Parents of the Future

Team 32- Damian Komosa, Sasan Erfan and Yarshun Jayakumar

ECE445 Design Document- Spring 2019

TA: David Null

Table of Contents

1 Introduction

1.1 Objective

One of the biggest hurdles associated with chores is the fact that children normally have no motivation when it comes to doing them. This lack of motivation stems from the fact that there generally aren't any rewards associated with the process and it's boring [7]. Chores are an area that didn't technologically advance with the rest of the world, which is something we hope to change with our invention. Additionally, keeping track of chore responsibilities is huge hassle not only for the children, but the parents as well.

The proposed solution would aim to modernize chores with the goal of making them more fun for the children and allowing trackability for the parents. We are aiming to make chores fun for kids with the use of modern age technology by creating an enjoyable and competitive online interface. In order to accomplish this goal we have chosen two critical sensors, the ultrasonic sensor and the pressure sensor, which will be indicative to determining a full or empty container. Our physical module will include an ATmega328 microcontroller to manage the sensor data and send it wirelessly to the online interface to be accessed by the parents and kids. This interface would help inspire children do chores by making them fun and allowing parents to have access to data and statistics regarding their completion. The interface would fight this issue through the implementation of a database, which would record chore time completion and allow for the assignment of chores by the parents. Based on the completion of chores and it's timeliness, the parents would be able to assign certain rewards and incentives for the kids to reach.

1.2 Background

Chores nowadays are becoming harder and harder for the modern American family to implement into their lifestyle. It is a complicated problem that stems from both social and economic strains. In certain households, such as part time dual earning households, the children do virtually zero chores [5]. With less time for parents to interact with their children, the need to make a positive impact with allotted resources is ever growing and present. Children are generally perceived as the source of most conflicts in American households, an attitude that generally makes them less likely to agree with parents [4]. Healthy completion of chores are the solution to all the problems listed above, and Parents of the Future can not only allow parents to efficiently and positively interact with their children but can also inspire positive habits that the children will carry through their life.

The ability to make chores fun or provide a tangible reward are just a few ways that parents can inspire children to consistently finish them. Experts believe that making the activity into a game, tying in allowance (or other reward) or providing a competitive environment between children are the most effective ways to make chores more fun and thus leading to them being done in a timely manner [8]. Additionally, according to Psychology Today, one of the biggest factors that is responsible for kids not doing chores is simply the fact that they forget their responsibilities due to other issues going on in their life [9]. The online interface would be a useful aid that could be used for assigning chores and act as a permanent reminder as it can be checked whenever necessary.

1.3 High-level requirements

i) Polling - Data must be successfully sent between the hardware device and the front end module receiver once every 5 minutes.

ii) Sensor Information - Through the use of the ultrasonic and pressure sensor, the device must be able to accurately determine a full garbage can/ laundry basket. This determination is made when the pressure sensor senses 5kg on its surface area and the ultrasonic sensor detects an obstruction within 7 inches of the top of trash can/ laundry basket.

iii) Software Functionality - Web page must have interactive data and chore allocation, with chore completion increasing the ranking of a kid’s profile by 100 points, and failure to complete a chore decreasing the ranking of a kid’s profile by 100 points.

