BIO-HAZARD WASTE BIN

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ABSTRACT

we designed and fabricated a biohazard waste bin than can be used in hospital and laboratories. The biohazard waste bin collects physical information from ultrasonic sensor, force sensing resistor and the water leak detector. In addition the biohazard waste bin allows the central microcontroller implemented by ARDUINO UNO to receive analog signals from the sensors installed.

The microcontroller makes use of RTC chip to keep track of time and passes out data to a half-bridge chip SN754410 to control the spinning direction and the speed of the motors. Also, the microcontroller passes out data to a relay switch to heat up or cool down the heating wire.

Finally, the microcontroller transmits data to the LCD screen. The LCD screen refreshes every second. Current time, current weight and detection of leakage will be displayed as readable message to the user terminal.

The ultrasonic sensor and force sensing resistor draws power directly from the ARDUINO. The motors draws 12 Volt DC from the AC/DC adapter. The water leak detector draws 5 Volt DC after DC/DC step down from original 12 Volt DC.

Although our project worked, there is still space for improvement on the length of the heating wire in physical application and the precision of the water leak detector and discussed later in the future development.

The cost of the final implementation are a little bit higher that we summed up in the draft.

OUTLINE

1. INTRODUCTION

We designed this Bio-Hazard waste bin that can be used in hospital or laboratories to provides relatively safer environment for doctors, nurses, patients or experimenters. The biohazard waste bin collects data from the sensor unit and controls other modules using microcontroller. The control data are transmitted to the execution module such as heat-sealing module and lid module. Also, the microcontroller module passes out data to the display module. All those modules draw power from the power unit.

1.1 PURPOSE

The purpose of this project is to provide relatively safer environment for doctors, nurses, patients or experimenters. Medical waste from hospital or laboratory waste from research institute, if not processed properly, will bring huge damage to the environment and people. We noticed that the waste bins which possibly contain bio-hazard waste in most hospitals and labs can be modified to be more efficient and safer. And we have thought of many ways to make the waste bin more secure easy-to-use. The final product has automatic lid to minimize the interactive contact. The trash is securely stored inside without any exposure in the air. When the current trash bag is full it will be heat-sealed. The LCD screen will show the time that this bag was set and that it was sealed, also a warning message that indicated dangerous leakage in order to have professional staff to clean up.

1.2 FUNCTIONS

With the ultrasonic sensor we installed on the lid, the lid will open and close automatically when human approaches. And our waste bin can provide proper seal of each bag to prevent the bacteria from spreading. There will also be an LCD display screen on the side of the waste bin.

Main functions of the biohazard waste bi can be concluded as below:

- Detect disposal action
- Auto-open lid
- Weight report
- Water leak detection in the trash can
- Auto heat- sealing instructed by MCU

On the LCD screen the following information will be displayed:

- The exact time when this garbage bag was set
- The current time
- The current weight of the garbage bag
- Whether the current bag is sealed
- A warning message when there is a leakage detected in the garbage bag

1.3 SUBPROJECTS

As introduced above, the design was broken into many modules, each of which performs specific tasks. The modules we decided to implement were:

1.3.1 SENSOR MODULE: Sensor Module collects physical quantity and converts them into signals which can be read by the MCU module (ARDUINO). Here three types of sensors are implemented, which are Ultrasonic Sensor, Force Sensing Resistor and Water Leak Detector. The output signals of these sensors are directly sent out to the MCU module. The sensors are powered by connecting to the Power Module.

1.3.2 POWER SUPPLY MODULE: The power supply module output 12Vdc and 5Vdc. 12V is to supply the power of the heat sealing module and Arduino and 5V is to supply the water leak sensor.

1.3.3 MCU MODULE: The MCU Module is implemented by using ARDUINO UNO Board. ARDUINO Board is an open-source electronics prototyping platform based on flexible, hardware and software. ARDUINO senses the environment by receiving input analog signals from the Sensor Module. Then the MCU Module passes output digital data to the Lid Module, Heat-Sealing Module and the LCD Display Module. The MCU Module is programmed using ARDUINO programming language and ARDUINO development environment. ARDUINO is powered by the Power Module.

1.3.4 MOTOR MODULE: The motor module includes two motors, one is the lid motor and the other is the heat sealing motor. Both motors are controlled by a half-bridge chip that receives signals from MCU and controls the speed and the direction of both motors independently.

1.3.5 HEAT-SEALING MODULE: The heat sealing module contains a nichrome wire and a relay switch. The nichrome wire can be heated up to a high temperature to melt and then seal the trash bag when it is connected to the circuit. The relay switch takes signals from Arduino and can therefore control the time that for how long the circuit is closed. For the remaining time, the circuit should always be open that the nichrome wire will not be powered up.

1.3.6 DISPLAY MODULE: the Display Module is implemented by LCD screen and receives data from the MCU Module and displays weight, date and time and warning message.

2 DESIGN PROCEDURE

2.1 WATER LEAK DETECTOR DESIGN

Use the schematic for assembling the water leak detector circuit. Connect the the circuit to 5 V dc from converted power supply. Continue building the circuit on the board, following the schematic. Transistor, PNP 2N 3906 and Transistor, NPN 2N 2222A, three 10kΩ resistors are being used. Finally, an output analog signal is drawn from the circuit to the ARDUINO.
We use a large needle to pierce 2 parallel holes into the side of a sponge, about 2" deep and 1" apart. Strip at least 2" of insulation off 2 pieces of solid copper wire, and insert the bare copper into these holes. Connect the other ends of the copper wires to the circuit, and lay the sponge on the bottom of the waste bin. When water leaks and is absorbed by the sponge, the resistance between the 2 bare copper wires drops to about 10kΩ or less. This forward-biases the 2 transistors and causes the output analog signal raises up to 5 V.

2.2 POWER SUPPLY DESIGN

We use an AC/DC power adapter to convert wall outlet to 12V dc. This 12V is to supply the motor module, the heat sealing module and Arduino. Two motors consumes 1A at maximum, the heat sealing module requires a current of 1.5A at maximum and at standard Arduino consumes 500mA but 1A at maximum. In this way, we specifically chose our adapter to have a maximum output of 5A at 12V. Besides, the 12V output needs to be regulated down to 5V for the water leak sensor. The water leak sensor takes less than 500mA so we can use a simple linear voltage regulator to step down the voltage, considering any power loss in this regulation, we add a heatsink on this regulator. The 5V output of Arduino will supply the force sensor, the ultrasonic sensor and the LCD screen.

2.3 MOTOR CIRCUIT DESIGN

We have two motors in our design and we want to control the direction, the speed and the time of running of both motors separately. We choose to use a single half-bridge chip to control motors, the chip is connected to Arduino and functions according to signals received. This chip is also connected to 12V external power supply for motor usage.

2.4 HEAT SEALING DESIGN

We choose to use the nichrome wire, a kind of resistance wire to seal the trash bag. The nichrome wire will be heated up to 130 ℃ to melt the trash bag in order to seal it. We have an input voltage of 12V, a gauge 26 nichrome wire, and to heat it up to 130℃, we have to use a 93.4 cm nichrome wire. We wrapped this length of wire around the movable rod. This rod is made of a kind of plastic that melts at 500℃, so it won’t affect the sealing process. The nichrome wire is finally held in position and protected by electric tape so that customers won’t be able to touch them directly.

3. DETAILED DESCRIPTION

3.1 SENSOR MODULE

Ultrasonic Sensor: we chose commercial PING))) Ultrasonic Distance Sensor for the distance sensing needed for the automatically opened lid. The PING))) Ultrasonic Distance Sensor is placed on the movable lid of the waste bin. As a human body passes in front of the waste bin, the ultrasonic pulse sent by the ultrasonic distance sensor will bounce back the human body and get back to the sensor, which will calculate the distance. When the ultrasonic distance detect that someone is closing in, it will pass a signal to the MCU Module. As indicated from the datasheet, the power supply needs to be 5 Volts DC and current supply needs to be with the range of 30 to 35 mA. While the measuring distance range is 2 to 300 cm. We programmed when users are no more than 15cm from the garbage can, microcontroller commands the lid open. The schematic is shown in figure 7.

Force Sensing Resistor: we chose FSR Part No. 406. FSR to detect the weight of the dispose. The FSR is place at the bottom inside the waste bin. This FSR will vary its resistance depending on how much pressure is being applied to the sensing area. The harder the force, the lower the resistance. When no pressure is being applied to the FSR its resistance will be larger than 1MΩ. This FSR can sense applied force anywhere in the range of 100g-10kg. Two pins extend from the bottom of the sensor as pitch.The schematic is shown in figure 8.

Water Leak Detector: Route schematic for assembling the water leak detector circuit. The input power supply is 5V DC, which gives an output voltage when the sponges is wet between the copper wires inside. The output voltage will be analyzed by the MCU Module.The schematic is shown in figure 9. The simulation is shown in figure 22.

3.2 POWER SUPPLY MODULE

AC/DC Converter: We use a commercial AC/DC adapter that outputs 12V dc and 5A, a maximum of 60W power supply. A trash can is a long-term product, if it uses battery for power supply, the customer will have to recharge it regularly, in particular, the heat sealing design is power consuming that a battery will not support for hundreds times of usage, thus we decided to use a wall outlet to provide the power.

The motor consumes Pm=Vm*Im=12V*1A=12W,

1A is because both motors are connected to a controller chip and this chip can drive at maximum of 1A.

The heat sealing module consumes Ps=Vs*Is=12V*1.5A=15W,

1.5A is the maximum current, theoretically it should be around 1.47A.

The Arduino consumes Pa=Va*Ia=12V*500mA=6W

We have a total power consumption of 12W+15W+6W=33W<60W, so the power design is safe.

DC/DC Converter: We need also a DC/DC converter to step down 12V to 5V. 5V is supplied to the force sensor, the ultrasonic sensor and the water leak detector. We use a LM7805 linear voltage

regulator to regulate the voltage. LM7805 has a maximum output current of 1.5A while the overall consumption of current of all sensors should be less than 1A. We could use LM317 which is an adjustable voltage regulator, however, since we only want a 5V output, to avoid any complexity of the circuit and since 7805 has a higher output current, we chose not to use LM317.
LM7805 only outputs 5V within a range of ±4%, to regulate the voltage down to 5V, it consumes $P_c=V_{c\_diff}*I_c=(12V-5V)*1A=7W$.
The operation temperature of 7805 is up to 125℃, with this 7W dissipation, we add a heatsink on this chip and so to prevent it from being burnt down.

3.3 MCU MODULE

Arduino Board: The Arduino Uno R3 board we are using as micro controller is what is really holding all the parts together. As shown in the high level block diagram, the MCU Module will interface with the LCD Display Module, the Motor Module, the Heat Sealing Module and the Sensors Module.
Interfacing with the Sensors Module: When the ultrasonic sensor on the lid detects human movement within range, or when the force sensor detects sufficient force, or when the leak detection sensor on the bottom of the waste bin detects a leak, they will all send a signal to the MCU Module, and the MCU module will decide what to do next, respectively.
Interfacing with the Motor Module: After the MCU Module receives a signal from the ultrasonic sensor indicating that human movement within range is detected, a signal will be sent from the MCU Module to the Lid Module to tell it to open the lid automatically and close it after 3 seconds.
Interfacing with the Heat Sealing Module: After the MCU Module receives a signal from the force sensor indicating that the specific weight of the waste bag has been achieved, the MCU Module will send a signal to the Heat Sealing Module to tell it that it is time to seal the current bag.
Interfacing with the LCD Display Module: The Arduino board will be outputting message to the LCD Display Module for it to display on the LCD screen at all time. The specific message displayed on the LCD screen is explained later.
RTC Chip: This is the Real Time Clock chip that we will use to calculate the delay time for the Lid Module. This will also be the signal to output to the LCD Display Module for the time display.

