs are coming in correctly, but none of the outputs are working. Gabryella is going to work on testing the outputs without the Arduino Thursday, 4/15.

Michael finished up schematics and physical layouts

Michael and Josh to add to presentation slides.

| | | | |
|---|---|---|---|
| Next Meeting Date: | 4/15/21 | Locatio | Remotely via Webex |

MIAMI UNIVERSITY
REGIONAL LOCATIONS
Hamilton - Middletown - West Chester

**Meeting Journal**
**Department of Engineering Technology**
**ENT 497/498 - Senior Design Project**
**Project Title:** Automated Livestock Barn

| | | Present |
|---|---|---|
| **Advisor:** | **Mert Bal** | [ No ] |
| **Student:** | **Joshua Hashman** | [ Yes ] |
| **Student:** | **Michael Wengard** | [ Yes ] |
| **Student:** | **Gabryella Law** | [ Yes ] |
| **Student:** | | [ ] |

**Meeting Date:** 3/25/21 & 3/27/21
**Meeting Location:** In person

**Topics Discussed**

testing code with wiring
updating code
coding first trial of water circuit & testing with sensors
downloading libraries for raspberry pi

**Responsibilities/ Actions Taken**

Josh and Gabryella met on Thursday to use a test button and LED breadboard to test the code
none of it worked but it was discovered after meeting that the pin set up was incorrect

some libraries had fatal error and were unable to download and install
looking into why this happened to see if we can download the libraries for the camera so that we can use it in the project. if unable to figure out and get installed camera will not be operational for project

group was informed while testing Saturday that the raspberry pi is only digital and can't receive analog inputs just like an arduino. group needs to figure out how to get raspberry pi to read the analog signals through wiring/code through items they already possess

we think none of the inputs registered and we are unsure if we can get things fixed in time to have a working project by presentation time.

all major wiring is finished. only wiring is directly linked to the breadboard of the raspberry pi to wire into the GPIO pins
this work will only take about 1 hr tops. code needs fixed. analog inputs to raspberry pi need to be reconfigured

**Next Meeting Date:** **4/1/21** **Locatioi** Remotely via Webex

MIAMI UNIVERSITY
REGIONAL LOCATIONS
*Hamilton · Middletown · West Chester*

**Meeting Journal**
**Department of Engineering Technology**
**ENT 497/498 - Senior Design Project**
**Project Title:** Automated Livestock Barn

| | | Present |
|---|---|---|
| **Advisor:** | **Mert Bal** | **[ No ]** |
| **Student:** | **Joshua Hashman** | [ Yes ] |
| **Student:** | **Michael Wengard** | [ Yes ] |
| **Student:** | **Gabryella Law** | [ Yes ] |
| **Student:** | | **[ ]** |

| | |
|---|---|
| **Meeting Date:** | 3/11/21 |
| **Meeting Locatioi** | Remotely via Webex |

**Topics Discussed**

code
mounting equipment
wiring
testing

**Responsibilities/ Actions Taken**

Team decided they will meet 3/27/21 to test code and wiring. Team will hook up all sensors to raspberry pi and outputs to a test LED llight breadboard.

Gabryella researched GUI application with Python code. She also completed a wiring diagram for needed power sources and minor wiring that isn't shown in existing schematic diagrams. Gabryella also started wiring on 120VAC circuits and got latching start-stop circuit wired and tested.

Michael mounted both liquid sensors and second linear actuator for feed circuit. Michael started wiring on liquid sensors and linear actuators.

Josh is continuing to work on code. Meeting to review code to be set in preparation for 3/27/21.

| | | | |
|---|---|---|---|
| **Next Meeting Date:** | **3/25/21** | **Locatioi** | Remotely via Webex |

MIAMI UNIVERSITY
REGIONAL LOCATIONS
Hamilton - Middletown - West Chester

**Meeting Journal**
**Department of Engineering Technology**
**ENT 497/498 - Senior Design Project**
**Project Title:** Automated Livestock Barn

| | | Present |
|---|---|---|
| **Advisor:** | **Mert Bal** | [ No ] |
| **Student:** | **Joshua Hashman** | [ Yes ] |
| **Student:** | **Michael Wengard** | [ No ] |
| **Student:** | **Gabryella Law** | [ Yes ] |
| **Student:** | | [ ] |

**Meeting Date:** 3/5/21
**Meeting Locatio** Remotely via Webex

**Topics Discussed**

code
wiring
inputs/outputs

Michael was unable to attend meeting but we discussed things that needed worked on for the model. Some adjustments that need to be made to the enclosure were discussed.

**Responsibilities/ Actions Taken**

Josh and Gabryella discussed code and went through the current code Josh had written. Adjustments were made to light circuit to remove code that did not apply to what we are doing in the project.

Gabryella will be making a wiring diagram for the project so that she can plan exactly how she is going to wire with the large amount of circuits. It was determined wiring on the spot was not a solid option and should be avoided.

Michael is going to continue to finish mounting equipment with Gabryella's guidance to ensure wireability.

**Next Meeting Date:** 3/11/21 **Locatio** Remotely via Webex

MIAMI UNIVERSITY
REGIONAL LOCATIONS
Hamilton · Middletown · West Chester

Meeting Journal
Department of Engineering Technology
ENT 497/498 - Senior Design Project
Project Title: Automated Livestock Barn

| | | Present |
|---|---|---|
| Advisor: | Mert Bal | [ No ] |
| Student: | Joshua Hashman | [ Yes ] |
| Student: | Michael Wengard | [ Yes ] |
| Student: | Gabryella Law | [ Yes ] |
| Student: | | [ ] |

| | |
|---|---|
| Meeting Date: | N/A |
| Meeting Locatio | Remotely via Webex |

**Topics Discussed**

No Webex meeting was held due to conflicting schedules this past week. However we did communicate through text message

set up meeting for review of code

liquid level sensor circuit testing
fire detector circuit with a 5V relay for alarm testing
wiring of model
additional mounting equipment

**Responsibilities/ Actions Taken**

Josh received video camera to set up with Raspberry Pi and gave liquid level sensors to Gabryella. Josh shared updated code. Team is going to review code on Friday

Gabryella worked on Start-stop button circuit and power needs for project. She is going to wire everything early next week.

Michael is mounting electromechanical relay, and term block that Gabryella had for testing.
Gabryella will finish testing this week and give Michael the rest of the equipment to mount.
He will also work on finishing the food system linear actuator mechanical setup.

| | | | |
|---|---|---|---|
| Next Meeting Date: | 3/5/21 | Locatio | Remotely via Webex |

MIAMI UNIVERSITY
REGIONAL LOCATIONS
Hamilton - Middletown - West Chester

Meeting Journal
Department of Engineering Technology
ENT 497/498 - Senior Design Project
Project Title: Automated Livestock Barn

| | | Present |
|---|---|---|
| Advisor: | Mert Bal | [ No ] |
| Student: | Joshua Hashman | [ Yes ] |
| Student: | Michael Wengard | [ Yes ] |
| Student: | Gabryella Law | [ Yes ] |
| Student: | | [ ] |

| | |
|---|---|
| Meeting Date: | 2/18/21 |
| Meeting Locatio | Remotely via Webex |

Topics Discussed

coding
wiring
electrical testing
feed system mounting and louver linear actuator

Responsibilities/ Actions Taken

Josh is continuing work on code. Finishing basic codes such as pin designations and initial pin output states

Gabryella is working on duplicating linear actuator circuit and wiring electrical components

Michael is finishing mounting for food system equipment and working on developing mount for linear actuator for louver

| | | | |
|---|---|---|---|
| Next Meeting Date: | 2/25/21 | Locatio | Remotely via Webex |

**Meeting Journal**
**Department of Engineering Technology**
**ENT 497/498 - Senior Design Project**
**Project Title:** Automated Livestock Barn

| | | Present |
|---|---|---|
| **Advisor:** | **Mert Bal** | [ No ] |
| **Student:** | **Joshua Hashman** | [ Yes ] |
| **Student:** | **Michael Wengard** | [ Yes ] |
| **Student:** | **Gabryella Law** | [ Yes ] |
| **Student:** | | [ ] |

| | |
|---|---|
| **Meeting Date:** | 2/11/21 |
| **Meeting Locatio** | Remotely via Webex |

**Topics Discussed**

code diagrams
linear actuator, fire detector, and photo sensor circuits
enclosure layout
mounting and testing equipment

**Responsibilities/ Actions Taken**

Josh is finalizing code diagrams and breadboard test wiring

Gabryella will check Josh's test wiring and work on testing the different circuits listed above
She will get current and voltage values for the different circuits to calculate needed fusing
and load additions to reduce current load on raspberry pi inputs and outputs

Michael and Gabryella worked together to lay out enclosure

Michael drafted up preliminary layout of electrical enclosure for future mounting and wiring
Michael is working on testing water pump and mounting of food system equipment

| | | | |
|---|---|---|---|
| **Next Meeting Date:** | **2/18/21** | **Locatio** | Remotely via Webex |

MIAMI UNIVERSITY
REGIONAL LOCATIONS
Hamilton · Middletown · West Chester

Meeting Journal
Department of Engineering Technology
ENT 497/498 - Senior Design Project
Project Title: Automated Livestock Barn

| | | Present |
|---|---|---|
| Advisor: | Mert Bal | [ No ] |
| Student: | Joshua Hashman | [ Yes ] |
| Student: | Michael Wengard | [ Yes ] |
| Student: | Gabryella Law | [ Yes ] |
| Student: | | [ ] |

| | |
|---|---|
| Meeting Date: | 2/4/21 |
| Meeting Locatioi | Remotely via Webex |

**Topics Discussed**

Code
Raspberry Pi wiring
Physical model layout
Fire detection, light, and louver circuit tests

**Responsibilities/ Actions Taken**

Michael will revise physical model layout and get approval. Once approved he will start mounting equipment to model. Michael will look into electrical conduit for ordering.

Josh is building a test breadboard to test outputs of Raspberry Pi and start coding

Gabryella will test fire detection, light, and louver circuits using an arduino and multimeter to provide data to Josh for coding

| | | | |
|---|---|---|---|
| Next Meeting Date: | 2/11/21 | Locatioi | Remotely via Webex |

MIAMI UNIVERSITY
REGIONAL LOCATIONS
Hamilton · Middletown · West Chester

Meeting Journal
Department of Engineering Technology
ENT 497/498 - Senior Design Project
Project Title: Automated Livestock Barn

| | | Present |
|---|---|---|
| Advisor: | Mert Bal | [ No ] |
| Student: | Joshua Hashman | [ Yes ] |
| Student: | Michael Wengard | [ Yes ] |
| Student: | Gabryella Law | [ Yes ] |
| Student: | | [ ] |

| | |
|---|---|
| Meeting Date: | 1/28/21 |
| Meeting Locatioı | Remotely via Webex |

**Topics Discussed**

coding
physical model layout
webpage/app interface
electrical schematics

**Responsibilities/ Actions Taken**

Josh will start working on code for systems
Michael will finalize physical model layout and have teammates review before mounting any equipment

Gabryella is working on testing electrical systems with Arduino Uno as input/output to gather voltage/current values for coding and to verify schematic design

| | | | |
|---|---|---|---|
| Next Meeting Date: | 2/5/21 | Locatioı | Remotely via Webex |

MIAMI UNIVERSITY
REGIONAL LOCATIONS
Hamilton · Middletown · West Chester

**Meeting Journal**
**Department of Engineering Technology**
**ENT 497/498 - Senior Design Project**
**Project Title:** Automated Livestock Barn

| | | Present |
|---|---|---|
| **Advisor** | **Mert Bal** | [ No ] |
| **Student** | **Joshua Hashman** | [ Yes ] |
| **Student** | **Michael Wengard** | [ Yes ] |
| **Student** | **Gabryella Law** | [ Yes ] |
| **Student:** | | [ ] |

| | |
|---|---|
| **Meeting Date:** | 11/13/20 |
| **Meeting Locatio** | Remotely via Webex |

**Topics Discussed**

oral presentation sections
final report sections
raspberry pi
material

**Responsibilities/ Actions Taken**

Josh will be in charge of the following:
Raspberry Pi, programming, and watering and feeding systems on oral presentation
Scope and methodology on systems Josh is responsible for as mentioned before in final report

Michael will be in charge of the following:
Objective, Scope and Methodology, Temperature control, and fire detection in oral presentation
Scope and methodology on systems Michael is responsible for and conclusion in final report

Gabryella will be in charge of the following:
Justification, past project slide, control device options, lighting, video system and monitoring and alarm slide in oral presentation
Executive summary, basic final report layout, scope and methodology on systems Gabryella is in charge of in final report

| | | | |
|---|---|---|---|
| **Next Meeting Date:** | **TBD** | **Locatior** | Remotely via Webex |

MIAMI UNIVERSITY
REGIONAL LOCATIONS
Hamilton · Middletown · West Chester

**Meeting Journal**
**Department of Engineering Technology**
**ENT 497/498 - Senior Design Project**
**Project Title:** Automated Livestock Barn

| | | Present |
|---|---|---|
| **Advisor** | **Mert Bal** | [ No ] |
| **Student** | **Joshua Hashman** | [ Yes ] |
| **Student** | **Michael Wengard** | [ Yes ] |
| **Student** | **Gabryella Law** | [ Yes ] |
| **Student:** | | [ ] |

| | |
|---|---|
| **Meeting Date:** | 11/5/20 |
| **Meeting Locatio** | Remotely via Webex |

**Topics Discussed**

Engineering ethics assignment
Final paper
Oral presentation
Raspberry pi
CAD files for design

**Responsibilities/ Actions Taken**

Team members are finishing their parts in the engineering ethics assignment
Gabryella Law submitted Armin Fleck Scholarship application to Mert for review
Michael is finishing CAD files for design to review and finalize
Gabryella working on executive summary and transferring scope and methodology topics to final report
Gabryella setting up presentation slides for group to fill in
Josh working on code for Raspberry Pi
Michael and Gabryella working on parts of final paper/presentation

| | | | |
|---|---|---|---|
| **Next Meeting Date:** | **11/12/20** | **Locatio** | Remotely via Webex |

MIAMI UNIVERSITY
REGIONAL LOCATIONS
Hamilton - Middletown - West Chester

**Meeting Journal**
**Department of Engineering Technology**
**ENT 497/498 - Senior Design Project**
**Project Title:** Automated Livestock Barn

| | | Present |
|---|---|---|
| **Advisor** | **Mert Bal** | [ No ] |
| **Student** | **Joshua Hashman** | [ Yes ] |
| **Student** | **Michael Wengard** | [ Yes ] |
| **Student** | **Gabryella Law** | [ Yes ] |
| **Student:** | | [ ] |

**Meeting Date:** 10/30/20
**Meeting Locatio** Remotely via Webex

**Topics Discussed**

scholarship application
engineering ethics assignment
final paper and presentation

**Responsibilities/ Actions Taken**

Michael Wengard working on final comments of scholarship application
Josh requested Raspberry Pi from Mert Bal
Group picked NSPE Case for engineering ethics assignment
Michael to do summary of case and one code relation
Josh to write about two code relations to case
Gabryella to write "what would you do" section of case report
Group to start looking at final paper requirements and make notes
Plan to start final paper in the next few weeks