2 Design

2.1 Block Diagram

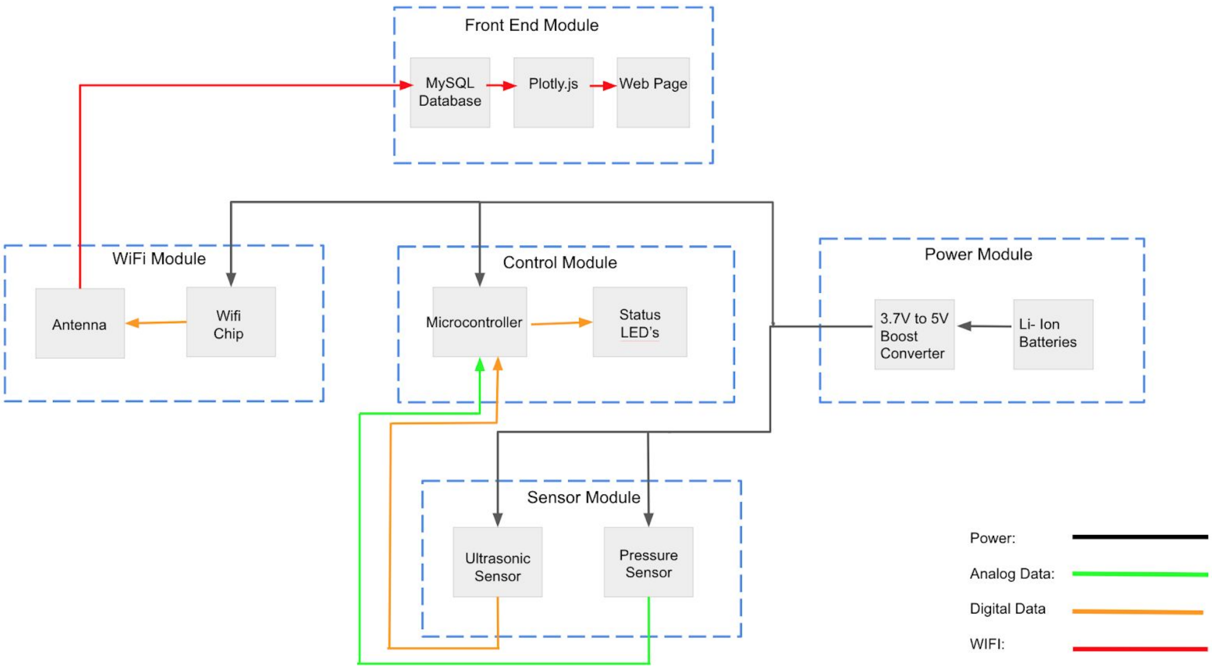

Figure 1: Block Diagram

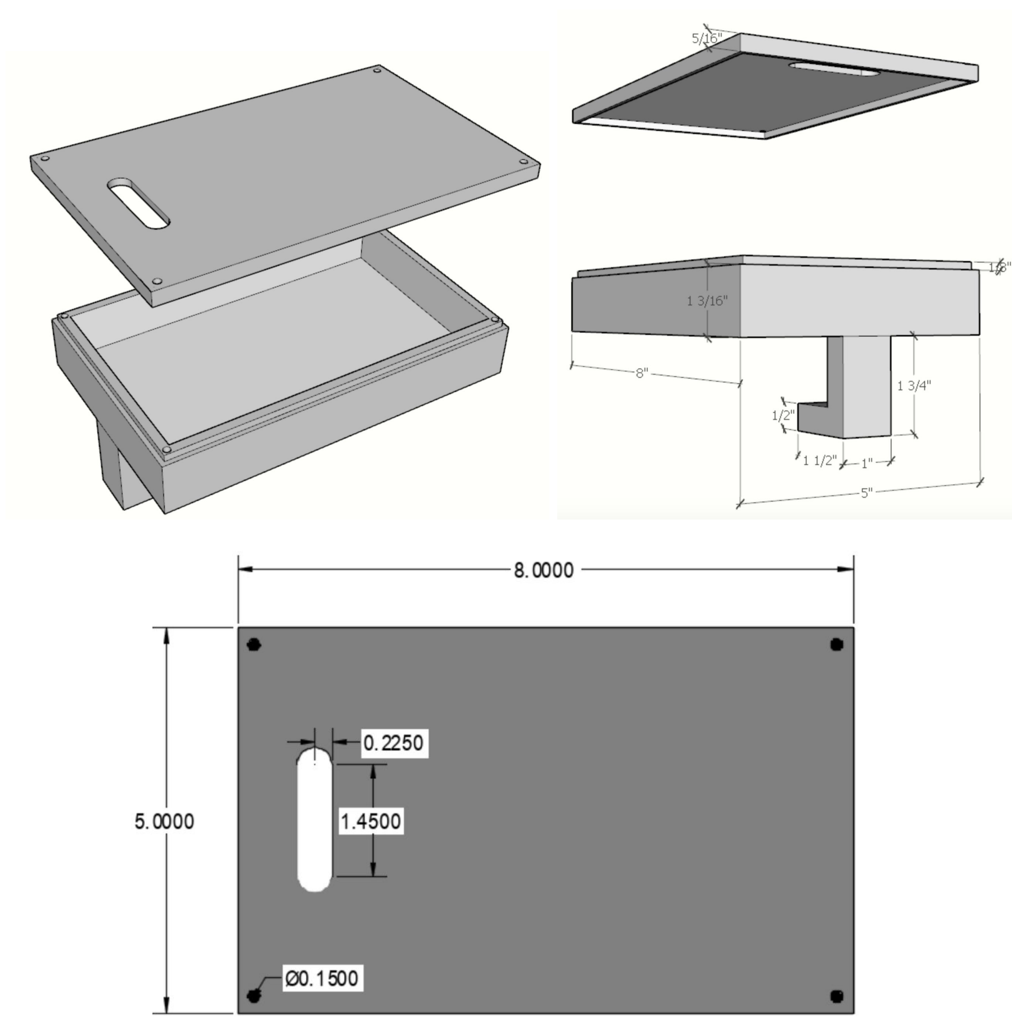

Figure 2: Physical Diagram

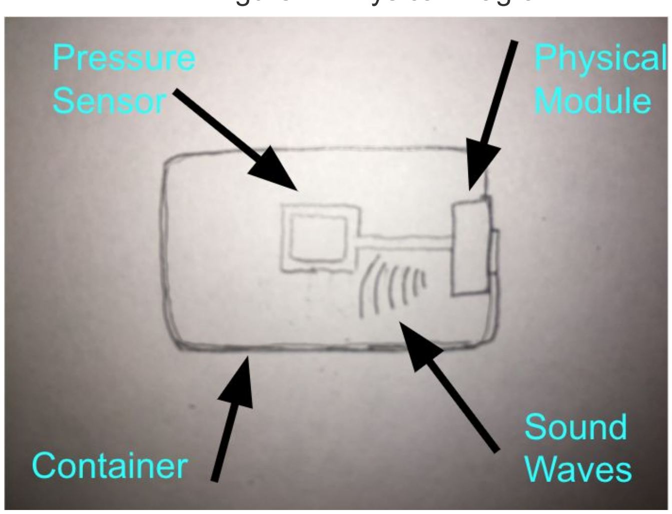

Figure 3: Physical Design Implementation (Top View)

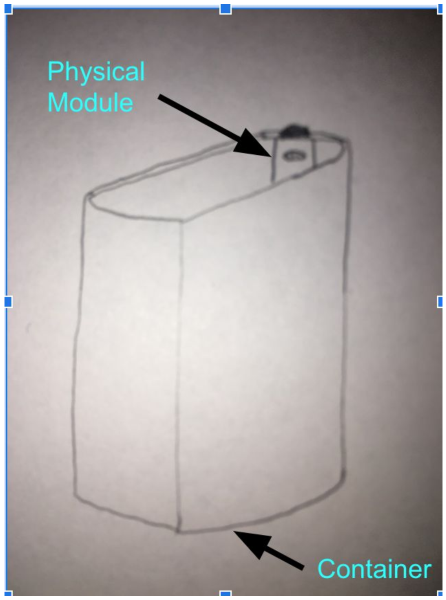

Figure 4: Physical Design Implementation (Side View)

The physical design of our product will be stylistically focused as we are trying to produce something marketable and viable. This is the reason why the thickness will be a minimal 1.5 inches, which will be enough to fit the ultrasonic sensor and our PCB design. In order to correctly implement the ultrasonic sensor, there is an opening on the front of the rectangular 3-D physical module. The physical module will be mounted on the upper edge of the container that the customer is wishing to monitor. In order to allow access to the PCB and wiring, there are a series of four screws on the four corners of the module. The side containing the opening for the ultrasonic sensor will be placed facing the middle of the container and the bottom will contain the opening for attaching the pressure sensor. The goal is to make this as sleek as possible, which means hiding any exposed wiring and other circuit components for the sake of style and safety.