3.4 MOTOR MODULE

Motor: The lid motor is a brush gear motor which contains an electric motor and a reduction gear train integrated into one package. We choose our motor to be Pittman GM9434 gear motor which has two permanent poles and can rotate smoothly at 105 rpm. Gear motor has a high torque that it will drive to open the lid easily. The heat sealing motor is of the same type.
Motor Controller: We have a two-pole motor which means that if we want the motor to be bidirectional, we can only reverse the direction of current that goes through. In accordance with

our ARDUINO design, we choose to use an H-bridge to make this work in a simple way. An H bridge is an electronic circuit that enables a voltage to be applied across a load in either direction. We choose SN754410 motor driver IC in our case, the data pin of which is shown in picture 16. We connect 1,2 EN to 5V power supply on ARDUINO, and we use pin 2 and pin 15 as PWM (pulse-width modulation) to set the motor I “full speed” and “brake” mode. If 1A is high and 2A is low, then 1Y, which is the power output is high, and 2Y is low, current flows from 1Y to 2Y; controversially if 1A is low and 2A is high then current flow from 2Y to 1Y. Therefore we have two directions of current flow based on signals of 1A and 2A, we connect the motor to 1Y and 2Y, it is then able to rotate in two opposite directions. If both 1A and 2A are high then motor is in “brake” mode. This is a dual half-bridge chip, so it has two inputs and outputs terminals, with these two input terminals connect to Arduino and outputs to two motors, we can control the speed and direction of these motors.

MCU Timer: We want the lid open when someone is throwing wastes. MCU will receive a signal from sensor and tell the timer to start to count. With this timer, the MCU will tell the lid motor when to run forward, backward or stop as we want to match “open the lid”, “close the lid” and “stop for 3 seconds” design. In a similar way, MCU will tell the heat sealing motor to drive the movable rod forward, stop, and backward.

3.5 HEAT-SEALING MODULE

Heating Controller: This part contains a relay switch and a MCU program that is basically a timer. We will connect our heating wire in series with the relay switch, and the switch is connected to Arduino. Between time W1 and W2, the MCU will continuously send signals “low” to the relay switch so that the switch is closed, the heating wire is powered up and seal the bag, for the rest of the time, the MCU will send signals “low” so that the circuit is open, the nichrome wire is not powered up.

Heating Wire: nichrome wire is has a specific characteristic that it heats up when electricity apply. It can be heated up to 900 degree Celsius so it is capable to melt trash bags at 130℃. Calculation of nichrome wire can be done online via Jacbos online: The heating wire we have has the gauge 26 and we select the voltage to be 12V, this is easier in design because we already have a 12V dc output. Then the only parameter left is the length of the wire. From this calculation we can see that the length we need is 93.4cm. From this calculation pic. 18 we can see that the current we need is 1.47A. An optional design is that, if we determine the length of the nichrome wire at first, and we set the size of the nichrome wire to be the variable, then for a 20cm nichrome wire (which is the width of our trash can), we can use a 40 gauge nichrome wire instead. (pic. 19) The benefit of this one is that we won’t have to wrap the wire around the rod but placed it straightly on the surface of the rod. The current will not affect much because 12V is an output from an AC/DC adapter. The reason that we couldn’t choose this design was because we don’t have gauge 40 nichrome wire at the school lab. A second optional design is that if we determine the length of the wire and the gauge of the wire at first, we calculate for the voltage, then we can see that it should be around 2.5V. pic

20. The problem of this design is that at 2.5V, we still need an output current of 1.47A. If we regulate this voltage from 12V down to 2.5V, there will be a lot of heat dissipate on the voltage regulator that it will not provide 1.47A constantly. The total resistance of a 20cm nichrome wire is only 1.75Ohm, that it consumes P=V2/R=2.5V^2/1.75Ohm=3.5W. Compared to the power dissipation on the voltage regulator which is P'=V*I=(12-2.5)V*1.46A=13.87W, and to prevent the circuit being shorted, the voltage regulator will drop its output voltage to balance the power dissipation, thus we won't have a 1.5A output to power up the nichrome wire. So our final decision was to use a 93.4cm nichrome wire, gauge 26 at 12V.

3.6 DISPLAY MODULE

The Arduino output 5V is connected to the LCD screen which consumes at maximum of 40mA.

LCD Screen: The LCD screen we are using is a 20x4 LCD screen based on HD44780. It shows white characters on blue background, and it has 4 rows and 20 characters in each row. It will display different information in different situations. It will get its signal from the MCU Module, and the connections between the LCD screen and the Arduino board in the MCU Module are shown in figure 21.

When the current bag in the waste bin has already been sealed, the LCD screen will display the time when the bag was set, the time when the bag was sealed, and the weight of the bag. It is shown in figure 15, left top.
When the current bag is not yet sealed, the second line will be replaced by the current time. It is shown in figure 15, left bottom.
When there is a leak happening on the bottom of the waste bin, the bottom line of the LCD display will be replaced by a warning message, as shown in figure 15, right:

4. VERIFICATION

4.1 SENSOR MODULE

Block	Requirements	Verifications
Ultrasonic Distance Sensor	a. Connect the PING))) Ultrasonic Distance Sensor Output Distance to 5V DC power b. Perform movements back and forth around 15 cm and testify if the output voltage changes on the oscilloscope. c. Connect the signal output of the sensor to Arduino Analog	**1. Verified. When the sensor is connected to 5V DC power the LED starts to blink.** **2. Verified. Clear signal is observed on the oscilloscope.** **3. Verified. The signal containing the distance of the object is being passed**

	input pin. Perform movements in front of the sensor within a range of 2 to 15 cm. Testify if the sensor and the program are functioning.	**through as ARDUINO serial input.**
Force Sensing Resistor	a. Connect the FSR Part No. 406 into a multimeter. Apply varying forces on the FSR. Record the produced resistance. b. Connect the FSR Part No. 406 to the ARDUINO. Apply varying forces on the FSR. Use the ARDUINO Serial Input window to monitor if the signal is being transmitted.	**1. Verified. The resistance is changing with the force exerted on FSR and the relationship between force and resistance matches the data sheet.** **2. Verified. When various force is exerted on FSR, the ARDUINO Serial Input window is able to display the force exerted.**
Water Leak Detector	a. Connect the circuit power terminal to the power supply of 5V b. With dry sponge connected into the circuit, check if output voltage is 0 V. c. With wet sponge connected into the circuit, check if output voltage is 5 V.	**1. Verified. The circuit power terminal has stable power and current supply.** **2. Verified. Output voltage around 325 mV.** **3. Verified. Output voltage around 4.99779 V.**

4.2 POWER MODULE

Block	Requirements	Verifications

Power	a. regulated down voltage to 5V. b. after power off, there's no energy left in the wire or other conductors.	**1. use an oscilloscope to check the voltage outputs;** **a) connect the output voltage of 7805 and ground, use oscilloscope to observe if this output is steady;** **b) connect this 5V to the force sensor, use oscilloscope to check the voltage across the sensor is still 5V;** **c) repeat for force sensor and water leak detector;** **d) connect all three sensors with 5V from output of 7805, observe that they all function normally.** **2. use oscilloscope to test current at nodes of each module after power is off, make sure that capacitors in the circuit (if there is one) does not store voltage.**

4.3 MCU MODULE:

Block	Requirements	Verifications
ARDUINO UNO	a. Connect the Arduino board to a 12V power source.	**1. Verified. When the arduino is connected to 12V**

	b. For the Lid Module and the Heat Sealing Module, a program can be written on the Arduino board to send a specific sequence of signal, and the oscilloscope will be used at the receiving end to check if the signal is received. c. Check if the output of the electric scale and the Sensor Module can be changed, and the data can be displayed on the Arduino Serial Input window.	**DC Power the green LED is on.** **2. Verified. We are able to make the LCD display whatever we want, and the functions written for lid opening and heat sealing motor movement are all working properly.** **3. Verified. We are able to observe the signal change coming from the Ultrasonic sensor and force sensor on the Arduino Serial Input window.**

4.4 MOTOR MODULE:

Block	Requirements	Verifications
lid motor & heat sealing motor	a. Rotates cw or ccw according to the input.	**1. Switch the input pins and check that after switch, the motor rotates in the other direction;** **a) Connect the output terminals of the motor to 12V and ground, observe that the motor runs in one direction;** **b) switch the input terminals, observe that the motor runs I the other direction** **c) set both input terminals to be ground, observe that**

	b. Is able to stay still quickly after power off. c. Is able to be driven at 12V DC.	**the motor stops.** **2. Check for power remaining after power off;** **a) Turn on the motor, make sure it's running smoothly and then shut off the power, check if the motor stops simultaneously or at least within an acceptable delay at 1~2 sec;** **b) use oscilloscope to connect to the motor to check the wave form of the motor motion, observe that it drops quickly after disconnect to the power.** **3. Connect the motor to a 12V DC power supply to see if it works steadily. Use oscilloscope to check the waveform of output**
Motor controller	a. Is able to receive signals from MCU.	**1. Check signal receiving ability;** **a) Connect H-bridge on bread board with 2 LEDs at two output terminals;** **b) Connect H-bridge with Arduino, use test program to change the signal input, check if only one LED is on each**

		time; **c) Do multiple switches check that LED lights are correct.**
	b. Is able to control the motor with external power supply of 12V.	**2. Connect the chip to 12V** **a) use multimeter to measure the voltage difference at the output terminals of the chip** **b) repeat verification in 1.**
	c. Is able to control two motors independently	**3. Connect two motors to the outputs;** **a) Repeat 1;** **b) instead of having LEDs, use motors directly and observe if the motor runs bidirectionally;** **c) by changing the input value of "enable" pin, observe that two motors can run one in sequence and/or simultaneously.**

4.5 HEAT-SEALING MODULE:

Block	Requirements	Verifications
Nichrome wire	a. Voltage across is 12V constantly.	**1. Connect the wire to 12V input;** **a) use oscilloscope to check that the voltage across the terminals of the wire is 12V constantly;**

	b. Current across is about 1.5A constantly. c. Is able to melt and seal the trash bag	**b) repeat this measurement for various time period (each timer period has a difference of 5 second, same for below.** **2. connect a multimeter in series with the nichrome wire,** **a) while still having a 12V output, check the output current of a 93.4 cm nichrome wire to see if it's 1.5A** **b) repeat the measurement for various time period, observe any drop of current** **3. Keeping a 12V input, cover the nichrome wire with a trash bag** **a) test if at 12V, 1.5A the wire melt the trash bag** **b) repeat the procedure for various time period to see which one melt the bag but not cut it** **c) record the best time period, repeat the experiments for 10 times to check if it does melt and seal the bag properly.**
Relay switch	a. is able to receive signal from	**1. Connect the switch**

	Arduino	**selection pin with Arduino and GND.** **a) Set Arduino output signal "high", measure the output voltage across the switch to see if it's 5V** **b) repeat if output signal is "low" to see if it's 0V.**
	b. is able to close and open the circuit	**2. Connect the switch with a multimeter** **a) when Arduino signal is "high", measure the resistance of the circuit, if closed, the resistance should be small** **b) when Arduino signal is "low", measure the resistance, and it should be very huge since the circuit is open**
	c. allows high current output with small current input	**3. Connect the switch with a multimeter in series. Arduino output current is always low, we measure the current at the output terminal** **a) Connect the switch with a 10 Ohm resistor, measure the current goes through the circuit** **b) repeat this for a 5 Ohm resistor and a 15 Ohm resistor, make sure that the**

		current varies but can be as high as 1.5A for a 8 Ohm resistor.