**Next Meeting Date:** 11/6/20 **Locatio** Remotely via Webex

MIAMI UNIVERSITY
REGIONAL LOCATIONS
Hamilton - Middletown - West Chester

**Meeting Journal**
**Department of Engineering Technology**
**ENT 497/498 - Senior Design Project**
**Project Title:** Automated Livestock Barn

| | | Present |
|---|---|---|
| **Advisor:** | **Mert Bal** | [ No ] |
| **Student:** | **Joshua Hashman** | [ Yes ] |
| **Student:** | **Michael Wengard** | [ Yes ] |
| **Student:** | **Gabryella Law** | [ Yes ] |
| **Student:** | | [ ] |

| | |
|---|---|
| **Meeting Date:** | 10/23/20 |
| **Meeting Location:** | Remotely via Webex |

**Topics Discussed**

project proposal revision
Armin Fleck Scholarship
Raspberry Pi coding

**Responsibilities/ Actions Taken**

Michael and Gabryella to work on finishing filling out scholarship application
Josh to request Raspberry Pi from Mert Bal so that he can start working on code and testing it for production in the next semester

**Next Meeting Date:** 10/30/20 **Locatior** Remotely via Webex

MIAMI UNIVERSITY
REGIONAL LOCATIONS
*Hamilton - Middletown - West Chester*

**Meeting Journal**
**Department of Engineering Technology**
**ENT 497/498 - Senior Design Project**
**Project Title:** Automated Livestock Barn

| | | Present |
|---|---|---|
| **Advisor** | **Mert Bal** | [ Yes ] |
| **Student** | **Joshua Hashman** | [ Yes ] |
| **Student** | **Michael Wengard** | [ Yes ] |
| **Student** | **Gabryella Law** | [ Yes ] |
| **Student:** | | [ ] |

**Meeting Date:** 10/15/20
**Meeting Locatioı** Remotely via Webex

**Topics Discussed**

project proposal rough draft
raspberry pi code research
electrical codes and standards
Armin Fleck scholarship application
Meeting with Austria students

**Responsibilities/ Actions Taken**

Michael is going to start filling out the scholarship application
Josh is going to research raspberry pi code, take notes, and report it to team members in following week
Gabryella is going to research electrical codes and standards to see what codes the group needs to abide by for the project construction as if it was a retailed product
Mert goes over rough draft of project proposal with students
Meeting with Austria to be near end of October (still to be determined)
Michael is going to try to get started drafting up CAD drawings for existing developed schematics

Gabryella fixing timeline to match dates for project submittal in proposal
Team to brainstorm on more information for the justification of the project

**Next Meeting Date:** **10/23/20** **Locatioı** Remotely via Webex

MIAMI UNIVERSITY
REGIONAL LOCATIONS
Hamilton - Middletown - West Chester

**Meeting Journal**
**Department of Engineering Technology**
**ENT 497/498 - Senior Design Project**
**Project Title:** Automated Livestock Barn

| | | Present |
|---|---|---|
| **Advisor:** | **Mert Bal** | **[ No ]** |
| **Student:** | **Joshua Hashman** | **[ Yes ]** |
| **Student:** | **Michael Wengard** | **[ Yes ]** |
| **Student:** | **Gabryella Law** | **[ Yes ]** |
| **Student:** | | **[ ]** |

| | |
|---|---|
| **Meeting Date:** | 10/9/20 |
| **Meeting Locatio** | Remotely via Webex |

**Topics Discussed**

Project Proposal sections
Future construction
Timeline
Material already obtained
Rough draft for Mert

**Responsibilities/ Actions Taken**

Michael is reviewing Josh's material and schematics
Gabryella is reviewing Michael's material and schematics
Josh is reviewing Gabryella's material and schematics

Feedback to be given during weekend to allow for updates to project proposal before submission

Gabryella Law writing final comments
Michael and Josh reviewing and updating objective, justification, and final comments

Sending rough draft to Mert on either Monday or Tuesday next week
Finished Step by Step Plan and Timeline

| | | | |
|---|---|---|---|
| **Next Meeting Date:** | **10/16/20** | **Locatio** | Remotely via Webex |

MIAMI UNIVERSITY
REGIONAL LOCATIONS
Hamilton - Middletown - West Chester

**Meeting Journal**
**Department of Engineering Technology**
**ENT 497/498 - Senior Design Project**
**Project Title:** Automated Livestock Barn

| | | Present |
|---|---|---|
| **Advisor:** | **Mert Bal** | [ No ] |
| **Student:** | **Joshua Hashman** | [ Yes ] |
| **Student:** | **Michael Wengard** | [ Yes ] |
| **Student:** | **Gabryella Law** | [ Yes ] |
| **Student:** | | [ ] |

| | |
|---|---|
| **Meeting Date:** | 10/2/20 |
| **Meeting Locatio** | Remotely via Webex |

**Topics Discussed**

Progression of project while Gabryella Law was gone
Project proposal
Additional research
Justification
How to account for "donated" or "recycled" materials

**Responsibilities/ Actions Taken**

Fill out cost section of proposal
Enter additional tasks
Review Gannet Chart
Michael is going to draft schematics through CAD
Research for similar products
Gabryella Law to write in basic thoughts on justification

| | | | |
|---|---|---|---|
| **Next Meeting Date:** | 10/9/20 | **Locatio** | Remotely via Webex |

MIAMI UNIVERSITY
REGIONAL LOCATIONS
Hamilton - Middletown - West Chester

**Meeting Journal**
**Department of Engineering Technology**
**ENT 497/498 - Senior Design Project**
**Project Title:** Automated Livestock Barn

| | | Present |
|---|---|---|
| **Advisor** | **Mert Bal** | **[ No ]** |
| **Student** | **Joshua Hashman** | **[ No ]** |
| **Student** | **Michael Wengard** | **[ No ]** |
| **Student** | **Gabryella Law** | **[ No ]** |
| **Student:** | | **[ ]** |

**Meeting Date:** N/A
**Meeting Locatio** Remotely via Webex

**Topics Discussed**

schematics to be done
Microsoft Project/Jira
New team meeting time

**Responsibilities/ Actions Taken**

Due to changes in team member schedules, the meeting set for Tuesday, Sept. 29th was not able to happen. Team members are meeting Friday, October 2nd instead. Messages were exchanged about team member availablility and project status. Step by Step Plan was filled out and needs to be reviewed/edited for project proposal.

**Next Meeting Date:** **10/2/20** **Locatio** Remotely via Webex

**Meeting Journal**
**Department of Engineering Technology**
**ENT 497/498 - Senior Design Project**
**Project Title:** Automated Livestock Barn

MIAMI UNIVERSITY
REGIONAL LOCATIONS
*Hamilton - Middletown - West Chester*

| | | Present |
|---|---|---|
| **Advisor** | **Mert Bal** | **[ No]** |
| **Student** | **Joshua Hashman** | **[Yes]** |
| **Student** | **Michael Wengard** | **[Yes]** |
| **Student** | **Gabryella Law** | **[ No]** |
| **Student:** | | **[ ]** |

| | |
|---|---|
| **Meeting Date:** | 9/22/20 |
| **Meeting Locatio** | Remotely via Webex |

**Topics Discussed**

Schematics that have been created/still need created
Potentially moving forward with Jira
Display style (plywood display)

**Responsibilities/ Actions Taken**

Finish schemtaics by Saturday
Continue filling out proposal where possible
Continue filling out step by step plan
Start creating CAD files for component schematics
Research Jira tutorials
Add terminal strips, breadboards, and power supplies to materials list
Edit research documents to match current plan

**Next Meeting Date: 9/29/20** **Locatio** Remotely via Webex

MIAMI UNIVERSITY
REGIONAL LOCATIONS
*Hamilton · Middletown · West Chester*

**Meeting Journal**
**Department of Engineering Technology**
**ENT 497/498 - Senior Design Project**
**Project Title:** Automated Livestock Barn

| | | Present |
|---|---|---|
| **Advisor** | **Mert Bal** | **[ No ]** |
| **Student** | **Joshua Hashman** | **[ Yes ]** |
| **Student** | **Michael Wengard** | **[ Yes ]** |
| **Student** | **Gabryella Law** | **[ Yes ]** |
| **Student:** | | **[ ]** |

| | |
|---|---|
| **Meeting Date:** | 9/15/202 |
| **Meeting Locatio** | Remotely via Webex |

**Topics Discussed**

Basic summary and expectations to send to Austria Students

Step by Step plan
Schedule

Component Research and basic schematics

**Responsibilities/ Actions Taken**

Setup Google Drive file shared folder
Started Step by Step plan
Started Project Proposal

Completed basic summary and expectations for Austria Students
View tutorials on how to use Microsoft Projects

Research Microsoft Project version on Google Drive for easy team collaboration

| | | | |
|---|---|---|---|
| **Next Meeting Date:** | **9/22/2020** | **Locatio** | Remotely via Webex |

MIAMI UNIVERSITY
REGIONAL LOCATIONS
*Hamilton - Middletown - West Chester*

**Meeting Journal**
**Department of Engineering Technology**
**ENT 497/498 - Senior Design Project**
**Project Title:** Automated Livestock Barn

| | | Present |
|---|---|---|
| **Advisor** | **Mert Bal** | **[ No ]** |
| **Student** | **Joshua Hashman** | **[ Yes ]** |
| **Student** | **Michael Wengard** | **[ Yes ]** |
| **Student** | **Gabryella Law** | **[ Yes ]** |
| **Student:** | | **[ ]** |

**Meeting Date:**
**Meeting Locatio** Remotely via Webex

**Topics Discussed**

Microprocessor/PLC platform
Scheduling tool
System research discussed
Canvas group site
Past PLC project info

**Responsibilities/ Actions Taken**

Raspberry Pi for interface of systems and monitoring
Sign up for Jira scheduling site
Gabryella Law to start setting up schedule in Jira
Team members to put research in Canvas group page

Talk to Mert about AutoDesk Electrical and other software access for designing schematics

Michael and Gabryella uploading documents from PLC project at Zane State to Canvas group page

More research needed into venting system (temp control) and motion/video system

**Next Meeting Date:** **9/15/2020** **Locatio** Remotely via Webex

MIAMI UNIVERSITY
REGIONAL LOCATIONS
Hamilton - Middletown - West Chester

**Meeting Journal**
**Department of Engineering Technology**
**ENT 497/498 - Senior Design Project**
**Project Title:** Automated Livestock Barn

| | | Present |
|---|---|---|
| **Advisor** | **Mert Bal** | **[ No ]** |
| **Student** | **Joshua Hashman** | **[ Yes ]** |
| **Student** | **Michael Wengard** | **[ Yes ]** |
| **Student** | **Gabryella Law** | **[ Yes ]** |
| **Student:** | | **[ ]** |

**Meeting Date:**
**Meeting Locatio** Remotely via Webex

**Topics Discussed**

Higher detail on functions for project
Does the team want to have an app/webpage made by Austria students?
Design from scratch or buy off shelf
Project Proposal paper

**Responsibilities/ Actions Taken**

Research (parts, spec sheets, price):
Fire System - Michael Wengard
Water System - Josh Hashman
Food System - Josh Hashman
Temperature Control - Michael Wengard
Lights - Gabryella Law
Video/Motion - Gabryella Law
Power sources - every person on team

Research until 9/21/20
Start Proposal 9/22/20

Discuss with Mert on where to purchase PLC/basic electrical equipment

What responsibility will we hold if webpage/app does not work at end of project?

**Next Meeting Date:** **9/8/2020** **Locatio** Remotely via Webex

MIAMI UNIVERSITY
REGIONAL LOCATIONS
Hamilton · Middletown · West Chester

**Meeting Journal**
**Department of Engineering Technology**
**ENT 497/498 - Senior Design Project**
**Project Title:** Automated Livestock Barn

| | | Present |
|---|---|---|
| **Advisor** | **Mert Bal** | [ No ] |
| **Student** | **Joshua Hashman** | [ Yes ] |
| **Student** | **Michael Wengard** | [ Yes ] |
| **Student** | **Gabryella Law** | [ Yes ] |
| **Student:** | | [ ] |

| | |
|---|---|
| **Meeting Date:** | 8/25/202 |
| **Meeting Locatio** | Remote over Webex |

**Topics Discussed**

Communication
Webex meeting for weekly group meetings
Possible project ideas: Automated Livestock Barn

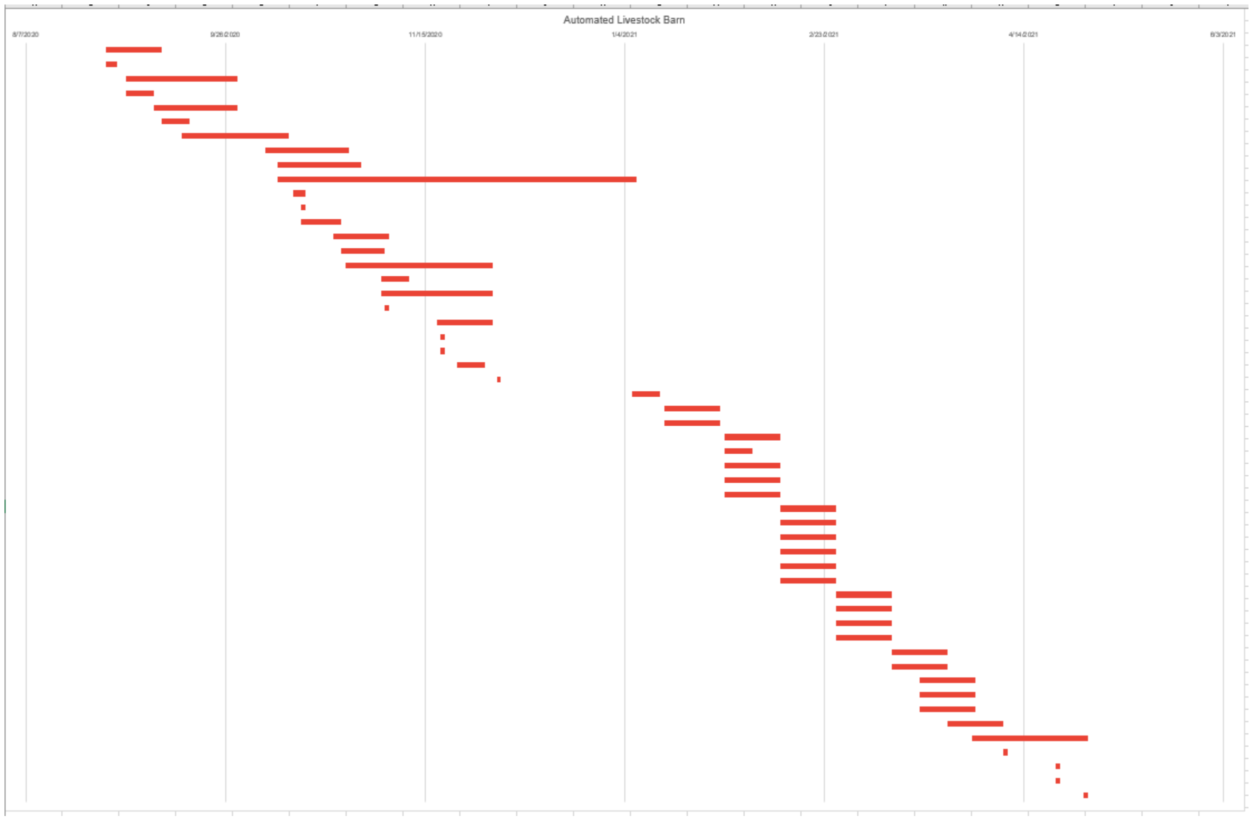
**Responsibilities/ Actions Taken**

Gabryella Law named group leader
Student are testing out different platforms for efficient communication
Webex meeting created for weekly collaboration of group outside of class
Project of an Automated Livestock Barn brought up by member of team
List of functions and questions for proposed project started

| | | | |
|---|---|---|---|
| **Next Meeting Date:** | 9/1/2020 | **Locatior** | Remote over Webex |