2.2 Front End Module

The front end module is the engineering behind the web page that the consumer will interact with. The high level purpose of this module is to organize and present the data from the sensors. This is done via the use of a database, a data visualization tool and an HTML web page. Following the description of how the sensor data is brought to the home computer, there will be an explanation of how the chores will be made fun.

Software Flow Chart

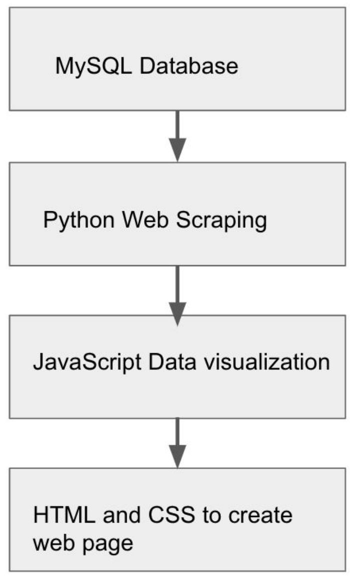

Figure 5: Software Flow Chart

The engineering behind the software is a relatively straightforward workflow. Assuming all of the hardware is working, all of the sensor data will be organized inside of the database. This leaves us with the task of scraping the database for the values we are interested in and formatting the data in a effective way. To help with formatting the data, we will use a JavaScript based data visualisation software, Plotly.js. There are a large number of alternatives, such as D3.js or Chart.js, but this can be easily replaced later with relatively little impact on how the product works.

After the data has been formatted in JavaScript, we can now focus on creating the web page the parents and children will interact with. We will need two web pages, one that acts as a parental control and another for the kid to use. The parental control page will give permissions to assign chores to the kids, the way this will be organized is by stamping the chore request to include the child's account ID. This avoids a profile system, which is a nontrivial solution. The child will be able to see their ranking, and what chores they have to complete. The child can check off whether or not they have completed their chore, and if completed their ranking will increase. The ranking system is explained below.

<u>Making The Chores Fun</u>

As seen in modern video games and social media apps, social engineering is a large part of what makes software addicting to use. Positive feedback loops and a reward based system are what make a website or app addicting to use. Facebook, for example, uses a simple numerically based like system that tallies how many people clicked like on a person's post. This combined with the social stigma of being well liked creates an incentive for people to post on the website, despite no physical value being added to their life. Despite no physical reward to using the site, Facebook is still the second most used website in the world.

The key to a website such as Facebook or a multiplayer video game is the concept of a rating. A rating system provides incentive for someone to increase their rating so that they can compete with their peers, which creates an intrinsic value to the rating. The intrinsic value to the rating will create a behavior cycle where the person sees their value increase or decrease depending on how they use the product, and incentivize them to continue to use the product to reach a desired rating or to have a higher rating than a beloved peer.

The rating system for this product will be based on a standard ELO system. The default ELO value for any new user to doing chores with our product will be 1200. 1200 is the standard starting value across many ELO based games, such as chess, League of Legends, Starcraft and more. The distribution for the ELO system will be as follows: top 1% is 2200+, top 7% is 1800+, top 15% is 1600+, top 50% is 1200+, top 75% is 800+, and the remaining bracket will be negligible.

How does rating affect the kids profile? It is quite simple, the border around their username will change. Top 1% for example could give the child a blue border, and it can be called a Diamond border. This mimics popular video games by assigning rarity to the user, making the rating literally correlate with how scarce the person's skill level is.

2.2.1 MySQL Database

The database acts as storage for all of the data coming from the sensors. Via wifi, an Arduino based microcontroller can directly push data to a database. Databases are a method of organizing data records and SQL is an implementation of the former that allow a user to obtain many records with a single command. SQL is attractive to a large array of problems due to this functionality, and is essential for our goal of visualizing statistical information.

Requirement	Verification
The database must be able to accept 5 bytes of data from wifi chip.	Needs to be tested with a computer and Wifi chip. Wifi Chip should send maximum possible 5 byte value to database and the database should correctly update.

Requirement	Verification
The database must be able to transmit 5 bytes of data to the web page.	The computer is the only tool needed to test this. The wifi chip will transmit data to the database and database should update the web page with the value sent

2.2.2 Plotly.js

Plotly.js is one of many data visualization libraries written in JavaScript. JavaScript handles the backend aspect of all World Wide Web pages alongside HTML and CSS. To have a functioning web page, all three aspects are required. To simplify the interactivity and data visualization aspect, we will utilize an existing open source library.

Requirement	Verification
Plotly.js must display data as interactive charts, updating every five minutes.	The data must update every 5 minutes. This is a minimum requirement.

2.2.3 Web Page

As mentioned above, the three technologies needed for a functioning web page are CSS, HTML and JavaScript. Since the backend aspect is already solved, all that will need to be done for this block is the CSS and HTML programming to create the page layout.

Requirement	Verification
The web page must work. Must be able to assign chores, check off completed chores and the ELO system must properly work.	What is needed to test this is just the web page. Child must start at 1200 elo and successfully completed chores increment the ranking by 100 points, chores unsuccessfully completed decrease the ranking by 100 points.

2.3 Wifi Module

The Wifi module is the most important aspect of our design, as it interfaces the information from the chores to the fingertips of the parents. The wifi module relies on a functioning wifi shield and antenna.

Similarly to the Front End Module, this section will also outline how the design is physically implemented. The ESP8266 is the chip we will use, and has both a software component and a hardware component to solve. The software component involves successfully programming a TCP/IP stack and making sure our chip is correctly programmed via the Arduino IDE.

The hardware aspect involves connecting it to the ATMEGA, and making sure that a few constraints are hit. The main constraint we need to be cautious of is the fact that all voltage applied to the pins must be below 3.7 V. Below is how the pin should theoretically be wired.