5. Costs

The Parts total and salary are listed in the table below in Appendix Costs.
The grand total is 36208.92usd.

6. CONCLUSIONS

6.1 Accomplishments

By the end of the semester, we have finished our design. Due to insufficient time we have, we are unable to move the circuit to a PCB or a vector board, but everything works as expected on the breadboard.

When we walk to the waste bin, the lid is able to open automatically when we are closer than 15cm, and the lid is able to automatically close after 3 seconds. The LCD screen is able to show different display message in different situations, and the time displayed on LCD is refreshed every second. When the weight of the garbage bag exceeds 900g, which will be displayed on the LCD, the Micro- controller will start to seal the bag. The clamp on which the heating wires are mounted will close up, then the nichrome wire will be heated up for 35 seconds, generating enough heat to melt and seal the garbage bag. After that the clamp will resume its original position and the sealed message will be displayed on the LCD. When we pour some liquid into the waste bin, the liquid detection sensor we designed is about to send a signal to Arduino which will inform the LCD to show the warning message.

We are pleased to see that all the features we have designed are working and this whole project is finished on time. Although there are still a lot of things we can improve on, we still have to say that we are very satisfied with what we have accomplished in this course.

6.2 Uncertainty

- water leak detector
  - needs accurate measurement on the threshold of the amount of water that triggers detection
  - needs more precise allocation on the spot of leakage
- ultrasonic sensor
  - only detects vertical movements

6.3 Ethical considerations

Our project is to design a bio-hazard medical trash can for hospitals and school labs. We want it to safe and clean, helps protect people from bacteria and we use AC supply instead of using batteries to help protect the environment. With such functionality, we design our project consistently with the first code of the IEEE Code of Ethics:

1. to accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment;

We introduce heat sealing into medical device. Although it has been used in other medical equipment before, it's the first time that it comes to the trash can. We have to organize the heat sealing mechanism to suit our trash can and we use MCU to control the it and its consequences.

5. to improve the understanding of technology; its appropriate application, and potential consequences;

We do get peer reviewing and feedbacks from others and we are sincerely thankful to their help and we are willing to correct our mistakes. Also, we’re willing to give suggestions to each other and to other groups if we know any.

7. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;

6.4 Future work /Alternatives

For further development of our project, we have two main concerns, first is that we can update our design of the heat sealing module. Instead of using a 93.4cm 26 gauge nichrome wire, we can use a 20cm 40gauge nichrome wire, or as an improved design for option 3 as discussed above, we can use a capacitor as the power supply. The problem we had before was that a linear voltage regulator that steps down the voltage from 12V to 5V cannot provide sufficient current to the nichrome wire of 20cm, in this way, we can design a capacitor that stores energy at normal time, but when we want to seal the bag, with the design of the relay switching, we make this capacitor a charger to power up the nichrome wire. The benefit of this design is that this capacitor does not have a current limit of 1.5A, the problem is that we have to deal with the decrease of the voltage because of the property of a capacitor charger.
The second concern is about the water leak detector. Currently, it can detect water because there are wires inside the sponge, only when the water touches the wire, the circuit will be connected, sometimes if we want to be more precise, this design will not satisfy the requirements. For future work, we could have more wires inserted into the sponge, and instead of having multiple wires in parallel with each other, we can create a grid structure at multiple layer of the sponge, in this way, the water leak detector will be more sensitive. But for this design, we have to be specific at the resistance of the total wires giving a 5V power supply.