## Appendix B: Gantt Chart and Tasks

| | **Automated Livestock Barn** | | | |
|---|---|---|---|---|
| **Task** | | **Start Date** | **Duration** | **Assignments** |
| 1 | Pick project for research and proposal | 8/27/2020 | 14 | Group |
| 2 | Setup regular team meetings and communication | 8/27/2020 | 3 | Gabryella Law |
| 3 | Research components for project systems (i.e. part numbers, data sheets, price, shipping time) | 9/1/2020 | 28 | Group |
| 4 | Setup basic guidelines for collaboration with Austria Students | 9/1/2020 | 7 | Group |
| 5 | Develop a budget based on parts research | 9/8/2020 | 21 | Group |
| 6 | Setup file sharing for team collaboration | 9/10/2020 | 7 | Group |
| 7 | Develop a timeline for project milestones and completion | 9/15/2020 | 27 | Group |
| 8 | Start electrical schematic design for project systems | 10/6/2020 | 21 | Group |
| 9 | Start mechanical design for project systems | 10/9/2020 | 21 | Group |
| 10 | Research and learn Raspberry Pi Programming Language | 10/9/2020 | 90 | Group |
| 11 | Submit rough draft of proposal to Advisor | 10/13/2020 | 3 | Gabryella Law |
| 12 | Submit project proposal to Advisor for approval | 10/15/2020 | 1 | Gabryella Law |
| 13 | Await approval/denial on project proposal from Advisor | 10/15/2020 | 10 | Mert Bal |
| 14 | Meet with Austria students to start project collaboration | 10/23/2020 | 14 | Group, Mert Bal |
| 15 | Start application for Armin Fleck scholarship | 10/25/2020 | 11 | Group |
| 16 | Start Final Report | 10/26/2020 | 37 | Group |
| 17 | Finalize and draft barn model and microprocessor control box physical layout designs | 11/4/2020 | 7 | Michael Wengard |
| 18 | Start developing preliminary coding for the different systems | 11/4/2020 | 28 | Josh Hashman, Gabryella Law |
| 19 | Submit application for Armin Fleck scholarship | 11/5/2020 | 1 | Gabryella Law |
| 20 | Begin ordering parts for the project | 11/18/2020 | 14 | Group |
| 21 | End of Semester Presentation | 11/19/2020 | 1 | Group |
| 22 | Complete any additional research for project | 11/19/2020 | 1 | Group |
| 23 | Submit rough draft of final report for review | 11/23/2020 | 7 | Group |
| 24 | Submit Semester Final report | 12/3/2020 | 1 | Group |
| 25 | Start physical building of barn model and microprocessor control box | 1/6/2021 | 7 | Michael Wengard |
| 26 | Mount light, temperature control, fire detection, and camera systems | 1/14/2021 | 14 | Group |
| 27 | Assemble and mount food and water systems | 1/14/2021 | 14 | Group |
| 28 | Setup Raspberry Pi power supply, breadboard, and WIFI connection | 1/29/2021 | 14 | Group |
| 29 | Wire needed power requirements to microprocessor control box and barn model | 1/29/2021 | 7 | Group |
| 30 | Wire and program Temperature control circuit | 1/29/2021 | 14 | Group |
| 31 | Test Temperature control circuit | 1/29/2021 | 14 | Group |
| 32 | Communicate with Austria students on design constraints and information transmission | 1/29/2021 | 14 | Group |
| 33 | Wire and program lighting circuit | 2/12/2021 | 14 | Group |
| 34 | Test lighting circuit | 2/12/2021 | 14 | Group |
| 35 | Wire and program food system | 2/12/2021 | 14 | Group |
| 36 | Test food system | 2/12/2021 | 14 | Group |
| 37 | Wire and program water system | 2/12/2021 | 14 | Group |
| 38 | Test water system | 2/12/2021 | 14 | Group |
| 39 | Wire and program security camera system | 2/26/2021 | 14 | Group |
| 40 | Test security camera system | 2/26/2021 | 14 | Group |
| 41 | Wire and program fire detection circuit | 2/26/2021 | 14 | Group |
| 42 | Test alarm notifications for fire detection | 2/26/2021 | 14 | Group |
| 43 | Run series of tests for the various systems | 3/12/2021 | 14 | Group |
| 44 | Troubleshoot and adjust wiring/programming for any problems | 3/12/2021 | 14 | Group |
| 45 | Test app/webpage interface with Raspberry Pi and security cameras | 3/19/2021 | 14 | Group |
| 46 | Communicate with Austria students any problems | 3/19/2021 | 14 | Group |
| 47 | Troubleshoot with Austria students on any problems | 3/19/2021 | 14 | Group |
| 48 | Retest systems and WIFI remote monitoring/user input | 3/26/2021 | 14 | Group |
| 49 | Write final report on planning, design, and results | 4/1/2021 | 29 | Group |
| 50 | Have project completed | 4/9/2021 | 1 | Group |
| 51 | Transport project for Senior Design Day at Miami University Hamilton campus | 4/22/2021 | 1 | Group |
| 52 | Set up project for display and present project | 4/22/2021 | 1 | Group |
| 53 | Submit final report | 4/29/2021 | 1 | Gabryella Law |


Automated Livestock Barn
8/7/2020
9/26/2020
11/15/2020
1/4/2021
2/23/2021
4/14/2021
6/3/2021

## Appendix C: Detailed Proposal

***Miami University***
***School of Engineering & Applied Science***
***Department of Engineering Technology***

***ENT 497/498***
***Senior Project***

***Title:*** Automated Livestock Barn for Animal Care and Monitoring

***Team Members:*** Michael Wengard, Joshua Hashman, Gabryella Law

***Advisors Name:*** Mert Bal

***Advisor's Signature*** ***Date***

***Supporting Company:*** Team Members, University through Armin Fleck Scholarship

***Objective:*** The students are developing a product to monitor and automatically care for livestock in small scale to large scale farming operations. The Automated Livestock Barn will feed and water the animals automatically. It will allow for temperature control of a livestock barn with fire detection and video monitoring. All information will be sent to a webpage/app through WIFI connection from the Raspberry Pi microprocessor. In case of emergency, the user of the system will be notified through the webpage/app and prompted to view the video surveillance.

***Justification or Applicability:*** Currently in the industry, there are numerous products for feeding and watering livestock in large scale farming operations. Through research, it was not discovered a system that did all the monitoring and automated systems as specified in this project. This automated barn system can help ease the burden of the everyday small operation farmer. But, this system isn't limited to small operations. The microprocessor product can be added onto as the needs of the farming operation grow.

***Miami University***
***School of Engineering & Applied Science***
***Department of Engineering Technology***

***ENT 497/498***
***Senior Project***

***Step by Step Plan:***

1. Pick project for research and proposal
2. Setup regular team meetings and communication
3. Research components for project systems (i.e. part numbers, data sheets, price, shipping time)
4. Setup basic guidelines for collaboration with Austria Students
5. Develop a budget based on parts research
6. Setup file sharing for team collaboration
7. Develop a timeline for project milestones and completion
8. Start electrical schematic design for project systems
9. Start mechanical design for project systems
10. Research and learn Raspberry Pi Programming Language
11. Submit rough draft of proposal to Advisor
12. Submit project proposal to Advisor for approval
13. Await approval/denial on project proposal from Advisor
14. Meet with Austria students to start project collaboration
15. Start application for Armin Fleck scholarship
16. Start Final Report
17. Finalize and draft barn model and microprocessor control box physical layout designs
18. Start developing preliminary coding for the different systems
19. Submit application for Armin Fleck scholarship
20. Begin ordering parts for the project
21. End of Semester Presentation
22. Complete any additional research for project
23. Submit rough draft of final report for review
24. Submit Semester Final report
25. Start physical building of barn model and microprocessor control box
26. Mount light, temperature control, fire detection, and camera systems
27. Assemble and mount food and water systems
28. Setup Raspberry Pi power supply, breadboard, and WIFI connection
29. Wire needed power requirements to microprocessor control box and barn model
30. Wire and program Temperature control circuit
31. Test Temperature control circuit
32. Communicate with Austria students on design constraints and information transmission
33. Wire and program lighting circuit
34. Test lighting circuit
35. Wire and program food system

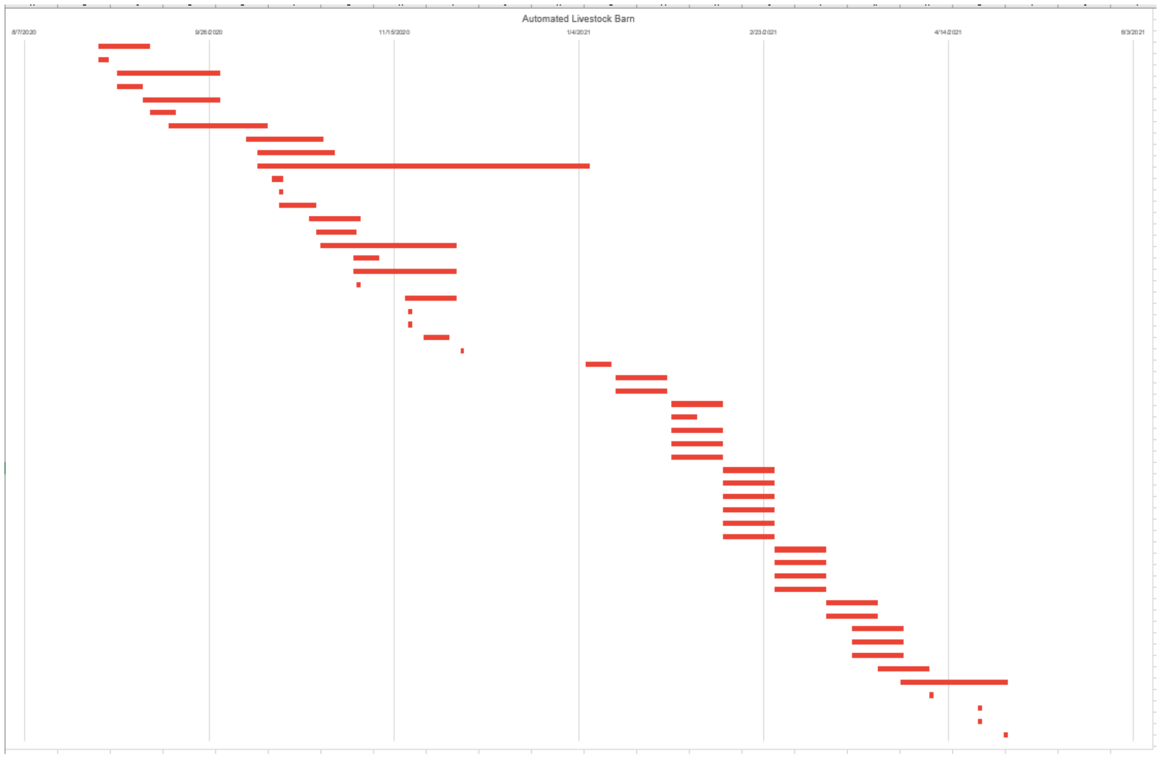
36. Test food system
37. Wire and program water system
38. Test water system
39. Wire and program security camera system
40. Test security camera system
41. Wire and program fire detection circuit
42. Test alarm notifications for fire detection
43. Run series of tests for the various systems
44. Troubleshoot and adjust wiring/programming for any problems
45. Test app/webpage interface with Raspberry Pi and security cameras
46. Communicate with Austria students any problems
47. Troubleshoot with Austria students on any problems
48. Retest systems and WIFI remote monitoring/user input
49. Write final report on planning, design, and results
50. Have project completed
51. Transport project for Senior Design Day at Miami University Hamilton campus
52. Set up project for display and present project
53. Submit final report

***Miami University***
***School of Engineering & Applied Science***
***Department of Engineering Technology***

***ENT 497/498***
***Senior Project***

***<u>Timeline (Appendix B):</u>***

| | Automated Livestock Barn | | | |
|---|---|---|---|---|
| Task | | Start Date | Duration | Assignments |
| 1 | Pick project for research and proposal | 8/27/2020 | 14 | Group |
| 2 | Setup regular team meetings and communication | 8/27/2020 | 3 | Gabryella Law |
| 3 | Research components for project systems (i.e. part numbers, data sheets, price, shipping time) | 9/1/2020 | 28 | Group |
| 4 | Setup basic guidelines for collaboration with Austria Students | 9/1/2020 | 7 | Group |
| 5 | Develop a budget based on parts research | 9/8/2020 | 21 | Group |
| 6 | Setup file sharing for team collaboration | 9/10/2020 | 7 | Group |
| 7 | Develop a timeline for project milestones and completion | 9/15/2020 | 27 | Group |
| 8 | Start electrical schematic design for project systems | 10/6/2020 | 21 | Group |
| 9 | Start mechanical design for project systems | 10/9/2020 | 21 | Group |
| 10 | Research and learn Raspberry Pi Programming Language | 10/9/2020 | 90 | Group |
| 11 | Submit rough draft of proposal to Advisor | 10/13/2020 | 3 | Gabryella Law |
| 12 | Submit project proposal to Advisor for approval | 10/15/2020 | 1 | Gabryella Law |
| 13 | Await approval/denial on project proposal from Advisor | 10/15/2020 | 10 | Mert Bal |
| 14 | Meet with Austria students to start project collaboration | 10/23/2020 | 14 | Group, Mert Bal |
| 15 | Start application for Armin Fleck scholarship | 10/25/2020 | 11 | Group |
| 16 | Start Final Report | 10/26/2020 | 37 | Group |
| 17 | Finalize and draft barn model and microprocessor control box physical layout designs | 11/4/2020 | 7 | Michael Wengard |
| 18 | Start developing preliminary coding for the different systems | 11/4/2020 | 28 | Josh Hashman, Gabryella Law |
| 19 | Submit application for Armin Fleck scholarship | 11/5/2020 | 1 | Gabryella Law |
| 20 | Begin ordering parts for the project | 11/18/2020 | 14 | Group |
| 21 | End of Semester Presentation | 11/19/2020 | 1 | Group |
| 22 | Complete any additional research for project | 11/19/2020 | 1 | Group |
| 23 | Submit rough draft of final report for review | 11/23/2020 | 7 | Group |
| 24 | Submit Semester Final report | 12/3/2020 | 1 | Group |
| 25 | Start physical building of barn model and microprocessor control box | 1/6/2021 | 7 | Michael Wengard |
| 26 | Mount light, temperature control, fire detection, and camera systems | 1/14/2021 | 14 | Group |
| 27 | Assemble and mount food and water systems | 1/14/2021 | 14 | Group |
| 28 | Setup Raspberry Pi power supply, breadboard, and WIFI connection | 1/29/2021 | 14 | Group |
| 29 | Wire needed power requirements to microprocessor control box and barn model | 1/29/2021 | 7 | Group |
| 30 | Wire and program Temperature control circuit | 1/29/2021 | 14 | Group |
| 31 | Test Temperature control circuit | 1/29/2021 | 14 | Group |
| 32 | Communicate with Austria students on design constraints and information transmission | 1/29/2021 | 14 | Group |
| 33 | Wire and program lighting circuit | 2/12/2021 | 14 | Group |
| 34 | Test lighting circuit | 2/12/2021 | 14 | Group |
| 35 | Wire and program food system | 2/12/2021 | 14 | Group |
| 36 | Test food system | 2/12/2021 | 14 | Group |
| 37 | Wire and program water system | 2/12/2021 | 14 | Group |
| 38 | Test water system | 2/12/2021 | 14 | Group |
| 39 | Wire and program security camera system | 2/26/2021 | 14 | Group |
| 40 | Test security camera system | 2/26/2021 | 14 | Group |
| 41 | Wire and program fire detection circuit | 2/26/2021 | 14 | Group |
| 42 | Test alarm notifications for fire detection | 2/26/2021 | 14 | Group |
| 43 | Run series of tests for the various systems | 3/12/2021 | 14 | Group |
| 44 | Troubleshoot and adjust wiring/programming for any problems | 3/12/2021 | 14 | Group |
| 45 | Test app/webpage interface with Raspberry Pi and security cameras | 3/19/2021 | 14 | Group |
| 46 | Communicate with Austria students any problems | 3/19/2021 | 14 | Group |
| 47 | Troubleshoot with Austria students on any problems | 3/19/2021 | 14 | Group |
| 48 | Retest systems and WIFI remote monitoring/user input | 3/26/2021 | 14 | Group |
| 49 | Write final report on planning, design, and results | 4/1/2021 | 29 | Group |
| 50 | Have project completed | 4/9/2021 | 1 | Group |
| 51 | Transport project for Senior Design Day at Miami University Hamilton campus | 4/22/2021 | 1 | Group |
| 52 | Set up project for display and present project | 4/22/2021 | 1 | Group |
| 53 | Submit final report | 4/29/2021 | 1 | Gabryella Law |



Automated Livestock Barn
8/7/2020
9/26/2020
11/15/2020
1/4/2021
2/23/2021
4/14/2021
6/3/2021

***Cost :***

The group has been given several options in the Raspberry Pi microcontroller platform. They have picked out a few models that offer a variety of options in the project build.