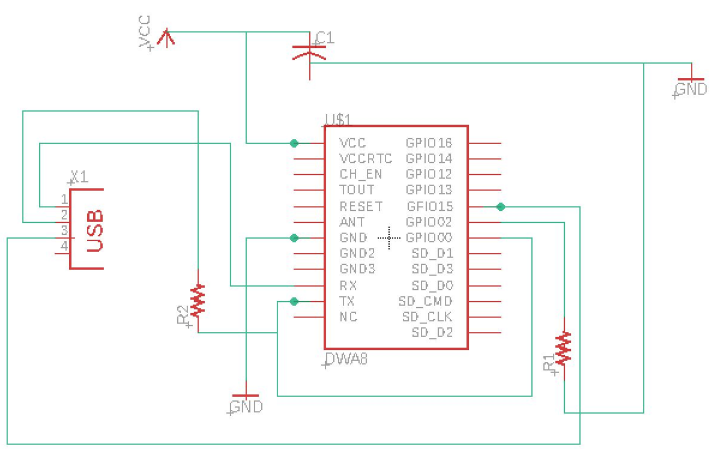

Figure 6: ESP8266 Wiring in EAGLECAD

Pins 1, 2 and 3 for the USB are TxD, RxD and GND, respectively. The capacitor and resistor values will be changed depending on what our final VCC value is in order to provide the correct amount of voltage to the respective pins.

2.3.1 Antenna

The antenna transmits radio signals to create wifi interactivity. The antenna is connected to the wifi shield, or in our case the wifi chip, and generates a wifi signal that travels a finite distance. Crucially, the antenna needs to create a signal with enough energy to travel fifty feet.

Requirement	Verification
The antenna must be powerful enough to transmit data to the network 50 feet away from the router. It needs to send data packets without any packet loss or disconnections.	Transmit 1 sensory reading per minute from the WiFi shield and antenna and confirm the database is receiving 1 multi-sensor data packet per second.

2.3.2 Wifi Chip

The Wifi chip is crucial as it implements the TCP/IP stack and keeps track of what information is actually being transmitted. TCP/IP stack is an implementation of the internet protocol suite requirements of how end-to-end communication should be completed. Without a functioning TCP/IP stack, no information can be transmitted via internet technologies.

Requirement	Verification
Wifi chip must correctly receive and send 5 bytes of data from the microcontroller to the database.	Needs the computer and the full PCB to test. Any value sent to the wifi chip from the microcontroller should be correctly stored in the database. This can be easily checked by seeing if the same 5 byte value appears in the database.

2.4 Power Module

This module will contain the necessary components that will provide power to the ATmega328P, ultrasonic sensor, pressure sensor and the ESP8266. The choices made involved taking into account the amount of space batteries would occupy and the requirements of each component. Using typical AA batteries which are 1.5V each would force us to include about 3 batteries, increasing the space occupied. By using one Lithium-Ion battery, about the same voltage input can be achieved, sufficient for the project. The fact that the Lithium-Ion battery is rechargeable makes it convenient for the user as they do not need to be replaced very often.

2.4.1 One 3.7V Lithium-Ion Rechargeable Battery

The single Lithium-Ion battery would act as the input voltage needed to power sensors, the microcontroller and the wifi chip. The type of battery that would be used is the 18650 Lithium Ion Cell 3.7V 2600mAH. The battery connected in series would go through a boost convertor to convert the 3.7V input to a 5V output to power the sensors and the microcontroller. A voltage regulator would also be used to step the voltage down to a suitable 3.3V for the wifi chip.

2.4.2 Voltage Regulator

A 3.7 V input voltage from the single Lithium-Ion battery is not suitable to be fed directly to the wifi chip. This regulator would be used to make sure 3.3 V is inputted to the wifi chip ensuring smooth operation within limits listed in the datasheets. The voltage regulator circuit would look as follows with the left nodes connected to the supply voltage of 3.7 V:

Requirement	Verification
The 3.7V from the battery has to be converted to 3.3V when inputted to the wifi chip.	A voltmeter can be used to make sure the output pin of the convertor is at a value of 3.3V± 0.3V.
At least 0.5 mA needs to be supplied to the wifi chip as needed for operation.	The current is measured by placing an ammeter in series with the output terminal to make sure the outputted current is in the proper region.

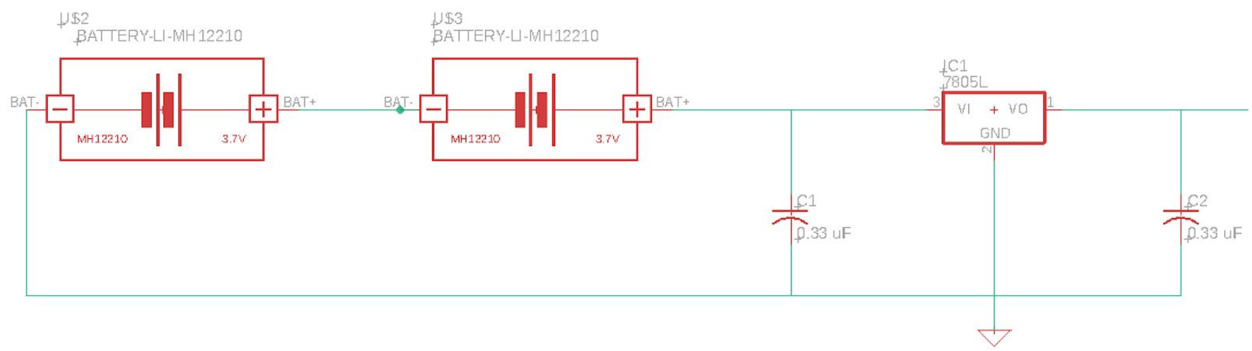

Figure 7: Circuit Schematic of Voltage Regulator

2.4.3 Boost Convertor

The 3.7V input from the single Lithium-Ion battery in series would be too low to power the microcontroller, ultrasonic sensor and pressure sensor. Thus, a boost convertor is used to step up the 3.7V to 5V. The type of boost converter that will be used is the TPS61200 boost converter. This increase in voltage would ensure the voltage inputted to both the microcontrollers and sensors are kept within suitable limits as listed in the datasheets. The boost converter circuit would look as follows with the left nodes connected to a supply voltage of 3.7 V:

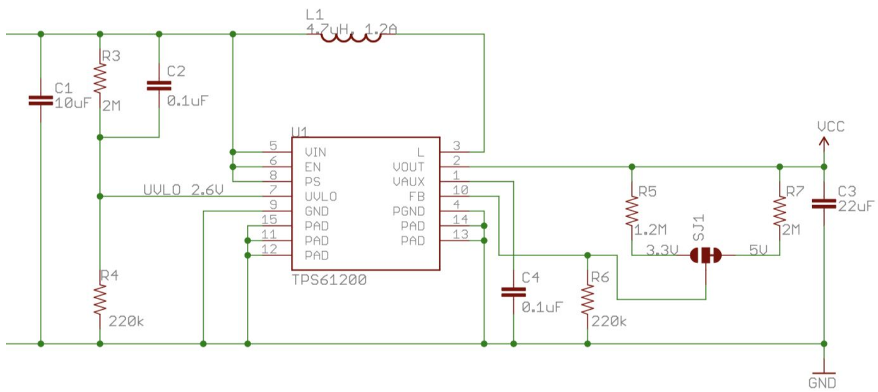

Figure 8: Circuit Schematic of Boost Convertor

Requirement	Verification
The 3.7V from the battery has to be converted to 5V when inputted to the microcontroller and sensors.	A voltmeter can be used to make sure the output pin of the convertor is at a value of 5V± 0.3V.
At least 28 mA needs to be supplied to the microcontroller and sensors as needed for operation.	The current is measured by placing an ammeter in series with the output terminal to make sure the outputted current is in the proper region.

2.5 Control Module

2.5.1 Microcontroller

The microcontroller that we have decided to use is the ATmega328P, which is a low-cost and low- power choice that will accomplish the data acquisition and transmission needs that we require. The ATmega328P will be receiving data from the ultrasonic sensor and pressure sensor through the Digital PWM input pins, as well as the Analog Input pins. There will be several female heads on the PCB to allow for the connection of the sensors to the

ATmega328P chip. The microcontroller will be powered by the stepped down voltage from the voltage regulator, which will be outputting 5V. This voltage level will be satisfactory for powering the device, allows us to take advantage of the 20 MHz clock speed and stays within the rated voltage of 6V.

The ATmega328P has the ability to perform in three different modes, which vary the power consumption greatly. If we were going to operate the ATmega328P at a clock speed of 1 MHz, the respective modes would have the following current measurements:

Active Mode: 0.2mA
Power-down Mode: 0.1μA
Power-save Mode: 0.75μA

The microcontroller PCB will contain a ESP8266 Wifi shield, which will be used as a transmitter and receiver of data between the local network and our design. The Wifi Chip has lower power infrastructure and can be used in different power- saving modes. The ATmega328 will be responsible for processing the data from the ultrasonic and pressure sensors and transfer the data to the ESP8266 Wifi shield.

Requirement	Verification
The microcontroller must have the ability to interface between the two sensors by receiving the data that is outputted by the respective sensor.	In order to verify this requirement, we will monitor the flow of data and ensure that there are two separate streams coming from the respective sensors.
When providing an input voltage of 5 V and the frequency being 20 MHz, the supply current should be approximately around 12 mA with a percent error of 10%	This will be measured using an ammeter on the power input pin to the ATmega328P microcontroller.
The microcontroller will generally be used in a typical household environment so it must be able to perform data acquisition and remain fully functional in temperatures ranging from 50 degrees to 90 degrees Fahrenheit	This will be tested through the confirmation of full functionality throughout the application of external heat and cooling. The ATmega328P will be kept in there conditions for a period of 30 minutes and tested afterwards.

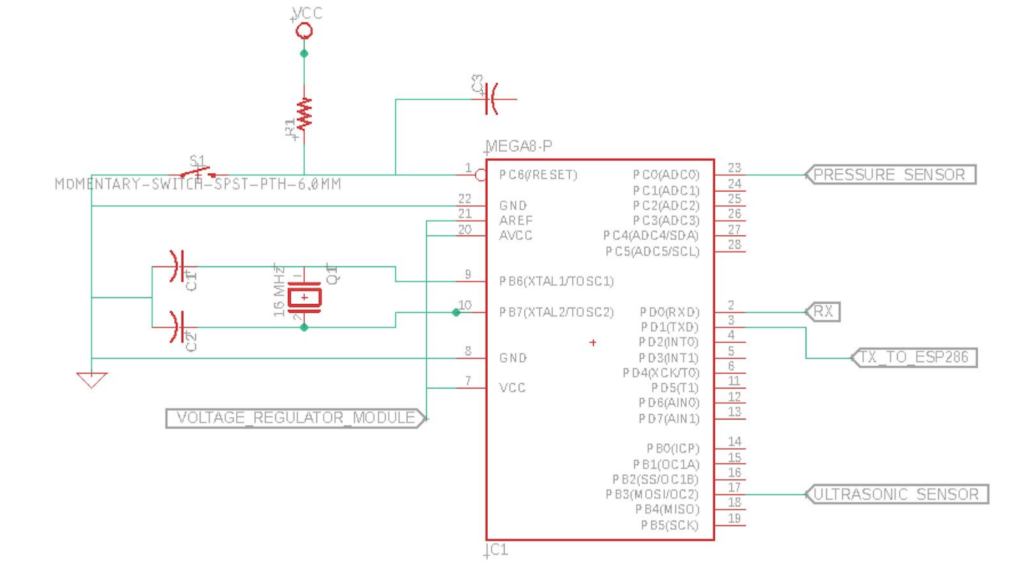

Figure 9: ATmega328P Microcontroller

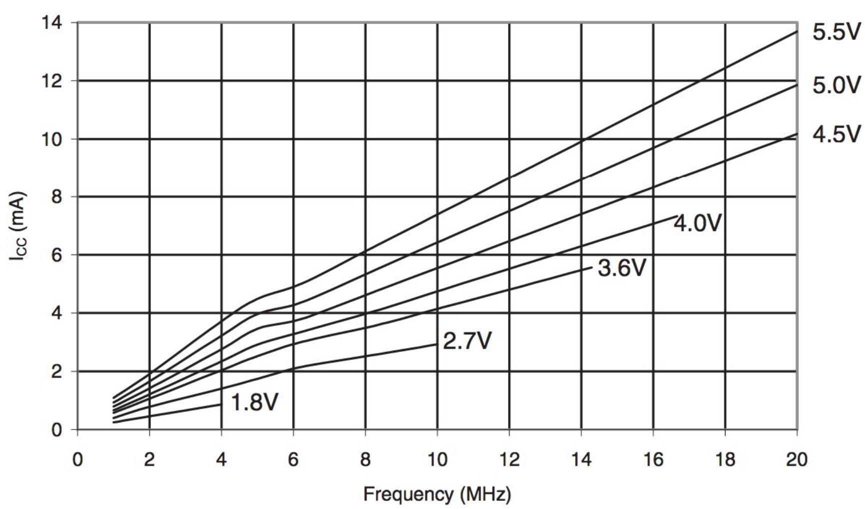

Figure 10. ATmega328P Active Supply Current vs. Frequency [10]