7. References

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Appendix A

a Block Diagrams

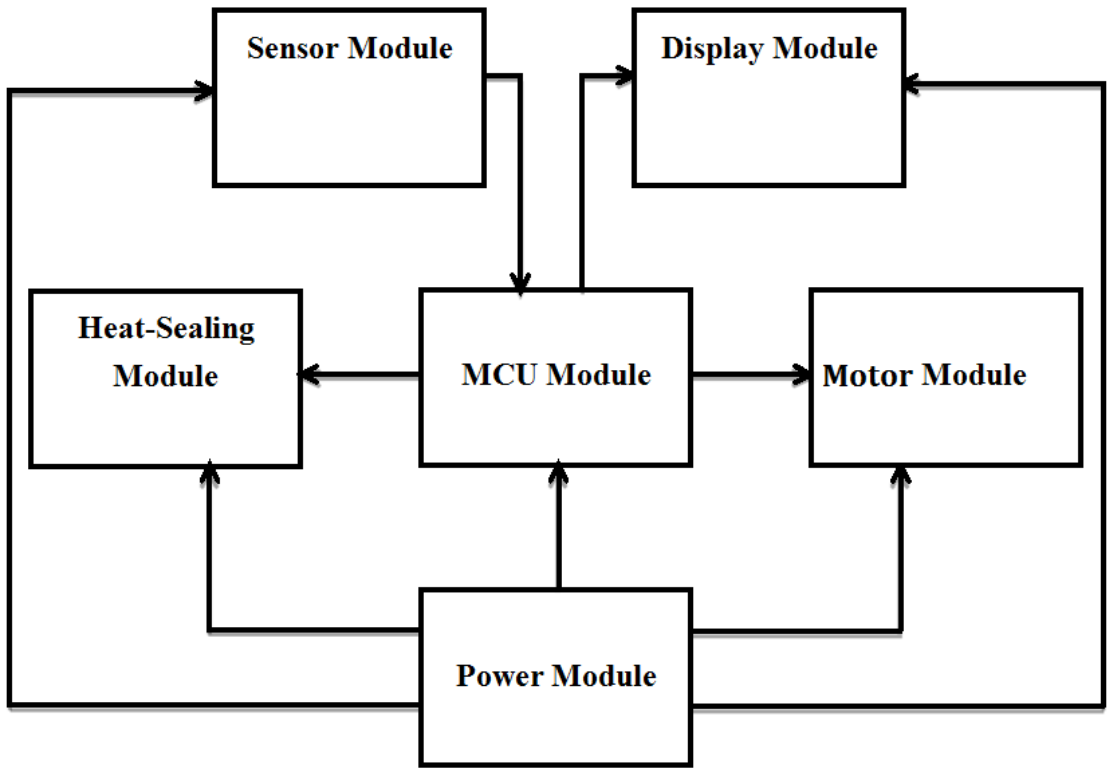


fig 1. overall block diagram

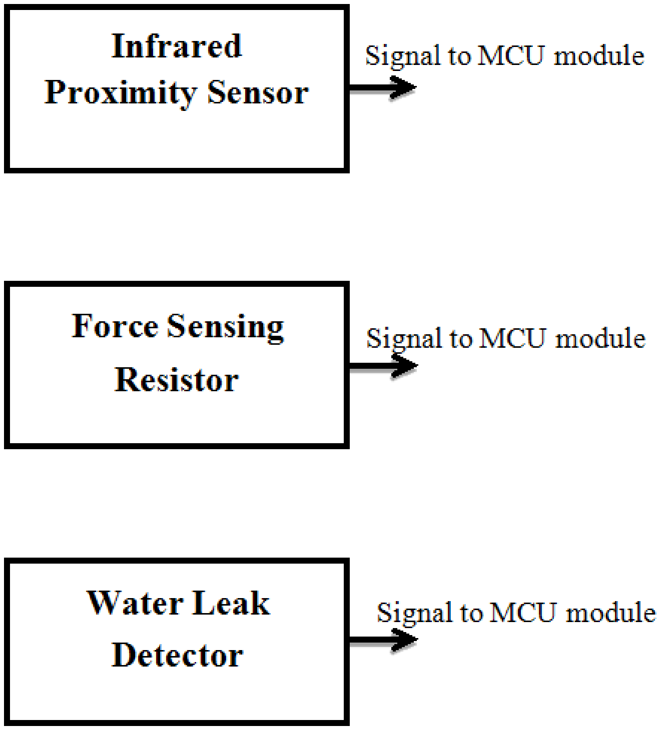


fig 2. Sensor Module Block Diagram

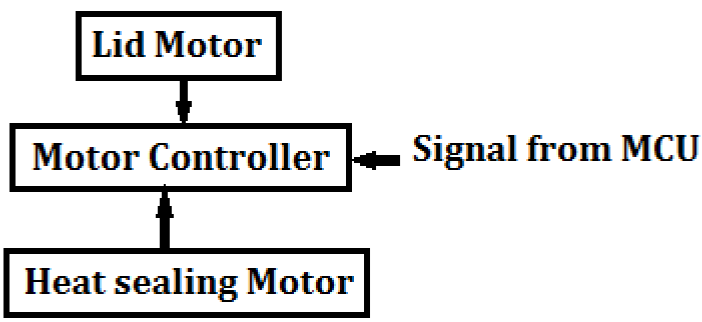


fig 3. motor block diagram

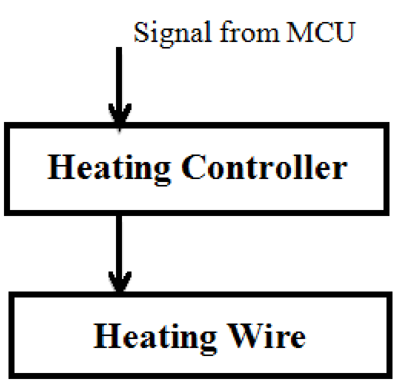


fig 4. heat sealing block diagram

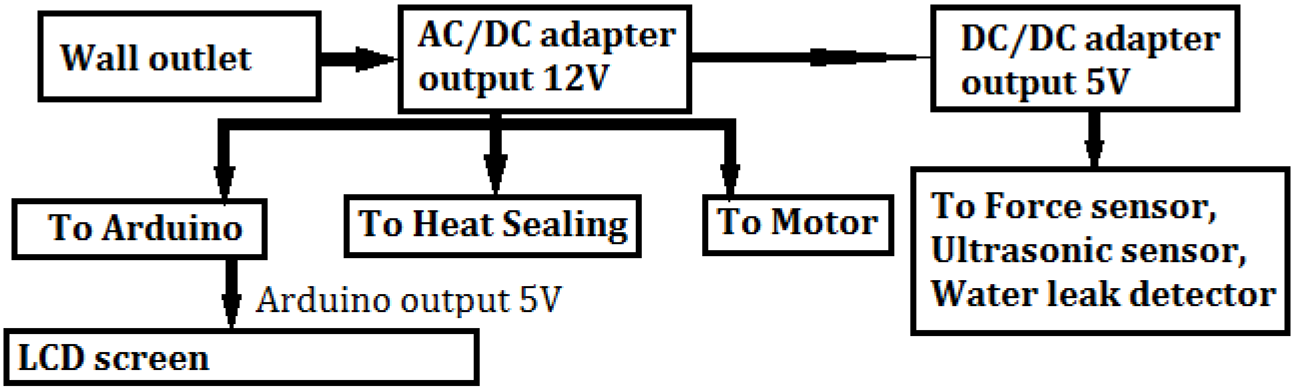


fig 5. power block diagram

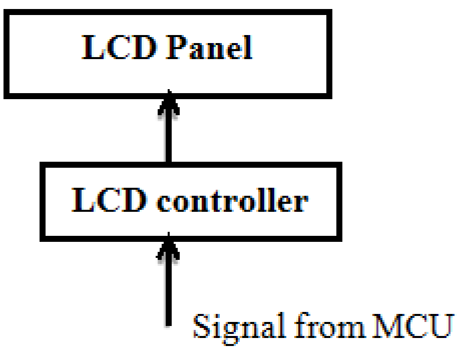


fig 6. LCD Display Module Block Diagram

Appendix B

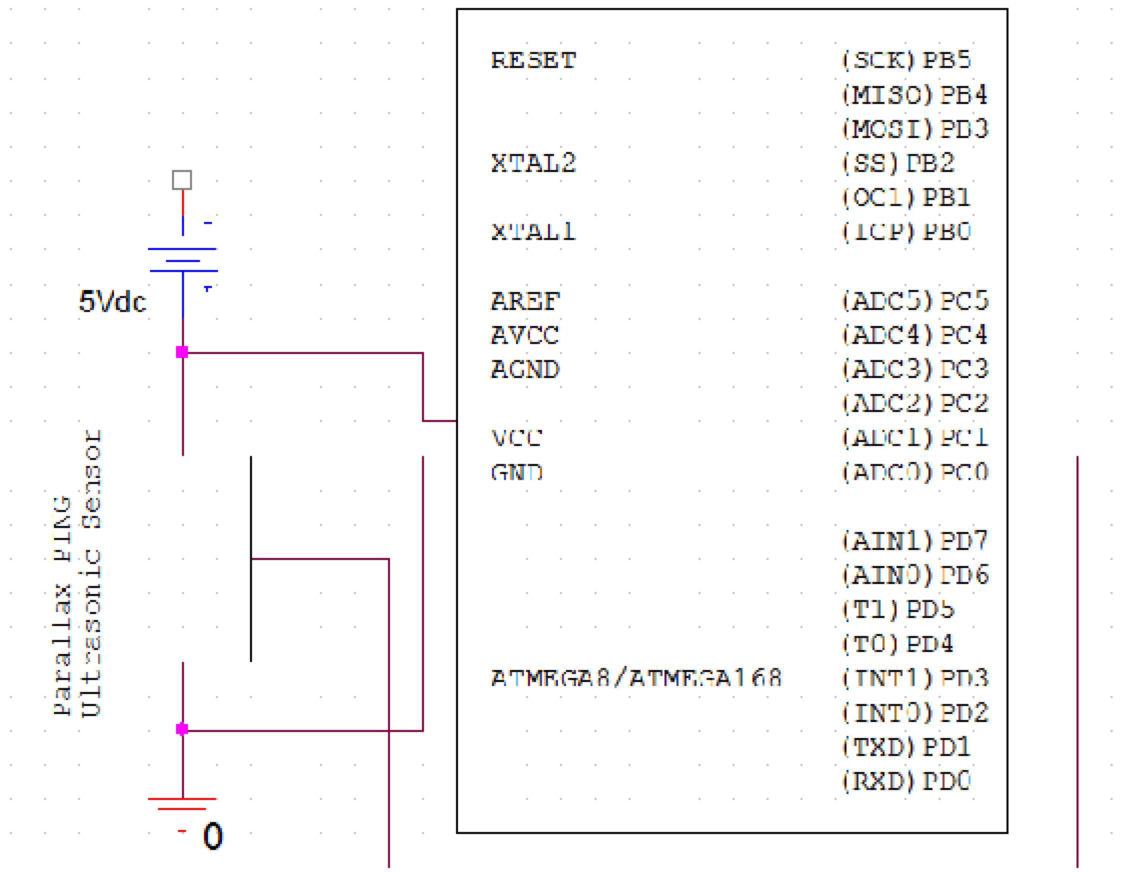


fig 7. Schematics of Connection between ultrasonic sensor and the ARDUINO Board