Option 1: The Raspberry Pi platform offers a microcontroller that can be used for larger applications such as industrial systems. This microcontroller is the Raspberry Pi Compute Module 3 Development Kit. This kit features a simple open-source breakout board and allows for expansion and addition of different Raspberry Pi system boards, such as WIFI. It has two camera ports, two display ports, an HDMI port, and a USB port. The board features 120 GPIO pins (5VDC, GND, INPUT and OUTPUT pins) for a large variety of connections. This product costs from $99.00 to $144.67 (without tax or shipping). However, there are a few drawbacks to this open-ended product. Most kits do not include the power supply, have very few accessories, and would require an additional kit to enable WIFI or bluetooth connectivity. In addition, there is only one USB port available with this model.

Option 2: This option is the Raspberry Pi 3 Model B+ microcontroller. Unlike Option 1, this microcontroller has built in WIFI and Bluetooth capabilities. It has four USB 2.0 ports, one CSI camera port, one DSI display port, a 4-pole stereo output and composite video port, Micro SD port for the operating system and data storage. Many product options in the market include the power supply for the microcontroller. This product has less display and camera ports, which can be negative to the future and expansion capabilities of the system. Another negative attribute to this model is a smaller amount of GPIO ports for external devices to connect to. This microcontroller costs $35.00 (without tax or shipping). There are also additional kits designed to add onto this microcontroller model that can cost $49.95 (without tax or shipping).

The group has decided to use Option 2 for the microcontroller. This microcontroller has more benefits and is cheaper than Option 1 in a more compact device. It fulfills all the requirements of the project systems and would allow for expansion in the future.

| Part Number | Qty. | Description | Individual Item Cost | Tax + Shipping | Vendor Name |
|---|---|---|---|---|---|
| BRK-9120B | 1 | First Alert 9120B 120V AC/DC Hardwired with 9V Battery Backup Ionization Smoke Alarm | $7.86 | $7.98 shipping | BRK |

| | | | | | |
|---|---|---|---|---|---|
| L110101010 11-1 | 2 | Linear actuator - 3” stroke | $30.99 | $2.25 | Amazon.com |
| G0388762 | 1 | 12”x12” Louver | $23.23 | tax + $5.00 | Zoro |
| T73 SRD-5VDC-SL-C | 1 | 5V SPDT Relay (10 pack) | $7.86 | $0.57 | Amazon.com |
| CF TB1512b | 2 | High voltage terminal strips (2 pack) | $7.99 | $0.58 | Amazon.com |
| N/A | 1 | LE Power Adapter, 2A 100-240VAC to 12VDC, 24W, Overvoltage/overcurrent and Short Circuiting protection | $12.99 | tax + free shipping | Amazon.com |
| 660WGU | 1 | Single-pole LED Toggle Light Switch | $0.69 | See Note 1 below | Lowes |
| 276WHCC1 8 | 1 | White Ceiling Socket (Lighting) | $1.58 | See Note 1 below | Lowes |
| 14250 | 1 | Sigma Electric 1-Gang Weatherproof Box | $3.48 | See Note 1 below | Lowes |
| 14216 | 1 | Sigma Electric 1-Gang Rectangle Weatherproof Electrical Box Cover | $4.98 | See Note 1 below | Lowes |
| ST-15 | 2 | ST-15 120V 1800W 1100VA Sensor | $12.84 | tax + $8.27 | greenelectricals upply.com |
| PC-LM1E | 1 | AUKEY 1080p Live Streaming Camera via USB | $49.99 | $3.62 + free shipping | Amazon.com |

| | | | | | |
|---|---|---|---|---|---|
| N/A | 1 | Living Whole Foods 5 Gallon White Bucket & Lid - Set of 3 - Durable 90 Mil All Purpose Pail - Food Grade - Contains No BPA Plastic | $31.48 | $2.21+ free shipping | Amazon.com |
| FF11BLACK | 2 | Little Giant Plastic Fence Feeder with Clips (Black) Heavy Duty Mountable Feed Trough Bucket for Livestock & Pets (4.5 Quart) | $18.04 | $1.27 + free shipping | Amazon.com |
| N/A | 2 | TotalPond Vinyl Tubing, 1/2-inch | $8.97 | $0.63 + free shipping | Amazon.com |
| N/A | 1 | GROWNEER 2 Packs 550GPH Submersible Pump 30W Ultra Quiet Fountain Water Pump, 2000L/H, with 7.2ft High Lift, 3 Nozzles for Aquarium, Fish Tank, Pond, Hydroponics, Statuary | $28.99 | $2.03 + free shipping | Amazon.com |
| LLC200D3SH-LLPK1 | 3 | Optomax Digital Liquid Level Sensor | $24.95 | $1.75+ free shipping | adafruit.com |
| 20240-83 | 2 | Deltrol Controls 120VAC Coil Electromechanical relay, 900 series | $22.75 | tax + $9.95 | galco.com |
| D2440 | 3 | Crydom Solid State Relay 3-32 VDC input 24-280VAC output | $46.74 | tax + $11.95 | galco.com |
| 9001-BG201 | 1 | Schneider Electric 9001BG201 Control Station Start-Stop Pushbutton | $49.94 | tax + $15.45 | superbreakers.com |
| RSC101004RC | 1 | RSC Gray Metal Weatherproof Standard Enclosure Electrical Box (10 in. x 10 in. x 4 in.) | $40.48 | See Note 1 below | Lowes |

| | | | | | |
|---|---|---|---|---|---|
| N/A | 1 | Raspberry Pi 3 Model B+ 1.4GHz Cortex-A53 with 1GB RAM | $35.00 | tax + $16.29 | adafruit.com |
| N/A | 1 | Starter Pack for Raspberry Pi Model B | $49.95 | tax + $4.99 | digikey.com |
| N/A | 1 | 5V 2.5A Switching Power Supply (20AWG MicroUSB Cable) | $7.50 | tax + free shipping | adafruit.com |
| N/A | 2 | 3/4-in HPVA Maple Plywood, Application as 4 x 8 | $53.53 | $3.88 tax (See Note 1) | Lowes |
| N/A | 1 | Fas-n-Tite #6 x 2-in Yellow Zinc Flat Interior Wood Screws (5-lb) | $21.98 | $1.59 (See Note 1) | Lowes |
| N/A | 3 | 2-in x 4-in x 8-ft Whitewood Stud | $6.56 | $0.48 (See Note 1) | Lowes |
| N/A | 1 | PVC Pipe cleaner and glue | $0.00 *See Note 2 | $0.00 | Group |
| N/A | 2 | 1" Dia. x 5' Long PVC straight section | $0.00 *See Note 2 | $0.00 | Group |
| N/A | 2 | 3/4" Dia. x 5' Long PVC straight section | $0.00 *See Note 2 | $0.00 | Group |
| N/A | 3 | 1" Dia. PVC elbow | $0.00 *See Note 2 | $0.00 | Group |
| N/A | 3 | 3/4" Dia. PVC elbow | $0.00 *See Note 2 | $0.00 | Group |
| N/A | 3 | DHT11 Temperature Sensor | $0.00 *See Note 2 | $0.00 | Group |
| N/A | 2 | 14 AWG THHN Str Cu 25ft Wire | $0.00 *See Note 2 | $0.00 | Group |
| N/A | 1 | Assorted fuse kit | $0.00 *See Note 2 | $0.00 | Group |

Note 1: Lowes equipment has a total of $227.72 for pickup and Estimated Tax of $18.61. The group should consider picking up equipment in store to lower costs.

Note 2: The group is providing existing equipment for the project.

***Final Comments***

The group is collaborating with Austria students on an app/webpage application. The group will be meeting with the Austria team and communicating throughout the project until completion. The group will be ordering the parts as soon as possible to ensure all materials are received before the planned start date of the project model construction. In the meantime, they will work on finalizing electrical and mechanical drawings. They will research the Raspberry Pi programming language and start developing preliminary code. Once the material is received, the group will start construction of the barn model and mounting the various systems. Once the barn model is constructed, the group will start wiring the Raspberry Pi microcontroller and connecting it to WIFI for data transfer. They will then wire, program, and test the project systems. They will again coordinate with the Austria team to test out the app/webpage application. The team will then perform a full system test to verify the functionality of the system and user interface through the app/webpage application. Once the project is completed, the group will write the final report and present the project to the advisor.

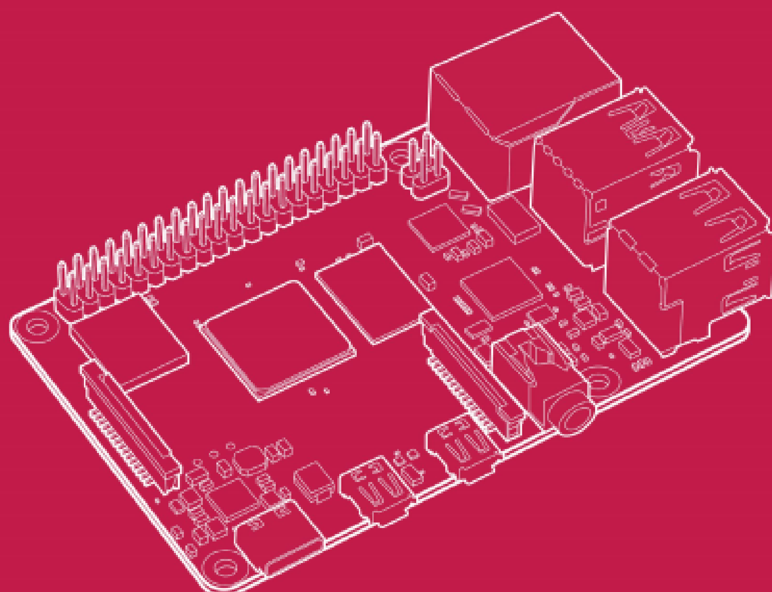
# Appendix D: Decision Matrix

| Guidelines | Importance Multiplier |
|---|---|
| Cost | 3 |
| Network Capabilities | 4 |
| Input/Output Options | 3 |
| External Compatability | 4 |

| | Guidelines | | | | |
|---|---|---|---|---|---|
| Options | Cost | Network Capabilities | Input/Output Options | External compatability | Total |
| ACE PLC | 3 | 1 | 3 | 2 | 30 |
| Arduino UNO | 5 | 3 | 4 | 3 | 51 |
| Raspberry Pi | 4 | 5 | 5 | 4 | 63 |

## Appendix E: Raspberry Pi 4 Model B+ Specification Sheet

# Raspberry Pi 4 Computer
Model B

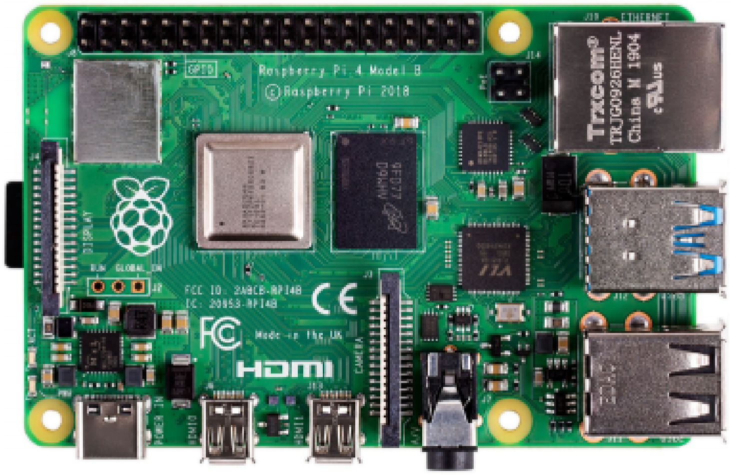


Published in May 2020
by Raspberry Pi Trading Ltd.

www.raspberrypi.org

Raspberry Pi

# Overview



Raspberry Pi 4 Model B is the latest product in the popular Raspberry Pi range of computers. It offers ground-breaking increases in processor speed, multimedia performance, memory, and connectivity compared to the prior-generation Raspberry Pi 3 Model B+, while retaining backwards compatibility and similar power consumption. For the end user, Raspberry Pi 4 Model B provides desktop performance comparable to entry-level x86 PC systems.

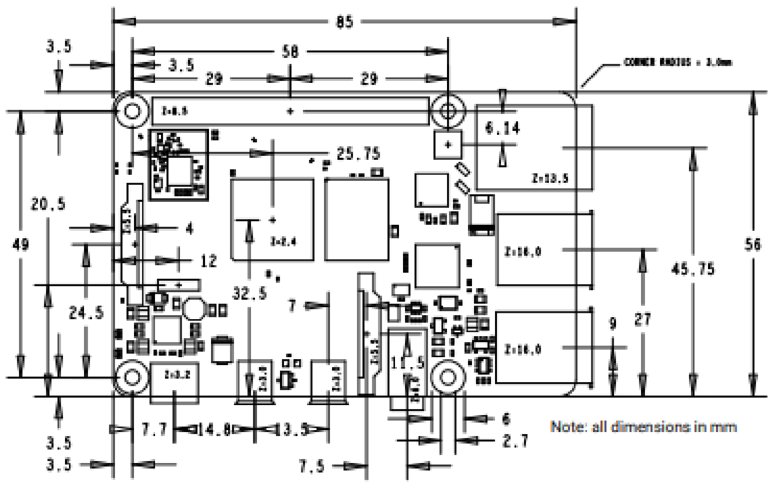
This product's key features include a high-performance 64-bit quad-core processor, dual-display support at resolutions up to 4K via a pair of micro-HDMI ports, hardware video decode at up to 4Kp60, up to 8GB of RAM, dual-band 2.4/5.0 GHz wireless LAN, Bluetooth 5.0, Gigabit Ethernet, USB 3.0, and PoE capability (via a separate PoE HAT add-on).