2.5.2 Status LEDs

The status LEDs will be located on the PCB and are being implemented with the goal of informing the user when the ATmega328P is in the on state and consuming power. This is being done with the purpose of providing the customer with the ability to monitor whether the device is correctly powered and collecting data from the sensors. The LED will connected to a standard PWM Digital Input pin and depending on the whether the device is powered, it will be on or off.

Requirement	Verification
When the ATmega is correctly powered with an input voltage of 5V and receiving data from the Ultrasonic/ Pressure sensor the LED should power on.	When the power module is connected to the PCB, the sensors are connected to ATmega, the LED should be held in the high position. This will be verified through the use of a multimeter

2.6 Sensor Module

2.6.1 Ultrasonic Sensor

The HC- SR04 ultrasonic sensor will be used in our design for the sake of determining distance and aiding the pressure sensor in the conclusion of whether a container is full. The ultrasonic sensor works by emitting a 40 kHz ultrasound wave and because of the fact that sound bounces of objects, it will be able to record the time it takes for the wave to echo back. The ultrasound is generated when Trig is on the high state for 10 microseconds, which is followed by the sensor sending 8 cycles of sonic burst that bounce off the nearest object. The ultrasound travels at the speed of sound and after bouncing returns back to the Echo pin, which will records the time in microseconds that the wave traveled. This sensor is necessary in our design because if it were to detect an item within a specified distance of 7 in. for a series of 10 echo cycles then it will send a “Full” command to the ATmega328P microcontroller. The sensor will be receiving power from the voltage regulator and the TRIG and ECHO pins on the sensor will be connected to the PWM (Pulse Width Modulation) pins on the ATmega328P, which is digital input pin on the ATmega.

Requirement	Verification
The ultrasonic sensor must be able to measure distance using the implemented algorithm and sense when an object is detected within 7 inches.	This sensor will be tested by checking that there is a seperate response when something is detected at a distance >7 inches versus <7 inches.

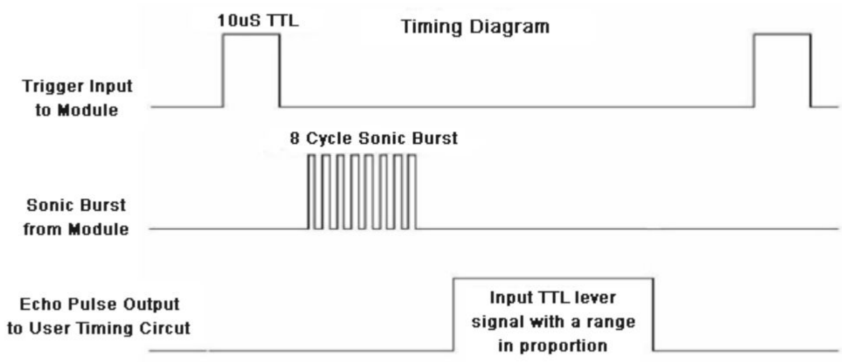

Figure 11: Ultrasonic Sensor Timing Diagram

In order to use the ultrasonic sensor to measure the accurate distance there needs to be specific calculation implementation. Since the ultrasonic sensor will track the amount of time necessary for the pulse to travel from the sensor to the object and back, the equation must account for this part.

$$Distance \ = \ (\frac{Time}{2}) * Speed\ of\ Sound\ at\ Sea\ Level$$

Equation 1: Distance formula to calculate distance depending on how pulses are sent out and detected

The speed of sound that we are using will be approximately 340 m/s or 34000 cm/s since we wish to work with smaller magnitude measurements.

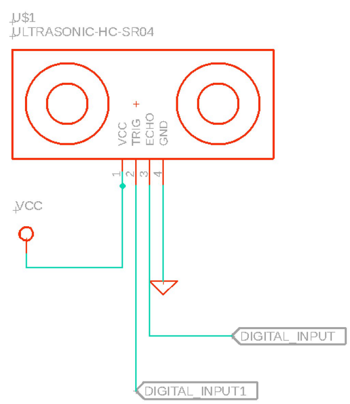

Figure 12: Ultrasonic Sensor EAGLE

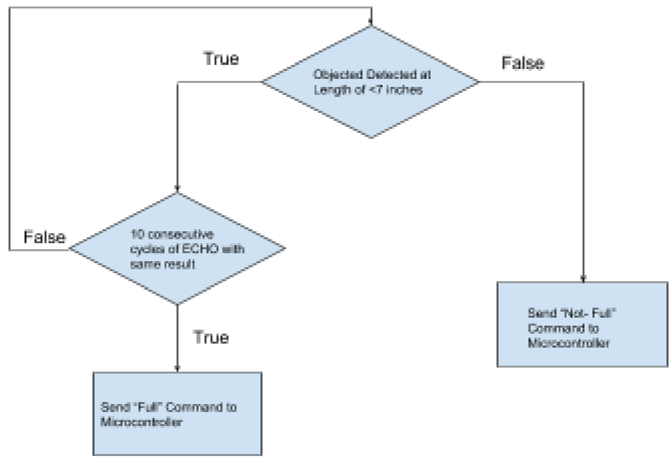

Figure 13: Ultrasonic Sensor Software Flowchart

2.6.2 Pressure Sensor

The Force Sensitive Resistor, otherwise referred to as the pressure sensor will be used to determine the amount of weight in the respective container. This sensor can differentiate between objects weighing 100g all the way up to 10 kg through. Depending on the pressure applied to the sensor the resistance will vary from a magnitude of 0.5kΩ up to 50 kΩ and thus indicating the force applied on the sensor. The respective log- log graph for Force vs. Resistance is pictured below. This data will be useful in conjunction with the ultrasonic sensor to determine whether the container is full by determining a threshold of 4kg. One important detail for understanding the logic used to pick the weight categories associated with this sensor is the measuring area. Since the pressure sensor is only 2 x 2 inches in area, it won't be used to measure the full weight of the garbage, but instead a smaller portion of it. According to our research, an average garbage can contents weigh around 10 kg, so we have decided that detecting 4 kgs on our sensor would substantiate a 'full' command being sent. The sensor will be attached to 5V of power, which will be coming from the voltage regulator and the data will be sent to the Analog Input pin on the ATmega328P Microcontroller chip.