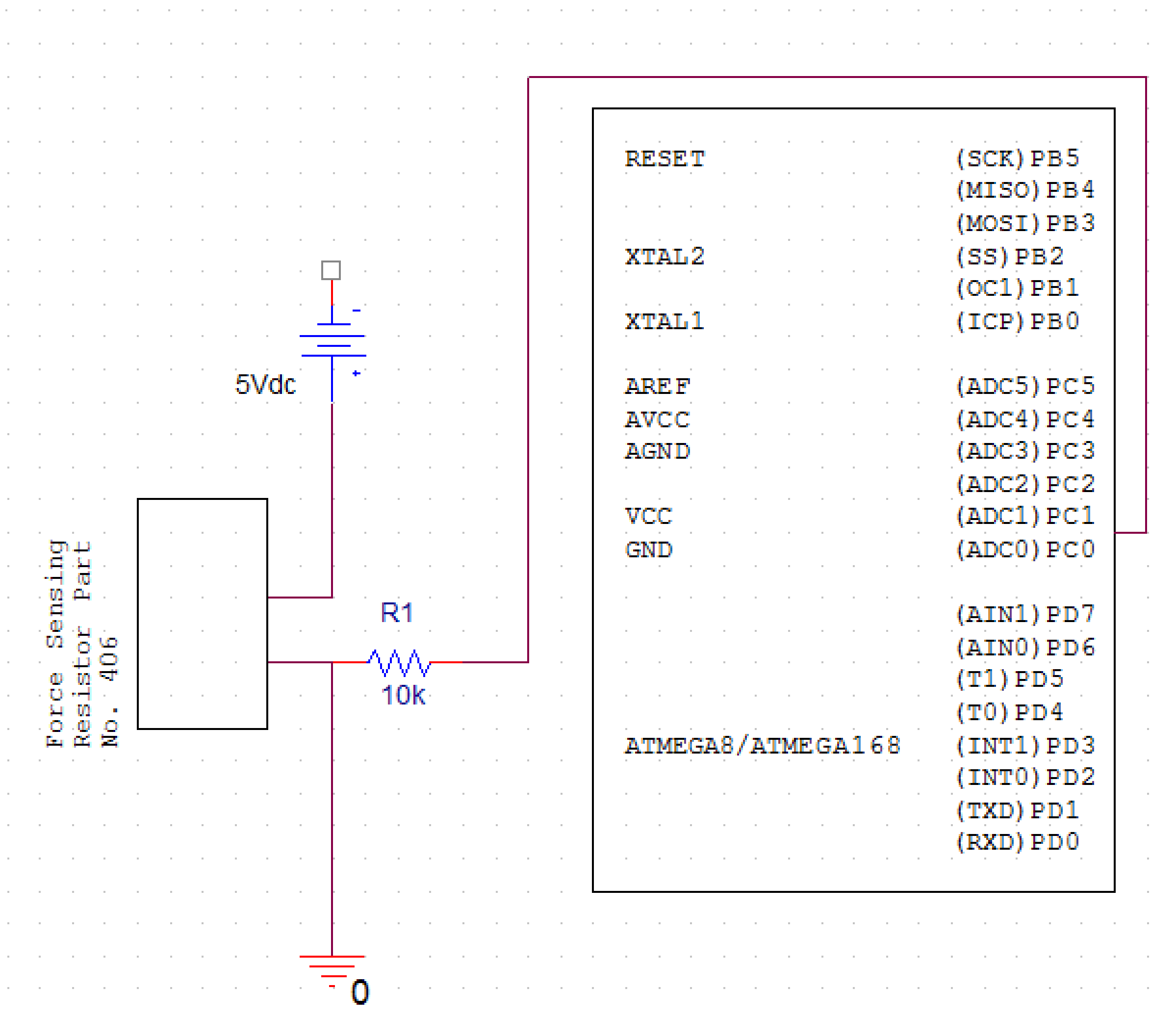


fig 8. Schematics of Connection between FIR Part No. 406 and the ARDUINO Board

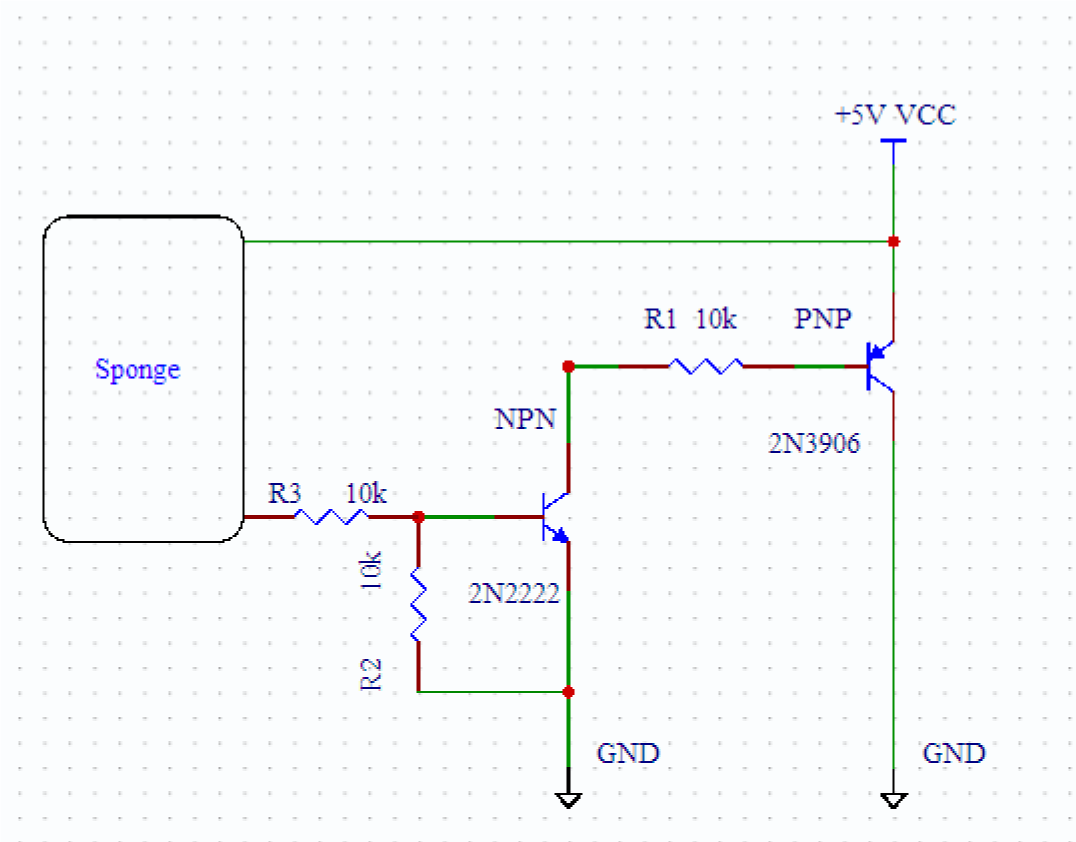


fig 9. schematic of water leak detector

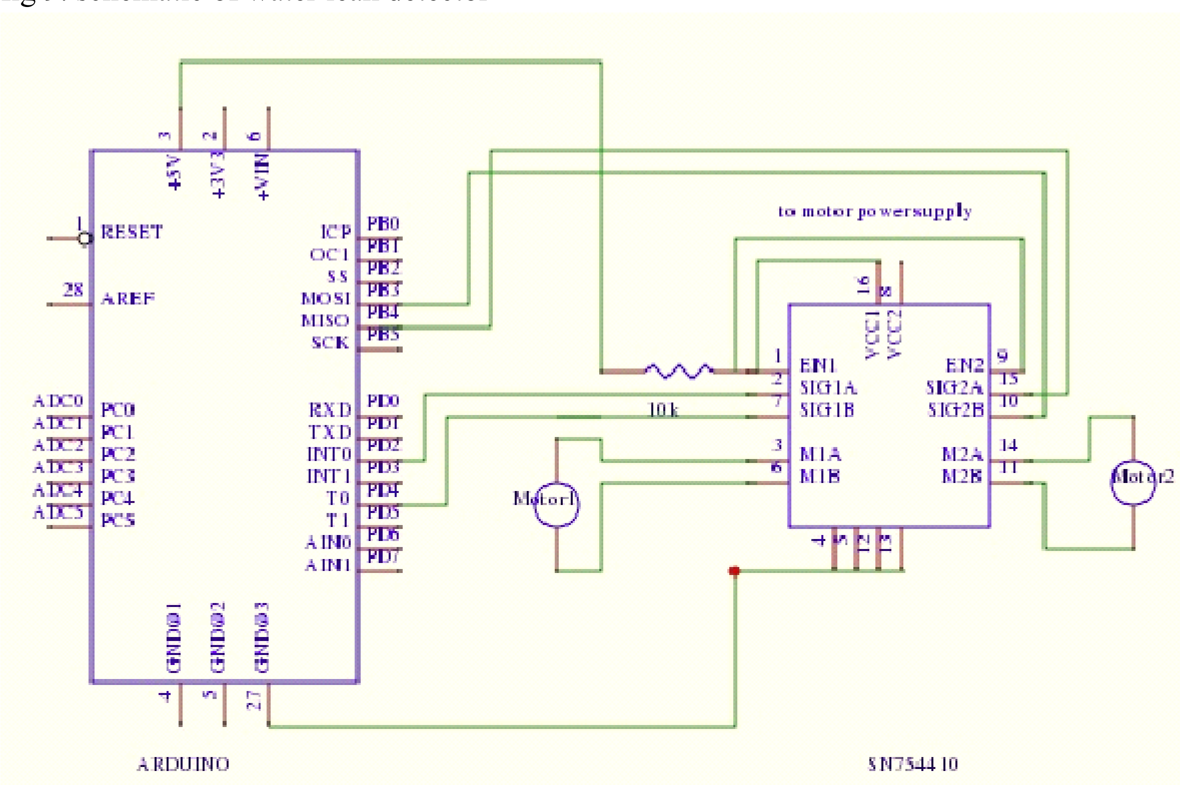


fig 10. schematic of lid/motor controller

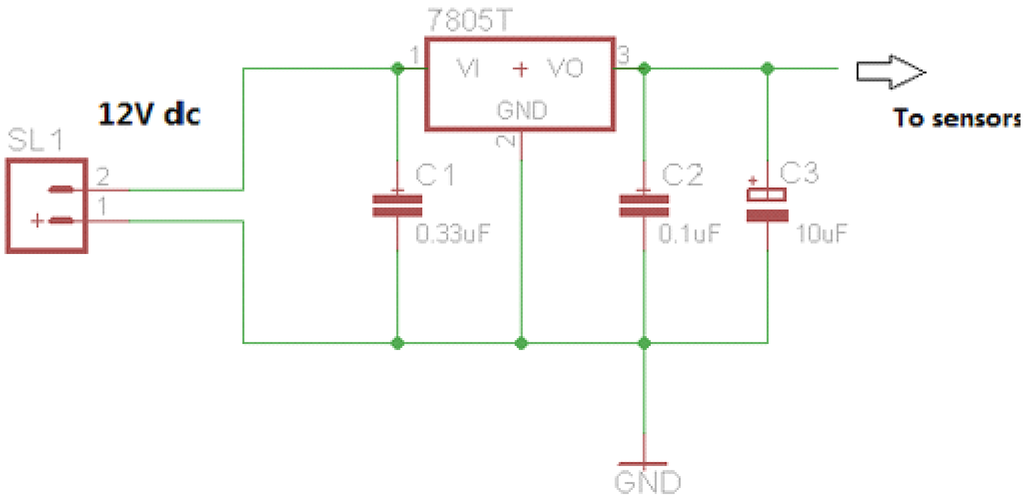


fig 11. schematic of voltage regulator 12V-5V

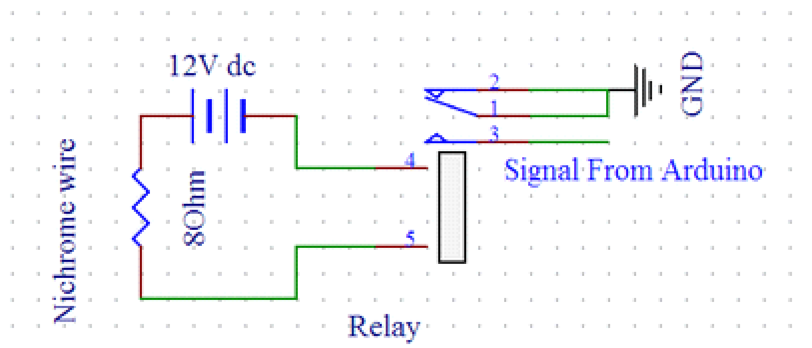


fig 12. relay switch for heat sealing

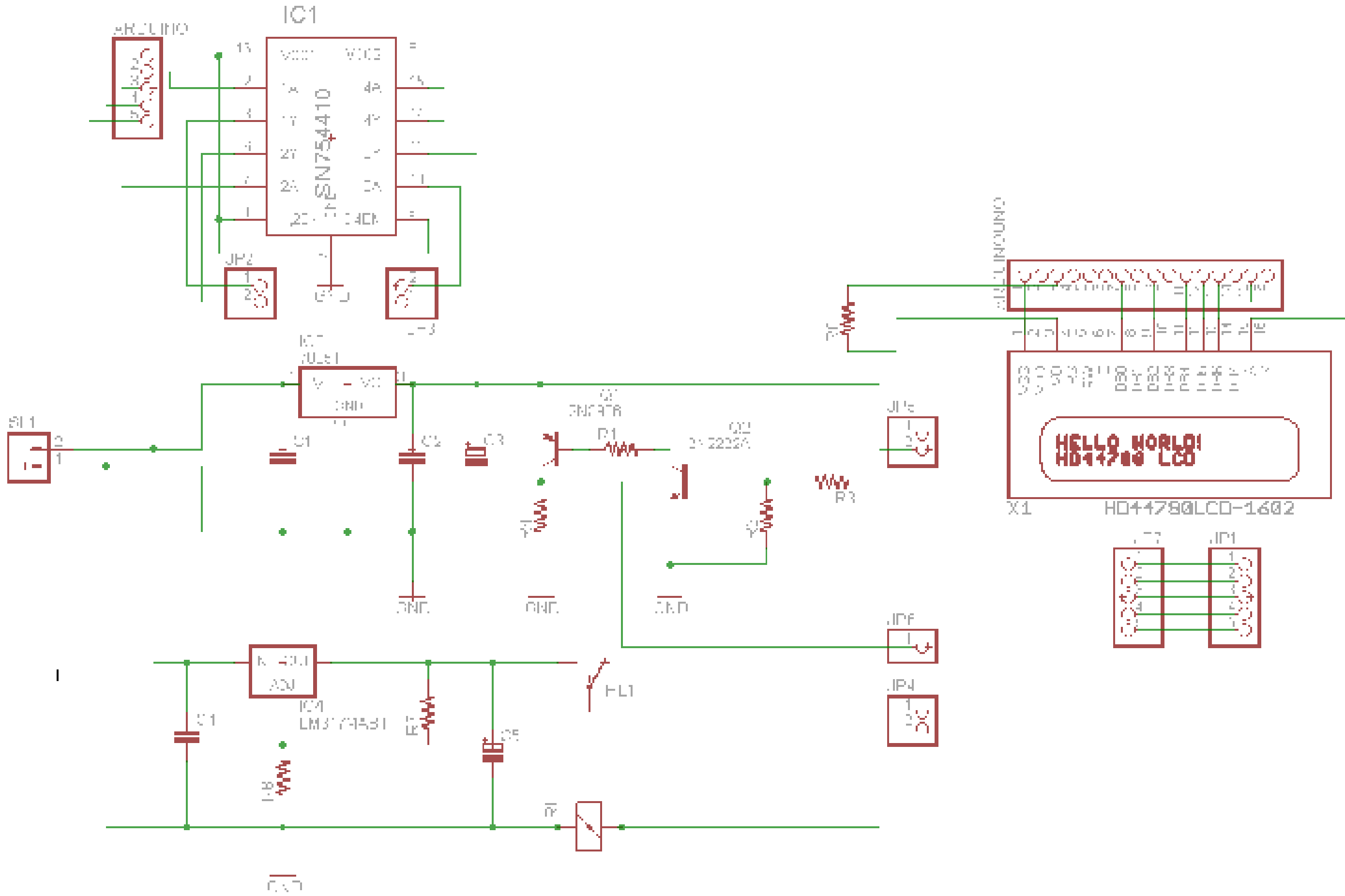


fig 13. overall schematics

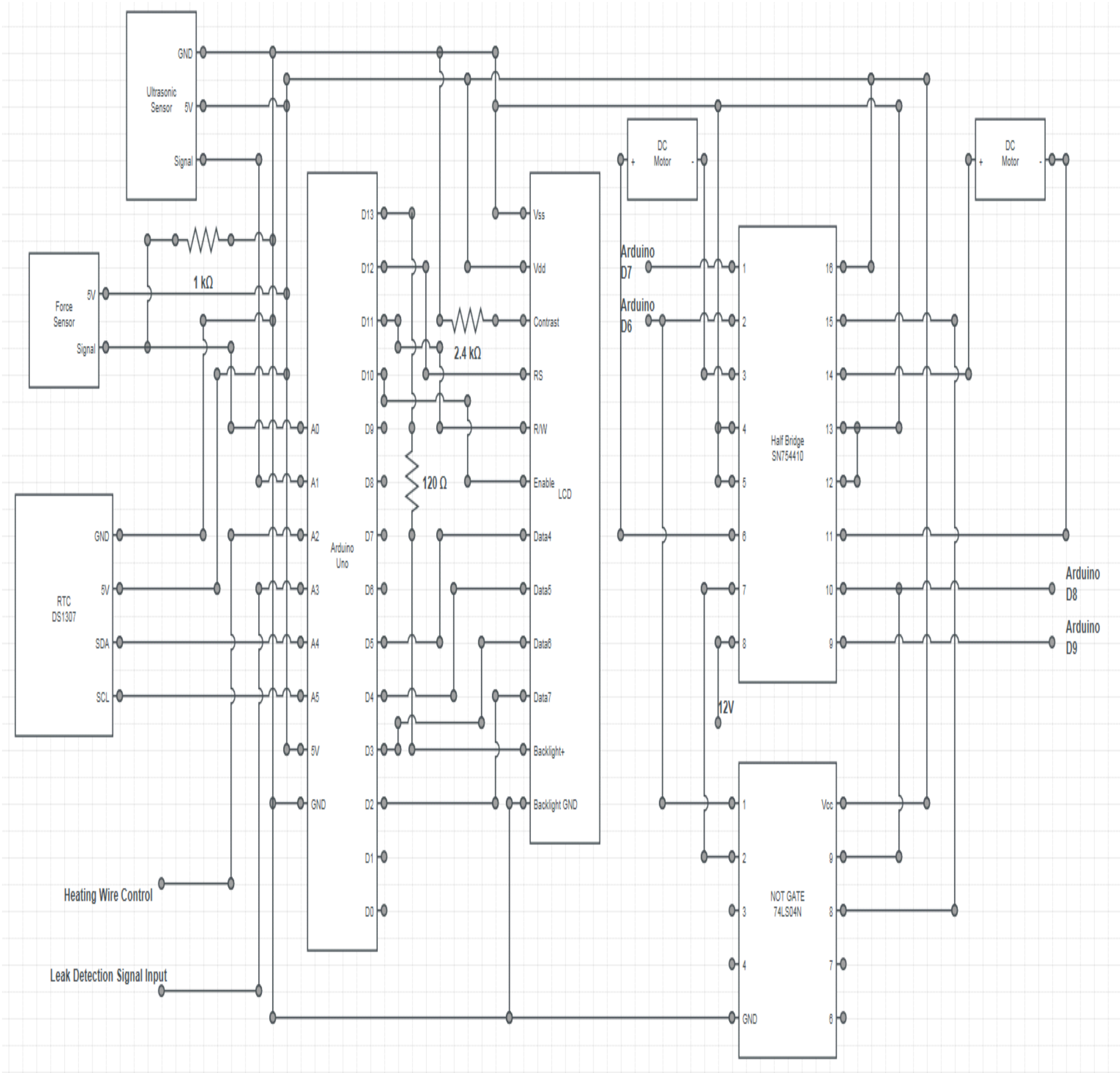
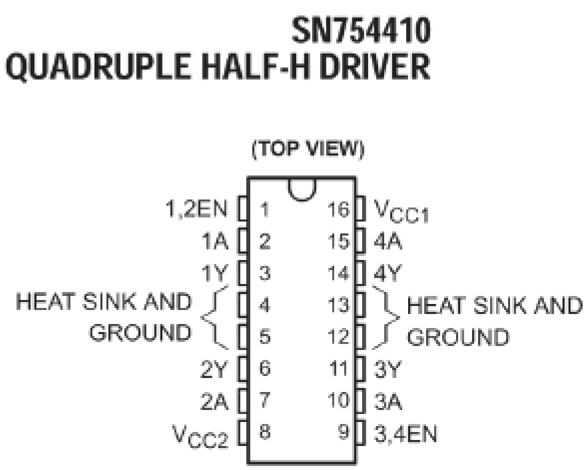