The dual-band wireless LAN and Bluetooth have modular compliance certification, allowing the board to be designed into end products with significantly reduced compliance testing, improving both cost and time to market.

# Specification

| | |
|---|---|
| **Processor:** | Broadcom BCM2711, quad-core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz |
| **Memory:** | 2GB, 4GB or 8GB LPDDR4 (depending on model) |
| **Connectivity:** | 2.4 GHz and 5.0 GHz IEEE 802.11b/g/n/ac wireless LAN, Bluetooth 5.0, BLE<br>Gigabit Ethernet<br>2 × USB 3.0 ports<br>2 × USB 2.0 ports. |
| **GPIO:** | Standard 40-pin GPIO header (fully backwards-compatible with previous boards) |
| **Video & sound:** | 2 × micro HDMI ports (up to 4Kp60 supported)<br>2-lane MIPI DSI display port<br>2-lane MIPI CSI camera port<br>4-pole stereo audio and composite video port |
| **Multimedia:** | H.265 (4Kp60 decode);<br>H.264 (1080p60 decode, 1080p30 encode);<br>OpenGL ES, 3.0 graphics |
| **SD card support:** | Micro SD card slot for loading operating system and data storage |
| **Input power:** | 5V DC via USB-C connector (minimum 3A[1])<br>5V DC via GPIO header (minimum 3A[1])<br>Power over Ethernet (PoE)–enabled (requires separate PoE HAT) |
| **Environment:** | Operating temperature 0–50°C |
| **Compliance:** | For a full list of local and regional product approvals, please visit https://www.raspberrypi.org/documentation/hardware/raspberrypi/conformity.md |
| **Production lifetime:** | The Raspberry Pi 4 Model B will remain in production until at least January 2026. |

## Physical Specifications




**WARNINGS**

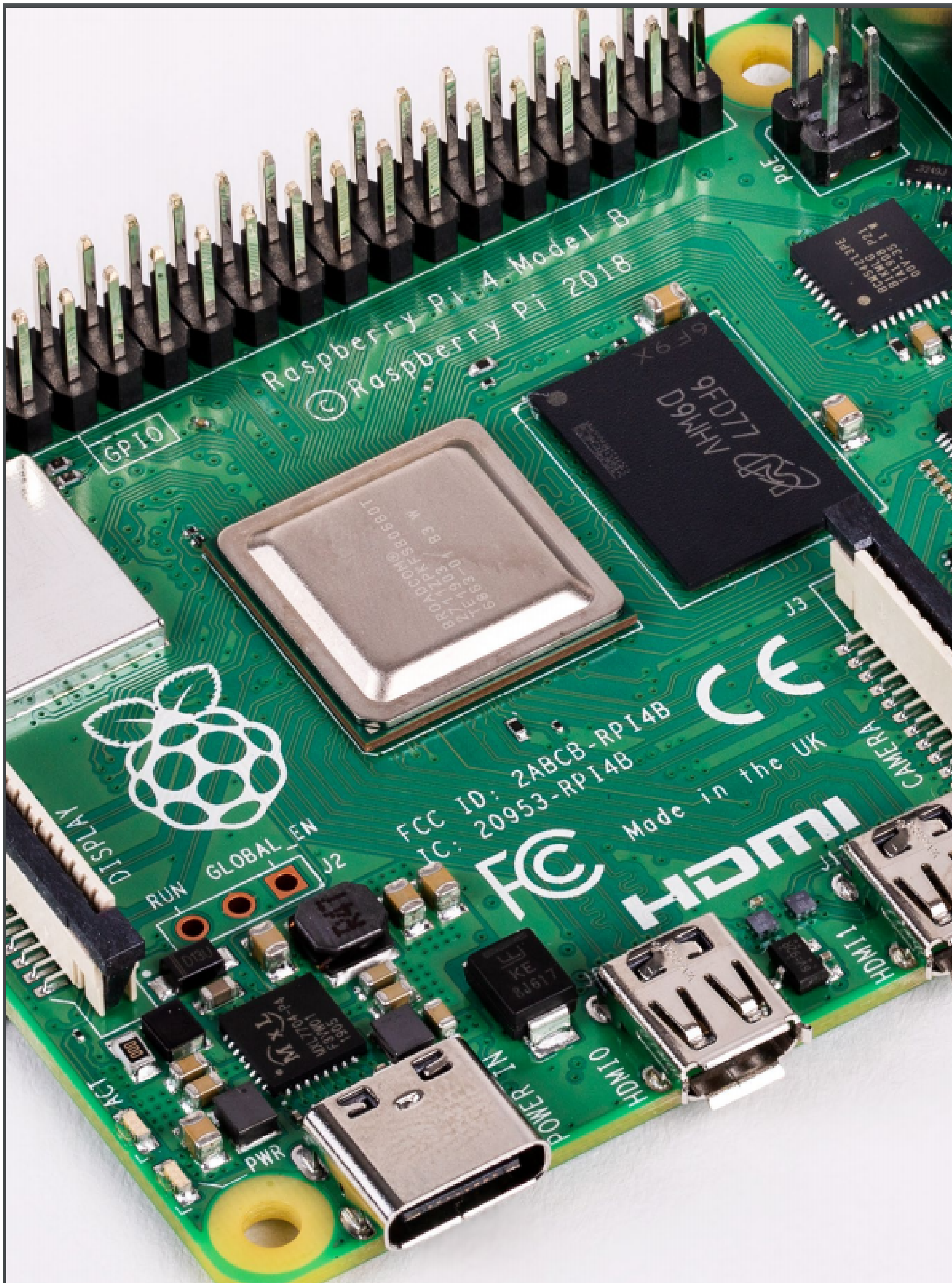
- This product should only be connected to an external power supply rated at 5V/3A DC or 5.1V/ 3A DC minimum[1]. Any external power supply used with the Raspberry Pi 4 Model B shall comply with relevant regulations and standards applicable in the country of intended use.
- This product should be operated in a well-ventilated environment and, if used inside a case, the case should not be covered.
- This product should be placed on a stable, flat, non-conductive surface in use and should not be contacted by conductive items.
- The connection of incompatible devices to the GPIO connection may affect compliance and result in damage to the unit and invalidate the warranty.
- All peripherals used with this product should comply with relevant standards for the country of use and be marked accordingly to ensure that safety and performance requirements are met. These articles include but are not limited to keyboards, monitors and mice when used in conjunction with the Raspberry Pi.
- Where peripherals are connected that do not include the cable or connector, the cable or connector must offer adequate insulation and operation in order that the relevant performance and safety requirements are met.

**SAFETY INSTRUCTIONS**

**To avoid malfunction or damage to this product please observe the following:**

- Do not expose to water, moisture or place on a conductive surface whilst in operation.
- Do not expose it to heat from any source; Raspberry Pi 4 Model B is designed for reliable operation at normal ambient room temperatures.
- Take care whilst handling to avoid mechanical or electrical damage to the printed circuit board and connectors.
- Avoid handling the printed circuit board whilst it is powered and only handle by the edges to minimise the risk of electrostatic discharge damage.

[1] A good quality 2.5A power supply can be used if downstream USB peripherals consume less than 500mA in total.




5 **Raspberry Pi 4 Model B** Product Brief


900 Long Base


900 Short Base

**DELTROL controls** | DIVISION OF DELTROL CORP.

# 900 SERIES RELAY 30 AND 50 AMP HEAVY DUTY POWER RELAY

## FEATURES

- Class F Coil Insulation System for 155°C Total Temperature
- Coil Molded in DuPont Rynite® for Environmental Protection
- Rugged Construction Rivets Terminals to Base
- 900, 900D and 900E are UL and cUL Listed
- 900-1C, 900Q and 900R are UL and cUR Recognized

## CONTACT DATA

**CONFIGURATION:**
Thru DPDT

**MATERIALS:**
All Versions
5/16" Diameter Silver Cadmium Oxide
Fine Silver Available on Special Order – Min. Qty. Req'd.

## CONTACT RATINGS

| MODEL | POLE CONFIGURATION | UL RATINGS |
|---|---|---|
| 900<br>900Q | SPST-NC short base<br>SPST-NO short base<br>SPST-NO-DM short base<br>SPST-NC-DB long base<br>SPDT short base<br>DPST-NO short base<br>DPST-NC long base<br>DPST-NC short base<br>DPDT long base | 30 amp or 1-1/2 HP at 120 or 240VAC<br>2 HP at 240VAC<br>3600W at 120 or 240VAC (ballast)<br>30 amp at 240VAC, 100,000 cycle (resistive)<br>20 amp at 600VAC<br>30 amp at 28VDC |
| 900-1C | | Same as 900 with addition of auxiliary 1/4 HP at 125 or 250VAC |
| 900D | | Same as 900 with additional rating of 20 amp at 125VDC |
| 900E<br>900R | | 50 amp at 277VAC resistive 100,000 cycles, 40 amp general use (Inductive) |

**UL RECOGNIZED FILE NO.:** E37066
900, 900D & E are UL and cUL listed. Other versions are UR and cUR recognized.
(US and Canadian Recognition)

## EXPECTED LIFE

**Electrical At Rated Load (Minimum)**
100,000 Operations

**Mechanical Life**
1,000,000 Operations

## DIELECTRIC STRENGTH

2200 VRMS, 60 Hz Between Contacts
2200 VRMS, 60 Hz Between Other Elements

## MODELS

**900:** Fast Acting 30 Amp Power Relays
**900-1C:** Same as 900 with Addition of SPDT Auxiliary Snap Switch Rated 10 Amp, 1/4 HP
**900Q:** Same as 900 with .250" Quick-Connect Termination
**900D:** Same as 900 with Addition of Blow Out Magnets for Switching DC Loads
**900E:** Same as 900 with 50 Amp Rating and Box Lug Termination
**900R:** Same as 900 with 50 Amp Rating and Standard Screw Terminals

## COIL DATA

| | NOMINAL VOLTAGE | RESISTANCE IN OHMS ± 10% | NOMINAL COIL POWER |
|---|---|---|---|
| AC Coils | 6VAC<br>12VAC<br>24VAC<br>120VAC<br>240VAC<br>480VAC | .85<br>2.85<br>11.5<br>295<br>1170<br>4860 | 9.5VA |
| DC Coils | 6VDC<br>12VDC<br>24VDC<br>48VDC<br>110VDC | 18<br>72<br>290<br>1,150<br>6,050 | 2W |

**Coil Voltages:** AC: Up to 600 Volts/60 Hz
DC: Up to 125 Volts

**Coil Treatment:** Molded Rynite® Std. Class F
**Insulation Resistance:** 100 Megohms Minimum
**UL Insulation System File No.:** E74443
S155D 155°C Total Temperature Std.
(Covers S105 Class A and S130D Class B Requirements)

## OPERATE DATA

**Pick Up (at 25°C):** AC Volts 85% or Less of Nominal
DC Volts 75% or Less of Nominal

**Operate Time:** Approx. 30 Milliseconds
**Release Time:** Approx. 30 Milliseconds

## ENVIRONMENTAL DATA

**Operating Ambient:** AC: -45° to 80°C @ 30 amps
AC: -45° to 70°C @ 50 amps
DC: -45° to 115°C @ 30 amps
DC: -45° to 105°C @ 50 amps

**Coil Temperature Rise:** (25°C Ambient – Continuous Duty)
AC: 70°C Approx. @ 60 Hz – Use at 50 Hz will Cause Slight Increase in Coil Rise
DC: 35°C Approx.

## MECHANICAL DATA

**Terminals:** Screw Type on all but SERIES 900Q which has Quick Connect, .250"

**Weight:** Short Base Versions 8 oz. Approx. (227 g)
Long Base Versions 10 oz. Approx. (283 g)

20

crydom™

# Series 1

**10-90Amp • 120/240 Vac - AC OUTPUT**

- **Zero Voltage and Random Turn-On Switching**
- **Panel Mount**
- **600V Transient Capability**
- **Internal Snubber**
- **110 & 125A Models Available**
- **Integrated Overvoltage Protection by Automatic Self Turn-On (Suffix P)**

Featuring state-of-the-art Surface Mount Technology, these SPST-NO relays deliver proven reliability in the most demanding applications. Output consists of an SCR AC switch and is available in zero-cross, random turn-on (phase controllable) and normally closed (Form B) versions with either AC or DC input (coil) control. Manufactured in Crydom's ISO 9001 Certified facility for optimum product performance and reliability.

| MODEL NUMBERS | AC CONTROL | A1210 | A1225 | A1240 | A2410 | A2425 | A2450 | A2475 | A2490 |
|---|---|---|---|---|---|---|---|---|---|
| | DC CONTROL | D1210 | D1225 | D1240 | D2410 | D2425 | D2450 | D2475 | D2490 |
| **OUTPUT SPECIFICATIONS** ① | | | | | | | | | |
| Operating Voltage (47-63 Hz) [Vrms] | | 24-140 | 24-140 | 24-140 | 24-280 | 24-280 | 24-280 | 24-280 | 24-280 |
| Max. Load Current ③ [Arms] | | 10 | 25 | 40 | 10 | 25 | 50 | 75 | 90 |
| Min. Load Current, [mArms] | | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| Transient Overvoltage [Vpk] | | 400 | 400 | 400 | 600 | 600 | 600 | 600 | 600 |
| Max. Surge Current, (16.6ms) [Apk] | | 120 | 250 | 625 | 120 | 250 | 625 | 1000 | 1200 |
| Max. On-State Voltage Drop @ Rated Current [Vpk] | | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 |
| Thermal Resistance Junction to Case ($R_{\theta JC}$) [°C/W] | | 1.48 | 1.02 | 0.63 | 1.48 | 1.02 | 0.63 | 0.31 | 0.28 |
| Maximum $I^2t$ for Fusing, (8.3 msec.) [$A^2$sec] | | 60 | 260 | 1620 | 60 | 260 | 1620 | 4150 | 6000 |
| Max. Off-State Leakage Current @ Rated Voltage [mArms] | | 8 | 8 | 8 | 10 | 10 | 10 | 10 | 10 |
| Min. Off-State dv/dt @ Max. Rated Voltage [V/µsec] ② | | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 |
| Max. Turn-On Time ④ | | 1/2 Cycle (DC Control), 10.0 msec (AC Control) | | | | | | | |
| Max. Turn-Off Time | | 1/2 Cycle (DC Control), 40.0 msec(AC Control) | | | | | | | |
| Power Factor (Min.) with Max. Load | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

| INPUT SPECIFICATIONS ① | DC CONTROL | AC CONTROL | 24V AC/DC CONTROL (E SUFFIX) |
|---|---|---|---|
| Control Voltage Range | 3-32 Vdc | 90-280 Vrms (60Hz) | 18-36 Vrms/Vdc |
| Max. Reverse Voltage | -32 Vdc | — | — |
| Max. Turn-On Voltage | 3.0 Vdc | 90 Vrms | 18 Vrms/Vdc |
| Min. Turn-Off Voltage | 1.0 Vdc | 10 Vrms | 4.0 Vrms/Vdc |
| Nominal Input Impedance | 1500 Ohms | 60K Ohms | 9.0K Ohms |
| Typical Input Current | 3.4mA @ 5 Vdc, 20mA @ 28Vdc | 2mA @ 120 Vrms, 4mA @ 240 Vrms | 3mA @ 24 V |



**GENERAL NOTES**

① All parameters at 25° C unless otherwise specified.
② Off-State dv/dt test method per EIA/NARM standard RS-443, paragraph 13.11.1
③ Heat sinking required, for derating curves see page 3.
④ Turn-on time for random turn-on versions is 0.02 msec (DC Control Models).