Requirement	Verification
The pressure sensor must have the ability to detect the weight of objects on top of it up to 9.5kg	This sensor will be tested by applying different weight blocks to the top of it and verifying that it accurately senses weight.
The sensor must be programmed to respond differently to weight lower than 4kg vs. detected weights of greater than 4	This will be tested by applying various weights lower than 4 kg and making sure that the sensor isn't triggering a full command. The same will be done to weight higher than 4 kg and determining that a full command is triggered.

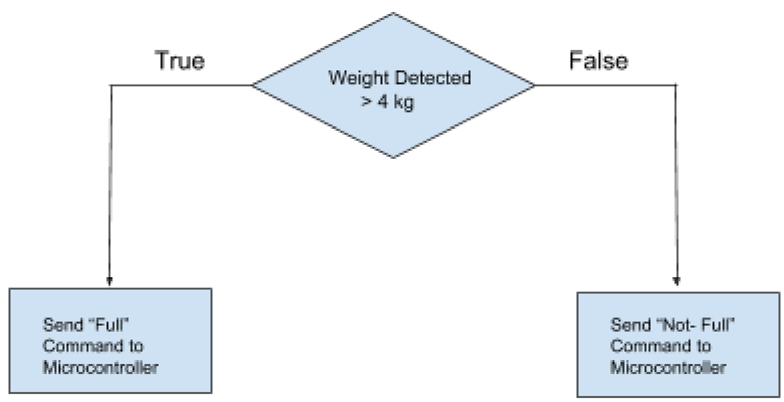

Figure 14: Pressure Sensor Software Flowchart

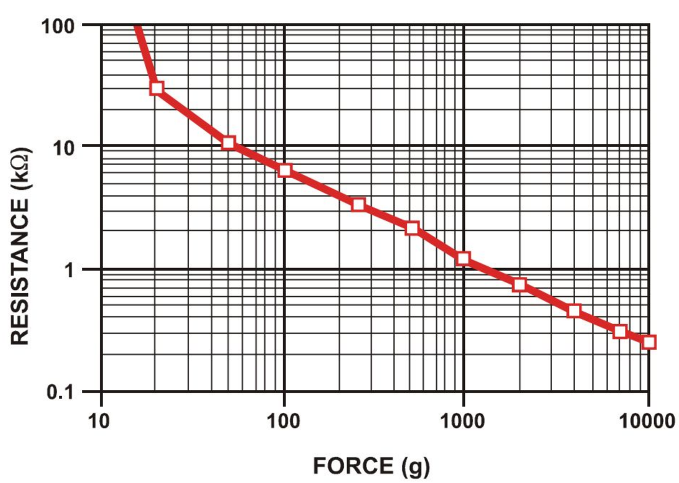

Figure 15: Force vs. Resistance Graph [11]

2.7 Tolerance Analysis

A key feature of this project is the ability of both the pressure and ultrasonic sensor to accurately detect if the trash can/laundry basket is full. The ultrasonic sensor chosen for the design is the HC-SR04 ultrasonic distance sensor and the requirements for this sensor is that it has to be able to detect when an object is present 7 inches away. We chose 7 inches to be the deciding distance between whether the trash can/laundry basket is full because it comes up to be the midpoint of the trash can/laundry basket, making it a good spot to collect data. This sensor has a ranging distance of 2 cm - 4m and this fact makes it capable of detecting an object at the 7 inches mark determined by us. Delving deeper into the requirements of this sensor, we can see that it has a ranging accuracy of 3mm. The worst case scenario would be the sensor not being able to sense garbage/clothes within a few millimeters but we do not think this would be a problem. This is because garbage and clothes are typically items that are spread over an area, making it tough for up to 3 millimeters to affect the ability of the ultrasonic sensor to do what is intended. Besides, the measuring angle of the pulses is within 30°, making it able to detect objects 15° below the sensor location. This 15° detection depth is suitable as pulses will not be sent to a height lower than 4.8cm at the midpoint of the trash can/laundry basket. 4.8cm is a tolerable amount that is not too large from our intended garbage can/laundry basket height tracking. Any larger angle that would have made the height lower by more than 5 cm could pose a height accuracy problem but that is not the case for our project. The 17.78cm value used below is a conversion from 7 inches and this is used to find the vertical detection length. The equations and diagram below shows the calculations made to determine if the 15° sensor angle is a suitable value for our sensor in completing our tasks.

$$\tan \Theta = \frac{\sin\Theta}{\cos\Theta}$$

Equation 2: Trigonometric ratios used to calculate distance based on given angle.

h = height of sensor reach

$h = 17.78\tan(15°)$

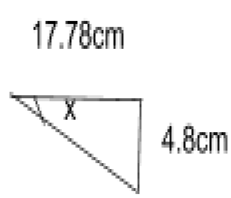

Figure 16: Right angled triangle where x = 15°.