fig 14. MCU pin layout overview

Appendix C

fig 15. LCD screen



FUNCTION TABLE
(each driver)

INPUTS†		OUTPUT
A	EN	Y
H	H	H
L	H	L
X	L	Z

H = high-level, L = low-level
X = irrelevant
Z = high-impedance (off)
† In the thermal shutdown mode, the output is in a high-impedance state regardless of the input levels.

fig 16. pin layout of H-bridge SN754410

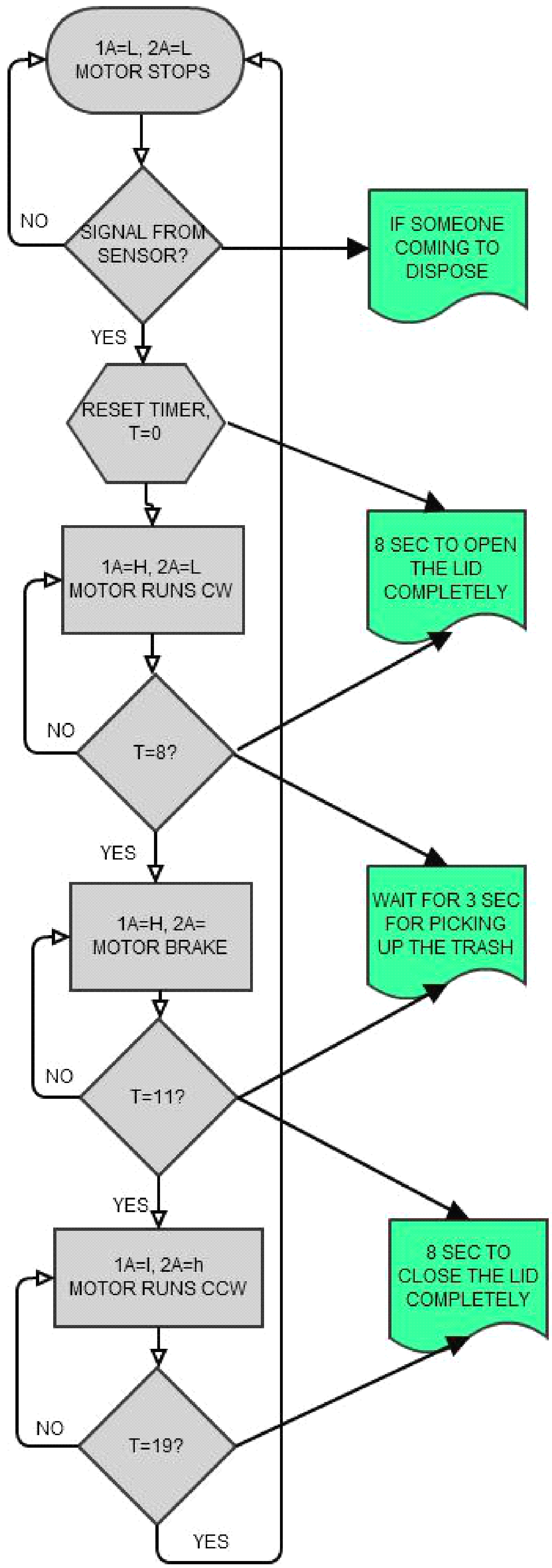

1A=L, 2A=L
MOTOR STOPS
NO
SIGNAL FROM
SENSOR?
IF SOMEONE
COMING TO
DISPOSE
YES
RESET TIMER,
T=0
8 SEC TO OPEN
THE LID
COMPLETELY
1A=H, 2A=L
MOTOR RUNS CW
NO
T=8?
YES
WAIT FOR 3 SEC
FOR PICKING
UP THE TRASH
1A=H, 2A=
MOTOR BRAKE
NO
T=11?
YES
8 SEC TO
CLOSE THE LID
COMPLETELY
1A=l, 2A=h
MOTOR RUNS CCW
NO
T=19?
YES