For recommended applications and more information contact:
**USA:** Sales Support (877) 502-5500 **Tech Support** (877) 702-7700 **FAX** (619) 710-8540
Crydom Corp, 2320 Paseo de las Americas, Ste. 201, San Diego, CA 92154
**Email:** sales@crydom.com **WEB SITE:** http://www.crydom.com
**UK:** +44 (0)1202 365070 • **FAX** +44 (0)1202 365090 Crydom International Ltd., 7 Cobham Road, Ferndown Industrial Estate, Ferndown, Dorset BH21 7PE, Email: intsales@crydom.com
**GERMANY:** +49 (0)180 3000 506

SERIES1
Rev. 062305
PAGE 1 OF 3

# DATA SHEET

## Liquid Level Switch

*Optomax* Digital
LLC200D3SH-LLPK1

SST
DESIGN • MANUFACTURE • CUSTOMISE • CONFIGURE

### FEATURES

Optomax Digital liquid level switches are ideal for applications with restricted space that require a miniature, low power and low cost sensing solution.

The microcontroller based sensor is solid state, incorporating an infra-red LED and phototransistor which are optically coupled by the tip when the sensor is in air. When the sensing tip is immersed in liquid, the infra-red light escapes making the output change state.

| Housing/ Mounting | Output Type / Logic | Supply Voltage | Output Current | Temp |
|---|---|---|---|---|
| M12x1 | PUSH PULL; 1 / 0 HIGH IN AIR | 4.5 - 15.4 V VOLTAGE | UP TO 100mA CURRENT | -25°C to +80°C TEMPERATURE |

### TECHNICAL SPECIFICATIONS

| | |
|---|---|
| Supply voltage (Vs) | $4.5V_{DC}$ to $15.4V_{DC}$ |
| Supply current (Is) | 2.5mA max. (Vs = $15.4V_{DC}$) |
| Output sink and source current (Iout) | 100mA |
| Operating temperatures | -25°C to +80°C |
| Storage temperatures | -30°C to +85°C |
| Housing material | Polysulfone[1] |
| Sensor termination | 24AWG, 250mm PTFE wires, 8mm tinned |
| Mounting thread[2] | M12x1x8g with hex nut[3] |
| Operating pressure | 7bar / 101psi maximum[4] |
| Tightening torque | 1.5Nm / 13.26 in-lb maximum |

### OUTPUT VALUES

| **Output Voltage[5] (Vout):** | **Iout = 100mA** |
|---|---|
| Output High | Vout = Vs - 1V max |
| Output Low | Vout = 0V + 0.5V max |

Other sensor options available on request, email: technical@sstsensing.com

**Need help? Ask the expert**
**Tel: +44 (0)1236 459 020**
**and ask for "Technical"**

*NOTES*

1) Before use check that the fluid in which you wish to use these devices is compatible with Polysulfone.
2) Sensor is mounted externally.
3) Hex nut and O-ring sold separately; email: technical@sstsensing.com for details.
4) When correctly sealed.
5) Voltages applicable to output value stated.

# SMOKE ALARM

## CAT. 9120 Series

(Model 9120B only)

### DUAL IONIZATION

Dual Ionization sensing chamber. Generally more effective at detecting small particles produced by flaming fires. Sources may include paper or kitchen grease.

### LATCHING ALARM INDICATOR

Remembers which unit initiated an alarm.

### SINGLE BUTTON TEST/SILENCE

Silences and tests alarm with a single button.

### TWO LOCKING FEATURES

Pins are provided to lock battery drawer and/or alarm to base. Perfect for apartment, dormitory or hotel applications.

***Available in the following versions:***

| | |
|---|---|
| *9120* | *AC Alarm with silence* |
| *9120B* | *AC Alarm with silence and battery backup* |
| *9120AB* | *Same as 9120B but with alkaline battery* |
| *9120LB* | *Same as 9120B but with lithium battery* |
| *9120B-48P* | *48 pack of Boxed 9120B* |
| *9120B-48B* | *48 pack of Bulk 9120B* |
| *9120B-GFD* | *18 count Gravity Feed Display* |
| *91206CP* | *Contractor Bulk 6-pack of 9120 Alarm* |
| *9120B6CP* | *Contractor Bulk 6-pack of 9120B Alarm* |

LIMITED 10 YEAR WARRANTY

IONIZATION

Listed to UL 217 Standard

# BRK®

**THE PROFESSIONAL STANDARD**

## 120V AC, 60Hz Wire-in with 9V Battery Backup (9120B)

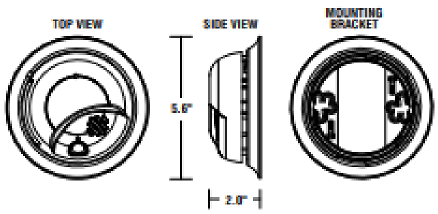
**Description:**

The BRK Brands, Inc. Model Numbers 9120 and 9120B are wire-in, 120V AC 60Hz single and/or multiple station smoke alarms specifically designed for residential and institutional applications including sleeping rooms of hospitals, hotels, motels, dormitories and other multi-family dwellings as defined in standard NFPA 101. Models 9120 and 9120B comply with UL217, CSFM, NFPA 72, HUD, FHA and other agencies that model their codes after the above agencies. They meet building codes where AC and AC/DC with Silence smoke alarms are required. The alarms are interconnectable with up to 18 devices, of which 12 can be smoke alarms.

The BRK® 9120 Series alarms feature a dual ionization smoke sensing chamber screened for insect protection, an 85dB horn, 9V battery back-up (all versions except model 9120) and a "silence" feature. The "Smart Technology" system is designed to reduce nuisance alarms. "Latching Alarm Indication" remembers which unit initiated an alarm. When interconnected in a series, the unit that triggered the alarm rapidly flashes its red LED indicator. After the alarm condition subsides, the initiating unit will store in memory or "latch" the information and begin to flash the green LED indicator 2 seconds on, 2 seconds off. The "Perfect Mount" system features a gasketless base and a mounting bracket that keeps the alarm secure over a wide rotation range to allow for true alignment. This will allow fine-tuning on the positioning to compensate for out of aligned wall studs and to keep the wording level when wall mounting. A Single button test/silence button eliminates confusion. Depending on what mode the alarm is in, pushing the button will test, silence, re-test the alarm when in silence and clear the latching feature. Battery installation and removal can occur while the unit is mounted to the ceiling or wall via the side load battery compartment. Other Contractor Preferred features include a dust cover to keep alarm clean during construction, keyhole slots in the mounting bracket eliminate the need to remove the electrical box screws for installation. Two locking features are provided to prevent battery theft and/or theft of the unit. Connection to AC power is made with a "Quick-Connect" wiring harness. Installation is quick, easy and cost effective.

# CAT. 9120 Series

(Model 9120B only)




## ARCHITECTURAL AND ENGINEERING SPEC

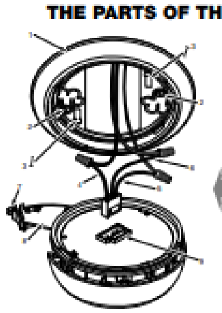
The smoke alarm shall be a BRK Model 9120B (battery backup) or 9120 (no battery backup) and shall provide at a minimum the following features and functions:

1. A Ionization smoke sensing chamber.
2. The unit shall be capable of self restoring.
3. Fully screened sensing chamber to resist entry of small insects thereby reducing the probability of unwanted alarms.
4. Powered by 120V AC, 60Hz and have a monitored 9V battery backup model (9120B only). and a solid state piezo horn rated at 85dB at 10 ft.
5. A visual green LED power-on indicator to confirm unit is receiving power or is in alarm.
6. A full function test button should check all alarm functions by simulating a smoke condition, causing the unit to alarm.
7. Silence feature - Temporarily silence unwanted nuisance alarms.
8. Two Locking features - tamper resistant locking pins that lock battery drawer and/or alarm to mounting bracket.
9. The unit shall be capable of operating between 40°F (4°C) and 100°F (38°C) and relative humidity between 10% and 90%.
10. The unit shall have a gasketless base for easy installation and be capable of keeping alarm secure over a wide rotation range to allow for true alarm alignment.
11. The unit shall have a plug in connector and be capable of interconnection of up to 18 alarms, 12 of which can be smoke alarms.
12. The unit shall at a minimum meet the requirements of UL217, CSFM, NFPA 72, NFPA 101, ICC

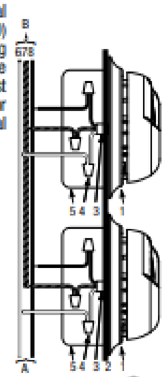
## INSTALLATION OF ALARM

Installation of this smoke alarm must conform to all local electrical codes and Article 760 of the National Electrical Code (NFPA 70) and NFPA 72. Interconnected units must meet the following requirements: Total length of wire interconnecting units should be less than 1000 feet, be #18 gauge or larger and be rated at least 300V. It is recommended that all units be on the same fuse or circuit breaker. If local codes do not permit, be sure the neutral wire is common to both phases.

### THE PARTS OF THIS SMOKE ALARM



1. Mounting bracket
2. Mounting Slots
3. Locking Pins
4. Hot (Black) AC Wire
5. Nuetral (White) AC Wire
6. Interconnect (Orange) Wire
7. Battery Drawer Latch
8. Battery Drawer - Install 9V battery here
9. Quick-Connect Plug




A. Unswitched 120VAC 60 Hz source
B. To additional units; Maximum = 18 total (Maximum 12 Smoke Alarms)

1. Smoke Alarm
2. Ceiling or Wall
3. Power Connector
4. Wire Nut
5. Junction Box
6. Neutral Wire (White)
7. Interconnect Wire (Orange)
8. Hot Wire (Black)

## TECHNICAL SPECS

| | |
|---|---|
| Alarm Dimensions: | 5.6" dia x 2.0"H |
| Weight: | 6.5 oz (9120); 7.8 oz (9120B) |
| Operating Voltage: | 120V AC 60Hz w/ 9V battery backup (9120B only) |
| Operating Current: | .04 amps (standby/alarm) |
| Temperature Range: | 40°F (4°C) to 100°F (38°C) |
| Humidity Range: | 10% to 90% relative humidity (RH) |
| Audio Alarm: | 85dB at 10 feet |
| Test/Silence: | Electronically simulates smoke condition, causing the unit to alarm<br>Press and hold test/silence button |
| Alarm Reset: | Automatic when smoke clears |
| Interconnections: | Up to 18 units of First Alert or BRK Smoke, CO and Heat Alarms. Maximum of 12 smoke alarms. See user's manual for details. |
| Smoke Sensor: | Dual chamber ionization |
| Indicator Lights/Sounds: | |
| AC Power: | Constant Green LED |
| DC Power: | Intermittent Red LED (9120B only) |
| Local Alarm: | Red LED flashes rapidly |
| Remote Alarm: | Red LED out. |
| Latching Alarm: | Green LED flashes 2 sec. on/2 sec. off after local alarm |
| Listing: | Listed to UL217 Standard |

## SHIPPING SPECS:

| | |
|---|---|
| Individual Carton Dimensions | 5.69"L x 2.25"W x 5.59"H |
| Weight | 0.53 lbs. (9120); .61 lbs. (9120B) |
| Cube | 0.041 ft3 |
| UPC | 9120: 0 29054 51300 7<br>9120B: 0 29054 51301 4<br>9120AB: 0 29054 51302 1<br>9120LB: 0 29054 51303 8 |
| Master Carton Dimensions | 14.43"L x 6.19"W x 12.63"H |
| Master Pack | 12 (9120, 9120B, 9120AB, 9120LB)<br>18 (9120B-GFD)<br>48 (9120B-48P, 9120B-48B) |
| Weight | 7.0 lbs. (9120)<br>7.9 lbs. (9120B)<br>12.8 lbs: (9120B-GFD)<br>25.0 lbs (9120B-48P, 9120B-48B) |
| Cube: | 0.653 ft3 (9120, 9120B, 9120AB, 9120LB)<br>1.20 ft3 (9120B-GFD)<br>2.36 ft3 (9120B-48P, 9120B-48B) |
| I2of5: | 9120: 100 29054 51300 4<br>9120B: 100 29054 51301 1<br>9120AB: 100 29054 51302 8<br>9120LB: 100 29054 51303 5 |
| Pallet Information | |
| Cases per Layer | 19 (9120, 9120B, 9120AB, 9120LB)<br>21 (9120B-GFD)<br>6 (9120B-48P, 9120B-48B) |
| Number of Layers: | 3 (9120, 9120B, 9120AB, 9120LB)<br>2 (9120B-GFD)<br>3 (9120B-48P, 9120B-48B) |
| Cases per Pallet: | 57 (9120, 9120B, 9120AB, 9120LB)<br>42 (9120B-GFD)<br>18 (9120B-48P, 9120B-48B) |
| Units per Pallet: | 684 (9120, 9120B, 9120AB, 9120LB)<br>756 (9120B-GFD)<br>864 (9120B-48P, 9120B-48B) |
| Cube: | 42.2 ft3 (9120, 9120B, 9120AB, 9120LB)<br>55.8 ft3 (9120B-GFD)<br>43.4 ft3 (9120B-48P, 9120B-48B) |
| Weight: | 393 lbs. (9120)<br>439 lbs. (9120B, 9120AB, 9120LB)<br>601 lbs: (9120B-GFD)<br>479 lbs (9120B-48P)<br>649 lbs. (9120B-48B) |

BRK® THE PROFESSIONAL STANDARD
brkelectronics.com

Roll over image to zoom in

Mini Electric Linear Actuator Stroke 3"–Force 4.5 lbs–12V | High-Speed 0.6"/sec–Weight 0.2KG Ideal for Intelligent Range Hood, Fan Blades, Cabinets, Window Opener, Robotics, Home Automation

Brand: ECO LLC

33 ratings | 22 answered questions

Price: $39.99 & **FREE Shipping**

Size: **3 inch**

| 1 inch | 2 inch | 3 inch | 4 inch | 6 inch |
|---|---|---|---|---|
| $33.98 | $39.99 | $39.99 | $42.99 | $32.99 |

Color: **Silver**

Number of Items: **1**

- ✦Specification:Stroke length = 3 inches (75mm);Travel Speed: 0.6in/sec(15mm/sec); Retracted length = 180mm(7.09"); Extended Length= 255mm(10.4");Maximum Load = 4.5lbs(20N);Inner Tube: Stainless Steel Tube;Input Voltage: 12VDC;Temperature: 0-50 degrees Celsius.
- ✦Advantage:Our Linear Actuator with Linear Reciprocating Motor and Durable Stroke Ideal for Intelligent Range Hood, Fan Blades, Cabinets, Window Opener, Robotics, Home Automation
- ✦Feel Stop: Stop at Any Position,With Automatic Machine Lock, It will Automatically Stop When It Reaches the Top.
- ✦Safe and Worry-Free: Overcurrent Protection, Short Circuit Protection, Overload Protection, Overvoltage Protection.
- ✦1 Year product warranty,any problems about the product please feel free to contact us.