fig 17. flowchart of lid motor with time control

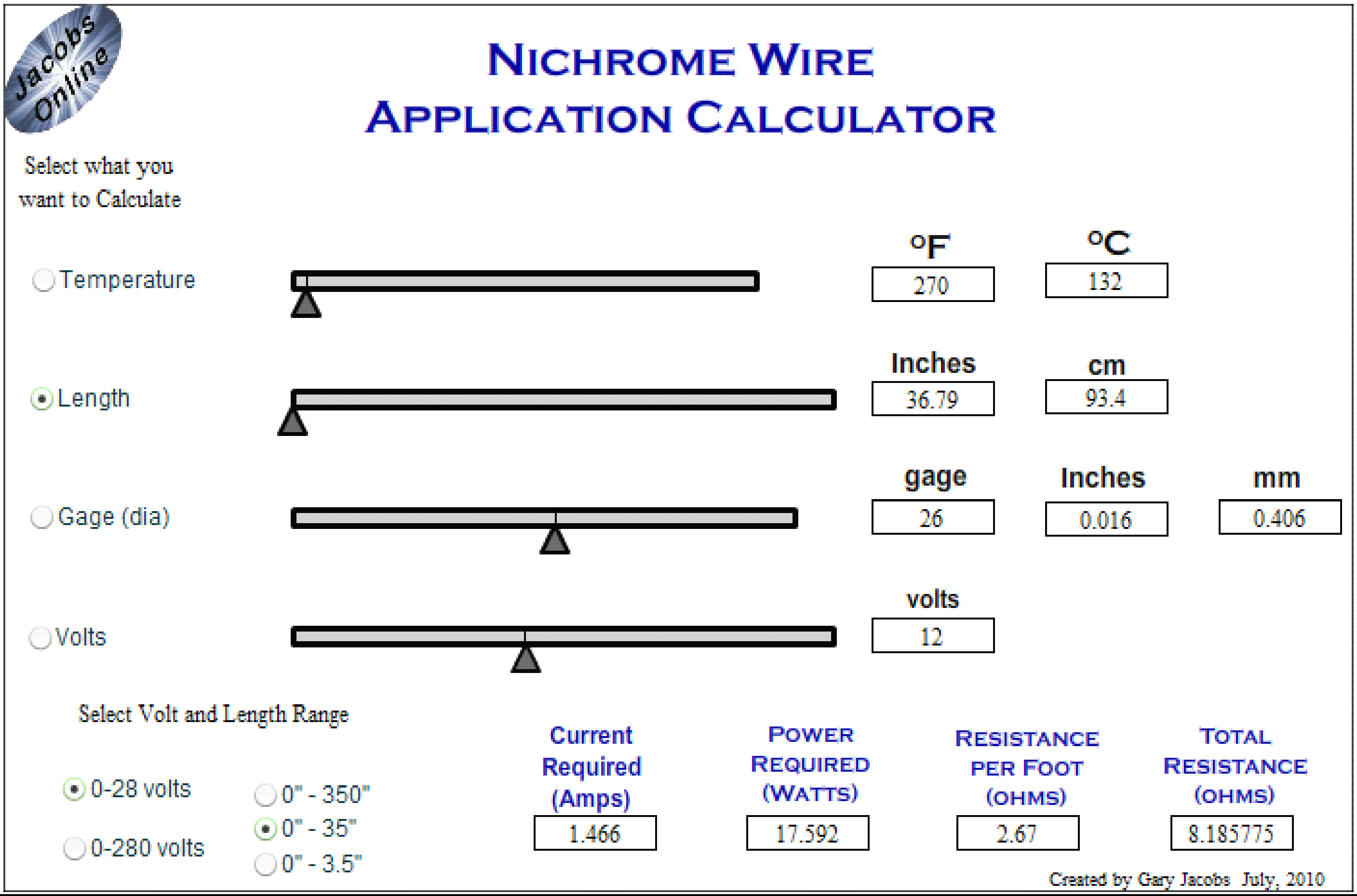


fig 18. calculation of length for nichrome wire

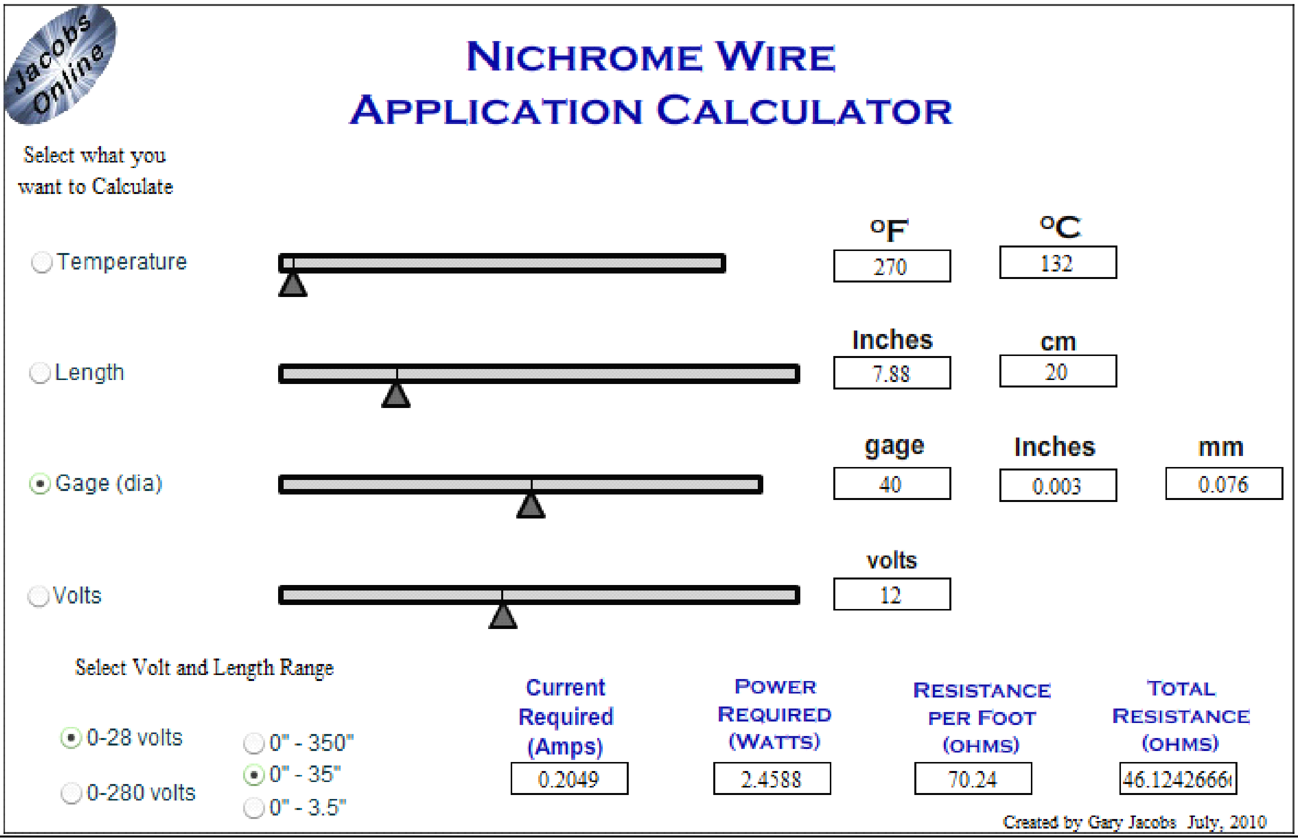


fig 19. calculation of gauge for nichrome wire

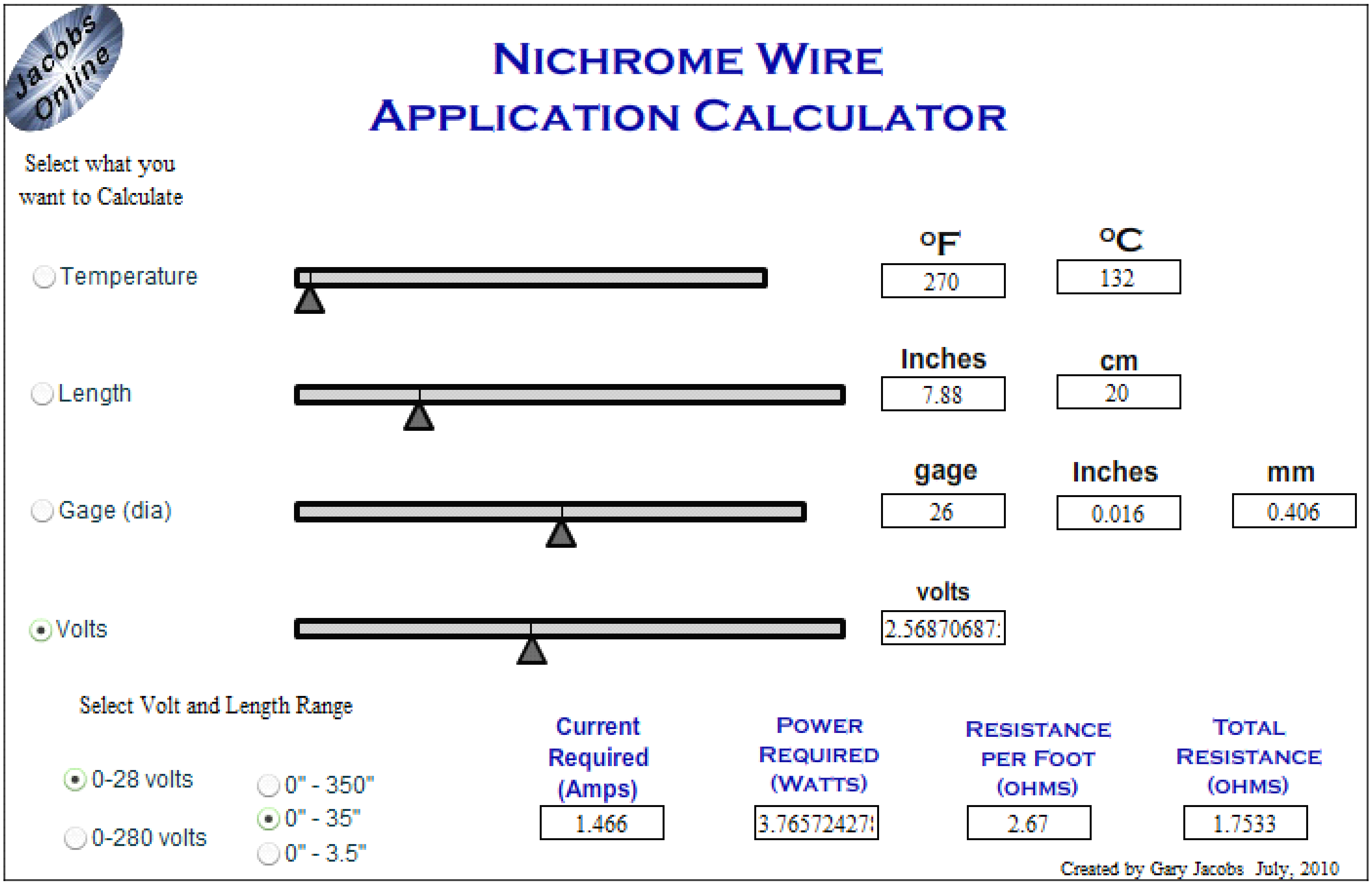


fig 20. calculation of voltage for nichrome wire

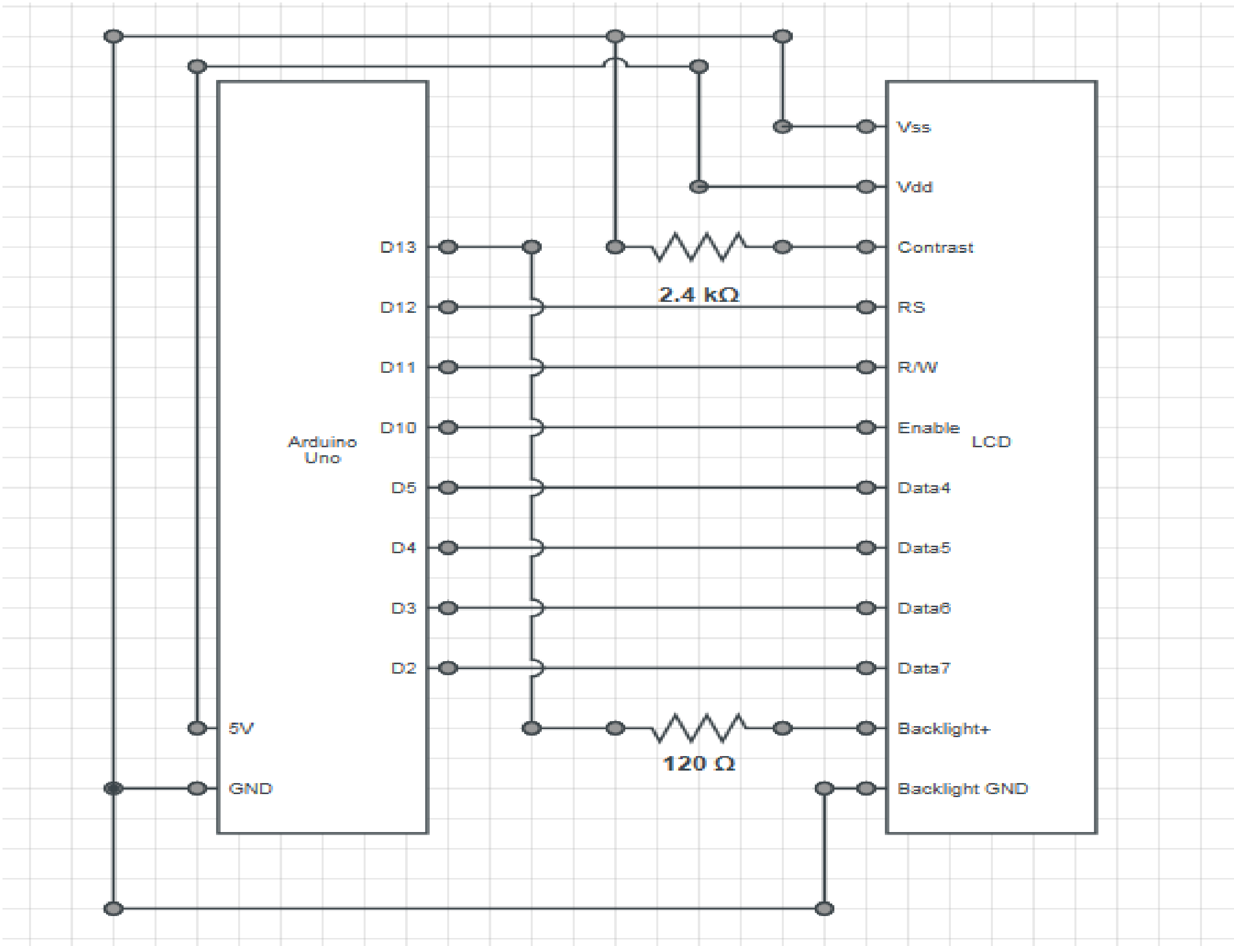


Fig 21. Lcd and arduino

Appendix D

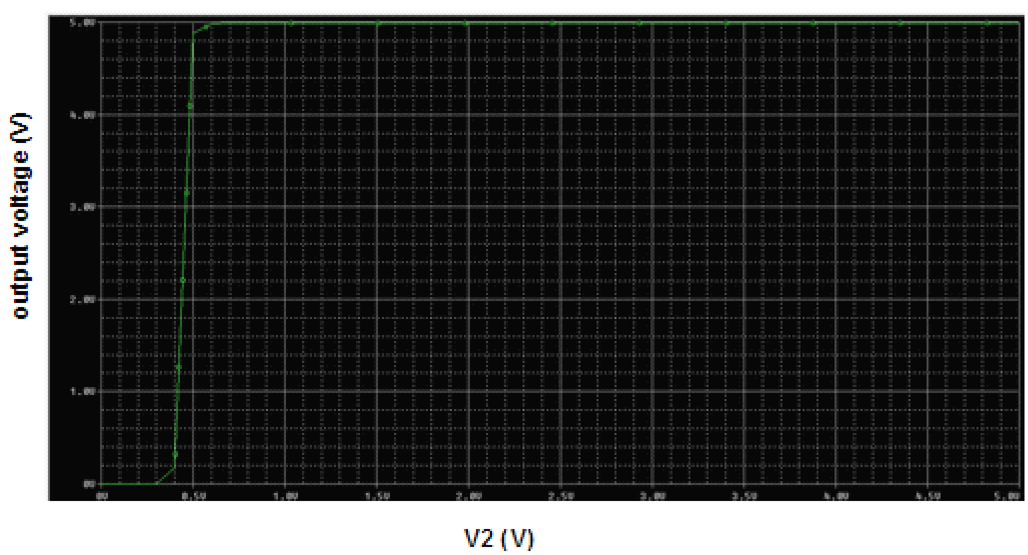


fig 22. simulation of water leak detector

Appendix E

```
#include <Wire.h>
#include "RTClib.h"
#include <LiquidCrystal.h>



RTC_DS1307 RTC;

LiquidCrystal lcd(12, 11, 10, 5, 4, 3, 2);
int distance;
const int pingPin = A3;
int leak;
int sealed = 0;
int set = 1;
int backLight = 13;    // pin 13 will control the backlight
int heat = A0;
int fsrAnalogPin = 1; // FSR is connected to analog 0
int fsrReading;      // the analog reading from the FSR resistor divider
int speed1Pin = 9;//H-bridge enable pin for speed control
int motor1APin = 7;//H-bridge leg 1
int motor2APin = 8;
int speed2Pin = 6;
int speed_value_motor1;//value for motor speed
int speed_value_motor2;//value for motor speed
int SealedMonth;
int SealedHour;
int SealedMinute;
int SealedDate;
int SealedWeight;
int SetMonth;
int SetHour;
int SetMinute;
int SetDate;
int SetSecond;

void setup()  {
  Serial.begin(9600);
  Wire.begin();
  RTC.begin();

  pinMode(backLight, OUTPUT);
  pinMode(speed1Pin, OUTPUT);
  pinMode(motor1APin, OUTPUT);
  pinMode(speed2Pin, OUTPUT);
  pinMode(motor2APin, OUTPUT);
  pinMode(A3, OUTPUT);
  pinMode(heat, OUTPUT);
  pinMode(A2, INPUT);
  digitalWrite(backLight, HIGH); // turn backlight on. Replace 'HIGH' with 'LOW' to turn it off.
  lcd.begin(20,4);              // columns, rows.
  lcd.clear();                  // start with a blank screen
  lcd.setCursor(0,1);           // set cursor to column 0, row 1
  lcd.print("TIME: NO INPUT");
  lcd.setCursor(0,2);         // set cursor to column 0, row 2
  lcd.print("WEIGHT:             ");
  if (! RTC.isrunning()) {
  Serial.println("RTC is NOT running!");
  RTC.adjust(DateTime(__DATE__, __TIME__));
```

```
  }
}

void loop(){
  DateTime now = RTC.now();
  lcd.setCursor(0,3);        // set cursor to column 0, row 3
  lcd.print("FUNCTIONING NORMALLY");
    long duration, inches, cm;
  // The PING))) is triggered by a HIGH pulse of 2 or more microseconds.
  // Give a short LOW pulse beforehand to ensure a clean HIGH pulse:
  pinMode(pingPin, OUTPUT);
  digitalWrite(pingPin, LOW);
  delayMicroseconds(2);
  digitalWrite(pingPin, HIGH);
  delayMicroseconds(5);
  digitalWrite(pingPin, LOW);
    pinMode(pingPin, INPUT);
  duration = pulseIn(pingPin, HIGH);

  // convert the time into a distance
  inches = microsecondsToInches(duration);
  cm = microsecondsToCentimeters(duration);

  Serial.print(inches);
  Serial.print("in, ");
  Serial.print(cm);
  Serial.print("cm");
  Serial.println();
  leak = digitalRead(A2);
  if (leak == 1)
  {
    lcd.setCursor(0,3);        // set cursor to column 0, row 3
    lcd.print("     LEAKING!!!     ");
  }
  Serial.print("\n");
  Serial.print(sealed);
  Serial.print(fsrReading);
  Serial.print("\n");
  Serial.print(now.year(), DEC);
  Serial.print('/');
  Serial.print(now.month(), DEC);
  Serial.print('/');
  Serial.print(now.day(), DEC);
  Serial.print(' ');
  Serial.print(now.hour(), DEC);
  Serial.print(':');
  Serial.print(now.minute(), DEC);
  Serial.print(':');
  Serial.print(now.second(), DEC);
  Serial.println();
  fsrReading = analogRead(fsrAnalogPin);
  SealedMonth = now.month();
  SealedDate = now.day();
  SealedHour = now.hour();
  SealedMinute = now.minute();
  if (set == 1)
  {
    set = 0;
    SetMonth = now.month();
    SetDate = now.day();
```

```
  SetHour = now.hour();
  SetMinute = now.minute();
  SetSecond = now.second();
  lcd.setCursor(0,0);           // set cursor to column 0, row 0 (the first row)
  lcd.print(" SET:");    // change this text to whatever you like. keep it clean.
  if(SetMonth < 10)
    {
    lcd.print("0");
    }
  lcd.print(SetMonth);
  lcd.print("/");
  if(SetDate < 10)
    {
    lcd.print("0");
    }
  lcd.print(SetDate);
  lcd.print(" ");
  if(SetHour < 10)
    {
    lcd.print("0");
    }
  lcd.print(SetHour);
  lcd.print(":");
  if(SetMinute < 10)
    {
    lcd.print("0");
    }
  lcd.print(SetMinute);
  lcd.print(":");
  if(SetSecond < 10)
    {
    lcd.print("0");
    }
  lcd.print(SetSecond);
}
if (sealed == 0)
{
lcd.setCursor(0,1);           // set cursor to column 0, row 1
lcd.print("TIME:");
if(now.month() < 10)
{
  lcd.print("0");
}
lcd.print(now.month());
lcd.print("/");
if(now.day() < 10)
{
  lcd.print("0");
}
lcd.print(now.day());
lcd.print(" ");
if(now.hour() < 10)
{
  lcd.print("0");
}
lcd.print(now.hour());
lcd.print(":");
if(now.minute() < 10)
{
  lcd.print("0");
}
```

```
lcd.print(now.minute());
lcd.print(":");
if(now.second() < 10)
{
  lcd.print("0");
}
lcd.print(now.second());
lcd.setCursor(7,2);         // set cursor to column 0, row 2
if(fsrReading < 20)
{
lcd.print("000g         ");
}
if(fsrReading > 19)
{
  if(fsrReading < 100)
  {
  lcd.print("0");
  lcd.print(fsrReading);
  lcd.print("g         ");
  }
  if(fsrReading > 99)
  {
  lcd.print(fsrReading);
  lcd.print("g        ");
  }
}
}
if(fsrReading > 900)
{
  if (sealed == 0)
  {
  seal();
  sealed = 1;
  lcd.setCursor(0,0);           // set cursor to column 0, row 0 (the first row)
  lcd.print("   SET:");
  if(SetMonth < 10)
    {
    lcd.print("0");
    }
  lcd.print(SetMonth);
  lcd.print("/");
  if(SetDate < 10)
    {
    lcd.print("0");
    }
  lcd.print(SetDate);
  lcd.print(" ");
  if(SetHour < 10)
    {
    lcd.print("0");
    }
  lcd.print(SetHour);
  lcd.print(":");
  if(SetMinute < 10)
    {
    lcd.print("0");
    }
  lcd.print(SetMinute);
  lcd.print("  ");
  lcd.setCursor(0,1);           // set cursor to column 0, row 1
  lcd.print("SEALED:");
```

```
    if(SealedMonth < 10)
      {
      lcd.print("0");
      }
    lcd.print(SealedMonth);
    lcd.print("/");
    if(SealedDate < 10)
      {
      lcd.print("0");
      }
    lcd.print(SealedDate);
    lcd.print(" ");
    if(SealedHour < 10)
      {
      lcd.print("0");
      }
    lcd.print(SealedHour);
    lcd.print(":");
    if(SealedMinute < 10)
      {
      lcd.print("0");
      }
    lcd.print(SealedMinute);
    lcd.print("  ");
    lcd.setCursor(7,2);
    lcd.print(fsrReading);
    lcd.print("g        ");
    }
  }
  if (cm < 15)
  {
    openlid();
  }
  delay(1000);
}

void openlid()
{
  digitalWrite(motor1APin,LOW);// set leg 1 of the H-bridge low
  speed_value_motor1 = 150; // half speed
  analogWrite(speed1Pin, speed_value_motor1);// output speed as PWM value
  delay(1000);
  digitalWrite(motor1APin,LOW);// set leg 1 of the H-bridge low
  speed_value_motor1 = 0; // stop
  analogWrite(speed1Pin, speed_value_motor1);// output speed as PWM value
  delay(3000);
  digitalWrite(motor1APin,HIGH);// set leg 1 of the H-bridge high
  speed_value_motor1 = 100; // half speed
  analogWrite(speed1Pin, speed_value_motor1);// output speed as PWM value
  delay(1000);
  digitalWrite(motor1APin,HIGH);// set leg 1 of the H-bridge high
  speed_value_motor1 = 0; // stop
  analogWrite(speed1Pin, speed_value_motor1);// output speed as PWM value
}

void seal()
{
  digitalWrite(motor2APin,LOW);// set leg 1 of the H-bridge low
  speed_value_motor2 = 200; // half speed
  analogWrite(speed2Pin, speed_value_motor2);// output speed as PWM value
```

```
  delay(1000);
  digitalWrite(motor2APin,LOW);// set leg 1 of the H-bridge low
  speed_value_motor2 = 0; // stop
  analogWrite(speed2Pin, speed_value_motor2);// output speed as PWM value
  digitalWrite(heat, HIGH);
  delay(35000);
  digitalWrite(heat, LOW);
  digitalWrite(motor2APin,HIGH);// set leg 1 of the H-bridge high
  speed_value_motor2 = 200; // half speed
  analogWrite(speed2Pin, speed_value_motor2);// output speed as PWM value
  delay(1000);
  digitalWrite(motor2APin,HIGH);// set leg 1 of the H-bridge high
  speed_value_motor2 = 0; // stop
  analogWrite(speed2Pin, speed_value_motor2);// output speed as PWM value
  SealedWeight = fsrReading;
}

long microsecondsToInches(long microseconds)
{
  // According to Parallax's datasheet for the PING))), there are
  // 73.746 microseconds per inch (i.e. sound travels at 1130 feet per
  // second).  This gives the distance travelled by the ping, outbound
  // and return, so we divide by 2 to get the distance of the obstacle.
  // See: http://www.parallax.com/dl/docs/prod/acc/28015-PING-v1.3.pdf
  return microseconds / 74 / 2;
}

long microsecondsToCentimeters(long microseconds)
{
  // The speed of sound is 340 m/s or 29 microseconds per centimeter.
  // The ping travels out and back, so to find the distance of the
  // object we take half of the distance travelled.
  return microseconds / 29 / 2;
}
```

Appendix F

1.1. Cost Analysis:

Name	Rate ($/hr)	Hours (hr)	Total ($)
ZEKUN LIU	30	160	30×160×2.5=12000
YANQIU YIN	30	160	30×160×2.5=12000
QIONG HU	30	160	30×160×2.5=12000
Labor Total	36000		

1.2. Parts:

Description	Specification	Manufacturer	Vendor	Price($)	Quantity	Total($)
DC Motor	GM9434G807	Pittman	Ebay	40	2	80
Nichrome 60	Gauge 26; Dia.0.0159 inch	Jacobs online	Jacobs online	3.5	1	3.5
Trash can	Rectangular step trash can	Nine Stars	Walmart	20	1	20
Trash bag	4-6 Gal. medium	Glad Tall	Walmart	3	1	3
Power supply ac/dc adapter	AC/DC 12V 5A	Sunforce	Amazon	34	1	34
Ultrasonic Distance Sensor	GP2Y0A21Y	Parallex	Radio-Shack	29.99	1	29.99

FSR Sensitive sensor	Part No. 406	FSR	Conrad	15	1	15
motor driver IC	SN754410	All Electronics	Alibaba	0.1	10	1
Arduino board	Uno R3	Arduino	ArduinoECE Store	29.3	1	29.3
LCD Screen	20x4 character	Hacktronic	Amazon	13.83	1	13.83

Parts total 208.92 usd.

1.3. Grand Total

Labor Total	36,000$
Parts Total	208.92$
Grand Total	36208.92$