**Product Specifications**

| | |
|---|---|
| Color | Silver |
| Ean | 0787502202117 |
| Material | Alloy Steel |
| Number of Items | 1 |
| Part Number | L11010101011-1 |
| Size | 3 inch |
| Style | Small |
| UPC | 787502202117 |

**Specification for this product family**

| | |
|---|---|
| Brand Name | ECO LLC |
| UNSPSC Code | 31251511 |


Roll over image to zoom in

## Senmod 10pcs 5VDC Household Appliance PCB Relay SRD-05VDC-SL-C Power Relay 5Pins for Arduino

Brand: SenMod

44 ratings

- Product Name : Power Relay; Model : SRD-05VDC-SL-C
- Coil Voltage : DC 5V;Load Capacity : 10A 250VAC/125VAC/30VDC/28VDC
- Coil resistance: 70 ohms
- Coil Current: 71-90mA
- Compact and sealed construction.

› See more product details



### Product description

Application: Modules, Development board, Connector, Cables & Adapters, DIY PCB Universal Board, IC Sockets

**Description:**
Model number: Power Relay
Power source: DC Voltage: 5V
Contact load: Power Relay
The relay plays the role as a protector or a circuit switch. It can protect your electric equipments very well.

Note: Light shooting and different displays may cause the color of the item in the picture a little different from the real thing. The measurement allowed error is +/-1-3 cm.

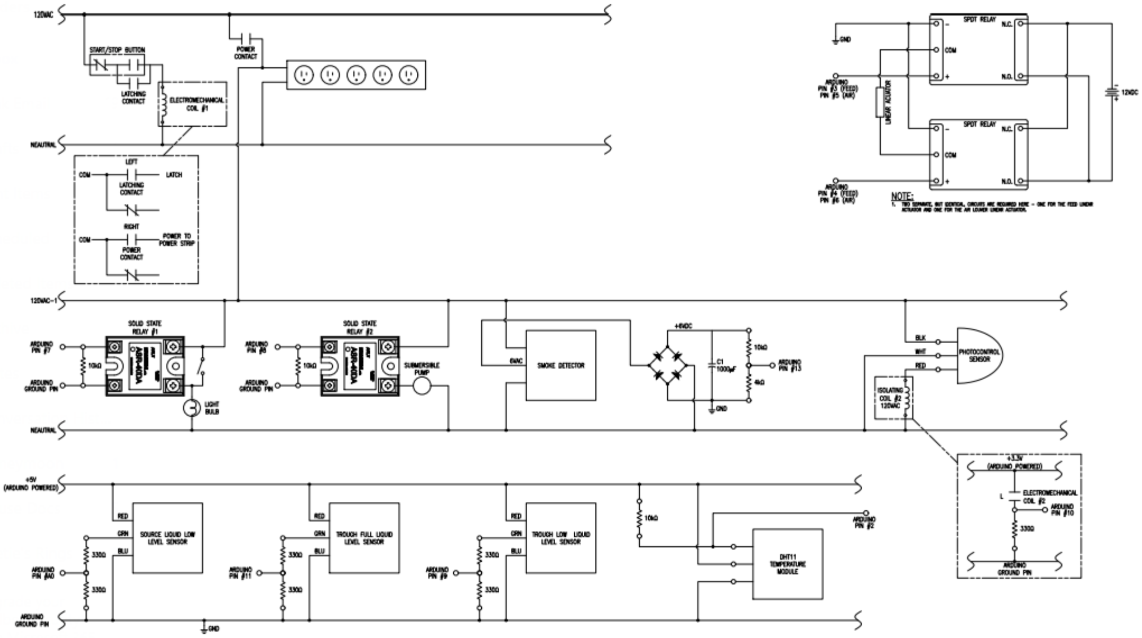
**Package Included:**
10pcs T73 SRD-5VDC-SL-C 5V10A 5 pin Electromagnetic Relays

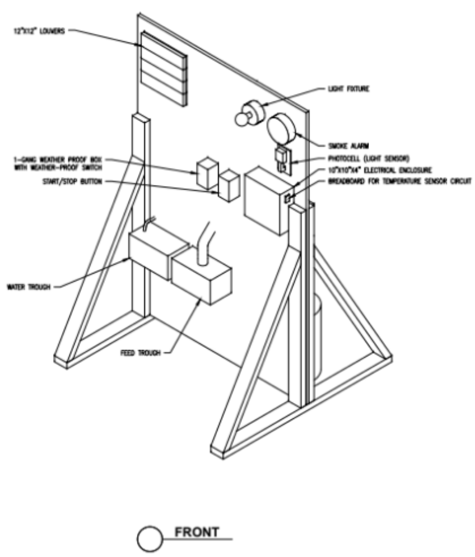
### Product information

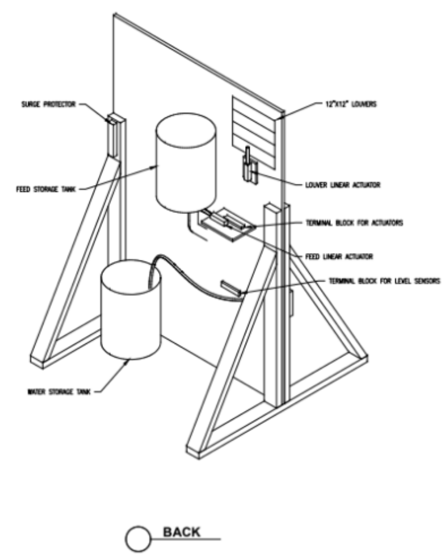
Technical Details

| | |
|---|---|
| Manufacturer | SenMod |
| Part Number | MC060-10 |
| Item Weight | 7.2 ounces |
| Package Dimensions | 4.5 x 3 x 0.8 inches |
| Color | Blue |
| Material | Plastic, Metal, Electronic component |
| Item Package Quantity | 1 |
| Number Of Pieces | 1 |
| Measurement System | Metric |
| Batteries Required? | No |

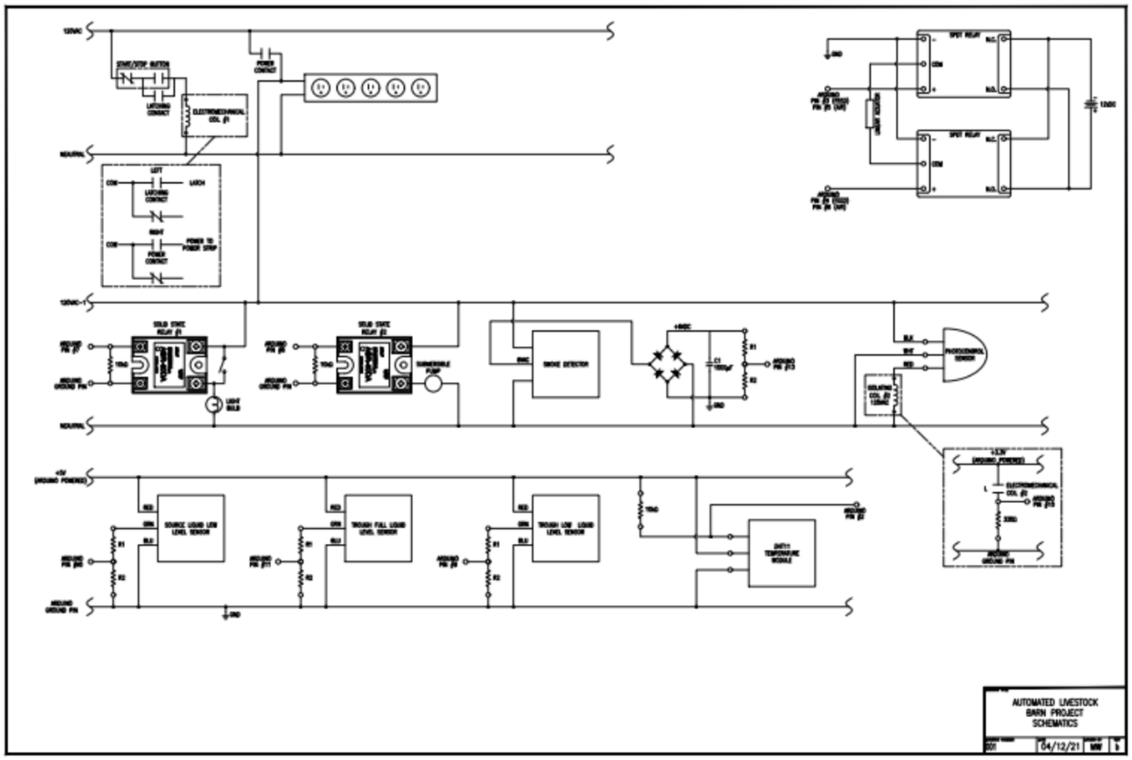
# Appendix G: Project Schematics and Physical Layout

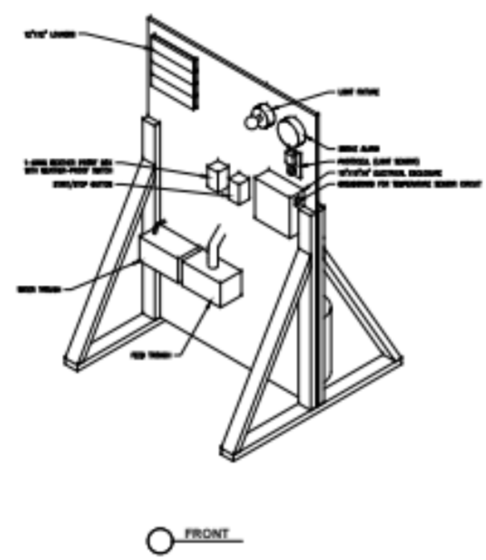


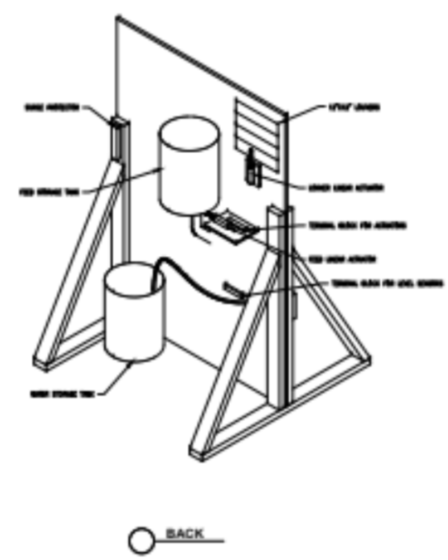



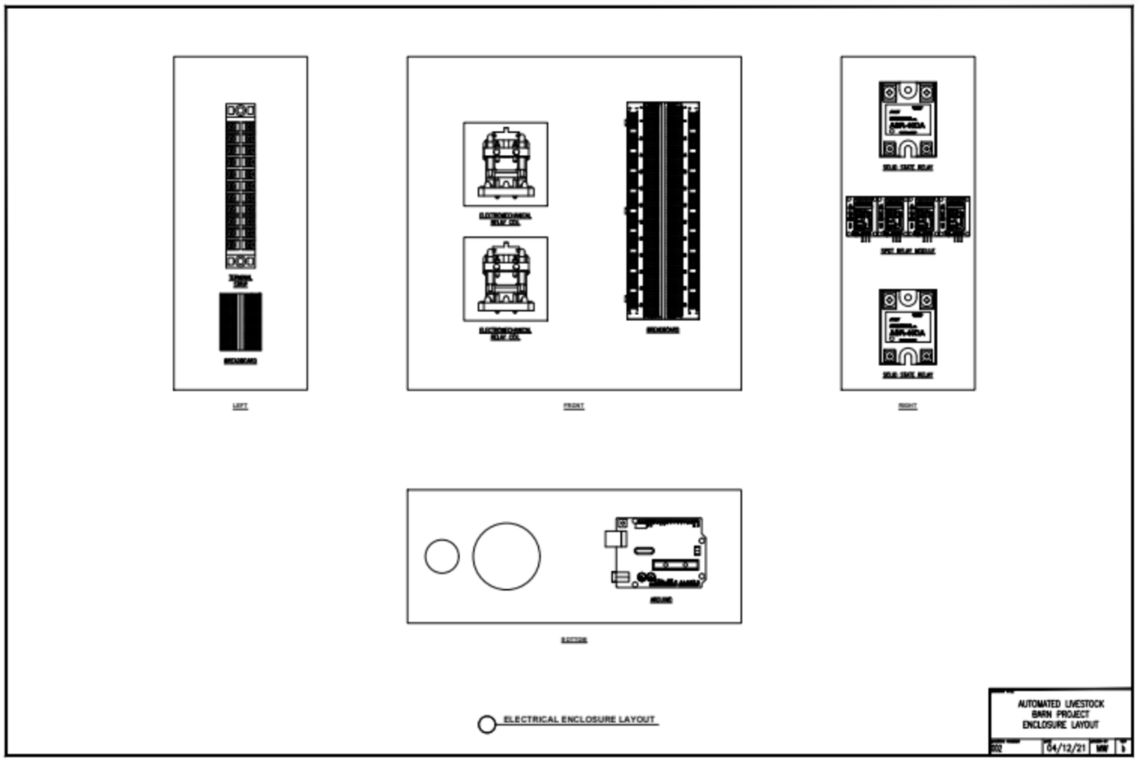



## Appendix H: Final Project Schematics, Physical and Enclosure Layout

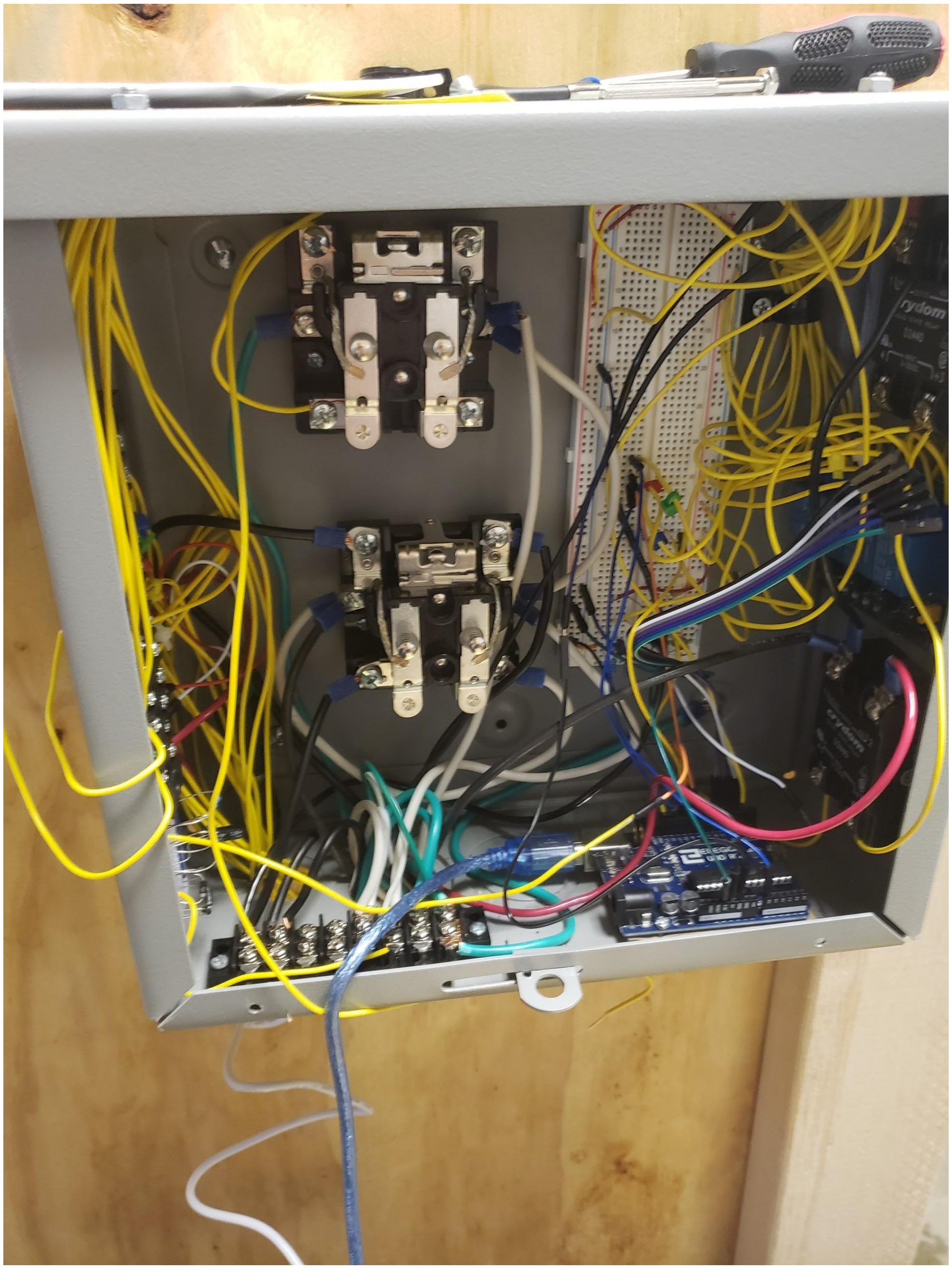



ELECTRICAL ENCLOSURE LAYOUT
AUTOMATED LIVESTOCK
BARN PROJECT
ENCLOSURE LAYOUT
04/12/21


START
STOP



## Appendix I: Zane State College Automation Project Prompt

**EEET 2510 – Introduction to Programmable Logic Controllers**
**Livestock Cooling, Lighting, Watering Control System**

Project Overview:
Your assignment is to design and construct a PLC-controlled, livestock cooling, lighting, and watering system.

Project Requirements:
- Your circuitry should use a SLC 5/04 PLC to control an Allen-Bradley PowerFlex 4® Adjustable Frequency AC Drive.
- The AC drive will control the speed of a three-phase squirrel cage induction motor that drives a cooling fan. Fan speed will be dependent on an average indoor building temperature taken at 4 different points. Fan speed as a function of temperature should correspond to the following relationship: 0°F – 70°F (0 RPM), 71°F – 80°F (25% of max. motor speed), 81°F – 90°F (50% of max. motor speed), 91°F – 100°F (75% of max. motor speed), above 101°F (100% of max. motor speed).
- If the temperature exceeds 110°F, a red warning light will flash.
- Motor speed is to be controlled by a 4 – 20 mA source from a SLC 5/04 PLC.
- Use the PLC output module to power a magnetic contactor that will provide power to the motor.
- The motor should be ramped up and ramped down in speed with temperature change and at startup and shutoff.
- Your circuitry and PLC program should turn indoor building lights on and off based on amount of daylight measured using a photoconductive cell.
- Use the PLC to control water supply to a watering trough using some type of level detection system.
- Use a stepper motor (with sprockets and chain) to rotate linkage to open air flow vents during fan operation to the fully shut position, fully open position, or half way open position.
- Use a linear actuator (transducer) to determine the position of the vents.
- Your circuitry should provide for emergency shutoff by the operator.
- Provide short circuit and overload protection.

Required documentation:
- Design proposal. Describe what you are trying to do and how you plan to accomplish it. Include sketches. Indicate the team manager. List all team members and their responsibilities, in detail. Include a project plan (sequence) of events with timetable. This is due week 2, day 1 of the project. Your project should strictly adhere to the adage, "Build in stages, test in stages." **Your instructor must approve each actionable event before you apply power!**

1

- Submit a progress report day 2 of the third week of the project that describes what has been done, including a detailed description of all testing of all phases and what remains to be done and a timetable to project completion.
- Keep a daily log (diary) of all that was done, by whom, for how long, and on what day. The team manager shall assign a different team member to write this the last 20 minutes of class **each** day on a computer in A1214/A126 and print out a copy, with date, to me in memorandum format. I will immediately review and edit. A final error-free copy is to be submitted shortly after your draft copy is evaluated.
- Print out of ladder logic (well documented) to perform the operation.
- Wiring diagram for the PLC modules.
- Engineering specifications and performance data for the AC drive (including all drive parameters), motor, magnetic contactor, thermal overload protection, and PLC modules.
- Electrical schematic diagrams of the motor control circuitry and AC drive circuitry.
- Hard copy of system documentation including the PLC program and operator instructions. Include an instruction manual describing set up, programming, and wiring of the variable-speed drive (VSD). E-mail an additional copy of the program to the instructor.
- Design/calculations sheet including each device and its current draw at turn on and under load. Nameplate data for motor and calculations for wire size, motor starter, and fuse protection. Current and voltage ratings for all switching and control devices (sensors, switches, magnetic contactor, PLC modules, thermocouple, programming data for thermocouple module, etc.).
- AutoCAD or OrCAD drawing of operator control panel.
- Include schematic and wiring diagrams of any remaining circuits.
- Describe all test and calibration procedures.
- Team members will develop a Power Point of their project for presentation during final exam week. Each team member will make an oral presentation of some phase of the project. A demonstration of the project will be made following the Power Point presentation. **Take digital photos of your project as you complete it.**

Things to do right away:

- Have one person become familiar with Microsoft Visio immediately. Eventually draw the water valve circuit using Visio.

2

- Eventually make an AutoCAD drawing of the entire mechanical assembly showing the location of the motor, vents, position transducer, light bulbs, etc.
    - Assign an AutoCAD designer(s). Become familiar with AutoCAD Electrical right now.
- Obtain an electronic copy of the PDF of the datasheet for the Honeywell Linear Position Transducer.
  - Read and understand it.
  - Design a circuit to use it to produce a 0 – 10 volt signal.
    - Work with team leader to design a mounting/test fixture.
    - Calibrate.
      - Document.
      - Determine the calibration constant.
  - Determine how to wire into the 1746-NIO4I. Work with the PLC programmer.
- Assign someone to get the PDF for the ASCO valve.
  - Learn the operation of the valve.
  - Power and test the valve.
    - Measure inrush and continuous current to the solenoids.
    - Record.
- Assign two people as the primary "wiring" technicians.
  - Identify all wiring currently in place and determine function.
  - Get data sheets for the Potter Brumfield control relays. Measure the inrush and continuous current.
  - Make sketches of circuits as they develop.
    - Forward to AutoCAD Electrical designer.
- Assign someone as the primary PLC programmer.
  - Begin with a basic start-stop circuit with B3:0s in front of everything to stop all function in a panic stop situation. Write the temperature measurement program. Use the thermocouple at your PLC trainer.
  - Obtain data sheets in electronic form for 1746-IV8 and 1746-OW8.
    - Get all current and voltage ratings.
- Become familiar with the operation of the three-phase motor and controls.
  - Use a magnetic contactor.
  - Measure its inrush and continuous coil current.
- Assign someone to build the stepper motor control circuit from EEET 2150.
  - Prototype.
  - Eventually interface to the PLC to download the pattern to the shift register.
- Obtain an electronic copy of the PDF of the User Manual for the Flex 4 drive.
  - Read and understand it.
  - Wire the VFD and test it.
  - Write subroutine for three different speeds.
- All individuals should ultimately understand all phases of the project.

3

- Team members should report to team leader to come up with a planned layout of the project to fit on, or near, the trainer.
- Start a logbook by day 2.
- Take pictures of what is being done with someone's cellphone to download to a PC.
- At 8:30 pm (or sooner) one person should be in front of a PC writing the daily memo. Hand it over to me at 8:40 pm or sooner.

MEMORANDUM

To: Livestock Controls President and CEO, Jim Davis
From: Who wrote it
Date: April 10, 2017
Subject: Summary of daily outcomes for project

Body of memo. Summary of who did what today.

Have a team member edit your work.

Give to me to be graded.

C:\2510Projects\Livestock HVAC System with Stepper Motor

## Appendix J: Raspberry Pi 4 Final Code in Python 3

```
#imports
import RPi.GPIO as GPIO
import math
import time
import board
#for light sensor obviously
import adafruit_dht
from gpiozero import LightSensor
#for time set up hope it works
import queue
import threading
import datetime
#pins Defined/ other definitions
flalPin = 7
flarPin = 11
avalPin = 12
avarPin = 13
rlbPin = 15
srwpPin = 16
llswPin = 18
llwsPin = 33
tempPin = 35
pcerPin = 36
flwsPin = 37
flslPin = 38
sdarPin = 40
#gpio set up
GPIO.setmode(GPIO.BOARD)
#outputs/inputs
GPIO.setup(flalPin,GPIO.OUT)
GPIO.setup(flarPin,GPIO.OUT)
GPIO.setup(avalPin,GPIO.OUT)
GPIO.setup(avarPin,GPIO.OUT)
GPIO.setup(rlbPin,GPIO.OUT)
GPIO.setup(srwpPin,GPIO.OUT)
GPIO.setup(llwsPin,GPIO.IN)
GPIO.setup(llswPin,GPIO.IN)
GPIO.setup(tempPin,GPIO.IN)
GPIO.setup(pcerPin,GPIO.IN)
GPIO.setup(flwsPin,GPIO.IN)
GPIO.setup(flslPin,GPIO.IN)
GPIO.setup(sdarPin,GPIO.IN)
```

```
#low or high at start?
#lightbuilb
GPIO.output(rlbPin,GPIO.LOW)
#water pump
GPIO.output(srwpPin,GPIO.LOW)
#feed actuators
GPIO.output(flalPin,GPIO.LOW)
GPIO.output(flarPin,GPIO.HIGH)
#air Vent actuators
GPIO.output(avalPin,GPIO.LOW)
GPIO.output(avarPin,GPIO.HIGH)
#feed works
#Start while loop
#feed on at a certain time of day
while True:
    time = datetime.datetime.now().strftime("%H:%M")
    if time == "12:00":
        GPIO.output(flalPin, True)
        GPIO.output(flarPin, False)
        #length of time on
        time.sleep(number_of_seconds_for_led_to_be_on_here)
        GPIO.output(flalPin, False)
        GPIO.output(flarPin, True)
    time.sleep(0.030)
try
    while 1:
        if
        else:
except
#resting state extended
#retract to feed
#activate for certain time
#then back to resting state
#air vents
#temperature setup needs changed to fit our needs and used to turn on/off air
tempPin = adafruit_dht.DHT11(board.D4, use_pulseio=False)

while True:
    try:
        # Print the values to the serial port
        temperature_c = dhtDevice.temperature
        temperature_f = temperature_c * (9 / 5) + 32
        humidity = dhtDevice.humidity
        #need to learn how to print to gui
```

```
        print(
            "Temp: {:.1f} F / {:.1f} C    Humidity: {}% ".format(
                temperature_f, temperature_c, humidity
            )
        )

    except RuntimeError as error:
        # Errors happen fairly often, DHT's are hard to read, just keep going
        print(error.args[0])
        time.sleep(2.0)
        continue
    except Exception as error:
        dhtDevice.exit()
        raise error
while temperature_f >= 80:
GPIO.output(avalPin,GPIO.HIGH)
GPIO.output(avarPin,GPIO.LOW)
else:
GPIO.output(avalPin,GPIO.LOW)
GPIO.output(avarPin,GPIO.HIGH)

#light bulb
#sets up pin as the light sensor need to figure out how to turn of on a LB


#Catch when script is interrupted, cleanup correctly
try:
    # Main loop fix to have print be light on not yet sure
    #while True: print(rc_time(pcerPin)) == 1
while True:
        GPIO.input(pcerPin) ==1
        GPIO.output(rlbPin,GPIO.HIGH)
except KeyboardInterrupt:
    pass
finally:
    GPIO.cleanup()
#photocell read 1 on 0 off delay 1 min after on 0 to off
#water pump

#top loop water source not empty
while True:
        GPIO.input(llswPin) == GPIO.LOW
        while True:
```

## Appendix J: Arduino UNO Final Code

```
// what needs included?
#include <SimpleDHT.h>
// define all pins
SimpleDHT11 dht11;
const int buttonState = 0;
const int flalPin = 3;
const int flarPin = 4;
const int avalPin = 5;
const int avarPin = 6;
const int rlbPin = 7;
const int srwpPin = 8;
const int llswPin = A0;
const int llwsPin = 9;
const int tempPin = 2;
const int pcerPin = 10;
const int flwsPin = 11;
const int sdarPin = 13;

void setup() {
  Serial.begin(9600);
  pinMode(flalPin, OUTPUT);
  pinMode(flarPin, OUTPUT);
  pinMode(avalPin, OUTPUT);
  pinMode(avarPin, OUTPUT);
  pinMode(rlbPin, OUTPUT);
  pinMode(srwpPin, OUTPUT);
  pinMode(llswPin, INPUT);
  pinMode(llwsPin, INPUT);
  pinMode(tempPin, INPUT);
  pinMode(pcerPin, INPUT);
  pinMode(flwaPin, INPUT);
  pinMode(sdarPin, INPUT);
}

void loop() {
  //starting varible states
  int flalPinState = 0;
  int flarPinState = 1;
  int avalPinState = 0;
  int avarPinState = 1;
  int rlbPinState = 0;
  int srwpPinState = 0;
```

```
 int llswPinState = 0;
 int llwsPinState = 0;
 int tempPinState = 0;
 int pcerPinState = 0;
 int flwaPinState = 0;
 int flslPinState = 0;
 int sdarPinState = 0;
 //reading pins as?
 llswPinState = digitalRead(llswPin);
 llwsPinState = digitalRead(llwsPin);
 tempPinState = digitalRead(tempPin);
 pcerPinState = digitalRead(pcerPin);
 flslPinState = digitalRead(flslPin);
 flwaPinState = digitalRead(flwaPin);
 sdarPinState = digitalRead(sdarPin);
 // read with raw sample data.
 byte temperature = 0;
 byte humidity = 0;
 byte data[40] = {0};
 if (dht11.read(pinDHT11, &temperature, &humidity, data)) {
   Serial.print("Read DHT11 failed");
   return;
 }
 int tempF= ((int)temperature)*1.8+32;
 String sensorValue =  String(tempF, DEC);
 String buttonString = String(buttonState,DEC);
 String comma = String(",");
 Serial.println(buttonString += comma += sensorValue);
 // DHT11 sampling rate is 1HZ.
 delay(1150);
// temp air vent function
 if (tempF >= 80)
   {digitalWrite(avalPin,HIGH);
    digitalWrite(avarPin,LOW);}
 else if (tempF <= 79)
     {digitalWrite(avalPin,LOW);
     digitalWrite(avarPin,HIGH); }
 //Lights
 if (pcerPin == HIGH)
   {digitalWrite (rlbPin,HIGH);}
 else if (pcerPin==LOW)
   {digitalWrite(rlbPin,LOW);}
delay(50)
 //smoke
```

```
  if (sdarPin == HIGH)
    {Serial.print("Fire!")}
delay(50)
  //food/water
  while (llwsPin == LOW){
  //how so the way the loops work in this is different so trying to figure this out again
   If (flwaPin == HIGH)//top dry add the sensor info in before testing
{delay(1080000)//3 hours fills up
digitalWrite(srwpPin,HIGH);
    digitalWrite(flalPin,HIGH);
    digitalWrite(flarPin,LOW);
    delay(700)
    digitalWrite(flalPin,LOW);
    digitalWrite(flarPin,HIGH);}
   If (flwaPin == LOW & llwsPin == LOW )//both wet add the sensor info in before testing
   {digitalWrite(srwpPin,LOW);}
}

}
```