By using Pythagoras' Theorem, we can also find out how long exactly the hypotenuse of the right angled triangle shown above is. This is important to determine because any object that lies along the hypotenuse can be sensed. Since the angle is fixed, we can predict where and at what distance would objects be sensed, triggering the full load case. Not taking into account the behavior of this sensor according to its sensing angle could have caused us to overlook certain cases that would trigger the full load case when it is not actually full. Besides, since the sensor would be placed on the top of the trash can/laundry basket, there would be the instance where something will be added into it. This instance would trigger the ultrasonic sensor and if the weight requirements are met, a full trash can/laundry basket would be sensed. To prevent this from happening, the ultrasonic sensor would only send data to the microcontroller when a steady sensor input is being obtained. This makes the sensor reliable in the sense that random obstacles will not cause the ultrasonic sensor to detect a full load. The Pythagoras' Theorem used to find this distance is showed below:

$a^2 + b^2 = c^2$

Equation 3: Pythagoras' Theorem

In our case, c would be 18.42cm and this means the 15° downward angle allows us to sense objects in the centre that are 15° lower than the horizontal length of the sensor only if they at least 18.42cm.

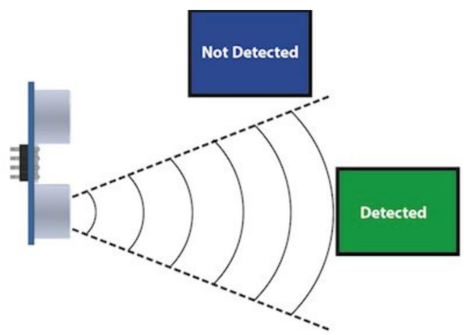

Figure 17: The whole detection arc of the sensor.

As for the pressure sensor, we will be using the Force Sensitive Resistor that has the ability to detect weights up to 10kg. We intend to classify anything above 9.5kg as an indication that the garbage can/laundry basket is full. To further explore this criteria, 9.5kg was chosen as the boundary weight between a full and partially full trash can because based on experience, a trash bag full of garbage on average weighs about 9.5kg. This makes our choice of pressure sensor a suitable component to detect this average weight. We opted to choose the threshold weight for the design instead of allowing the parents to make the decision because we do not expect the parents to know how much their trash weighs on average. Making parents choose the threshold might lead them to make the wrong decision and this may lead to our sensors sensing a full load when it is not or vice versa. Based on the datasheet of this pressure sensor, the range of force accuracy is roughly ±5% - ±25% and this depends on the measurement consistency and actuation system, the repeatability tolerance held in manufacturing and the use of part calibration. This accuracy range depends on many factors and since we are only using it to detect whether or not a specific weight boundary has been left, it is sufficient. Using this pressure sensor to detect exact weights where it acts as a scale would not be suitable due to its low accuracy. Thus, as long as exact weights are not trying to be measured, data from a sensor of this nature can be used as one of the two requirements before the laundry basket/trash can is determined to be full.

2.8 Requirements and Verification Points Distribution Table

Module Name	High Level Requirements	Points
Power Module	This module should successfully step up the voltage from 3.7V to 5V and distribute it to the Ultrasonic sensor, Pressure Sensor, ATmega328 and ESP8266.	10
Sensor Module	The Ultrasonic sensor and Pressure Sensor must correctly transmit data to the ATmega328P with the purpose of determining the state of the container. The data from the individual sensors will be used together to determine whether the container is empty or full.	15
Control Module	The Control module is responsible for data acquisition and through the use of software, it will determine the state of the container. The ATmega328 will also transmit data to the ESP8266 in order to bring the data to a local database	10
Front End Module	The front end module handles presenting the data to the parents and creating a ranking system for the kids. It is created through the use of a database, Python, JavaScript, HTML and CSS.	5
Wifi Module	The wifi module is needed to send data from the sensors directly to the database. This is handled by the ESP8266, which covers the requirements of needing a wifi antenna and a wifi shield.	10

3 Cost and Schedule

3.1 Cost Analysis

The fixed development costs are estimated to be $40/hr, 12 hours a week for three people. The project will take us an approximate 10 weeks to complete. Total labor costs will be:

$$3 \cdot \frac{\$40}{hr} \cdot \frac{12\ hr}{week} \cdot 10\ weeks = \$14,400$$

Equation 5: Equation to calculate total labor costs

Part	Manufacturer	Prototype Cost ($)	Bulk Cost ($)
Wifi Module - ESP8266	Sparkfun	6.95	6.26
ATMEGA328P	Microchip Technology	2.14	1.78
Force Sensitive Resistor	Sparkfun	11.25	10.13
Ultrasonic Ranging Module	Sparkfun	3.95	3.56
UA7805CKCT Voltage Regulator	Texas Instruments	0.58	0.21
2 Li-ion Batteries	EBL	9.00	9.00
Li-ion Battery Charger	EBL	10.00	10.00
2 10uF capacitors, 2 1uF caps, 3 10kOhm resistors, 1 220Ohm resistor, 1 LED, 100nF cap, 1 4.7kOhm	Mouser	6.00 (Estimated)	3.00 (Estimated)
Total		43.87	40.94

3.2 Schedule

Date	Sasan	Damian	Yarshun
2/18	Finish pin assignments, begin TCP programming	Finish research regarding ATmega328P	Research on ATmega328P pin assignments
2/25	Create sample web page with basic plotly.js implementation	Work on Circuit Schematics between sensors and ATmega328	Work on Circuit Schematics between sensors and ATmega328
3/4	Start programming the ESP chip with Arduino IDE	Order Parts for the Assembly and design PCB	PCB design
3/11	Finish programming ESP chip	Prototype the design with the Arduino Elegoo and order PCB	Prototype the design with the Arduino Elegoo and order PCB
3/18	SPRING BREAK	SPRING BREAK	SPRING BREAK
3/25	Finish front end module	Assemble the PCB and solder	Assemble the PCB and solder
4/1	Test the software and wifi capabilities	Test the ATmega data acquisition capabilities	Test the ATmega data acquisition capabilities
4/8	Make sure Software-hardware handshake works correctly	Verify the requirements set forth by the tables above	Verify the requirements set forth by the tables above
4/15	Verify the requirements set forth by the tables above	Assemble the physical module	Assemble the physical module
4/22	MOCK PRESENTATION	MOCK PRESENTATION	MOCK PRESENTATION
4/29	FINAL PAPER	FINAL PAPER	FINAL PAPER

4 Discussion of Ethics and Safety

There exists a number of potential safety hazards based on the way our system is implemented, specifically, the usage of lithium ion batteries. One of the safety concerns surrounding lithium ion batteries is the fact that it should not make contact with water under any circumstances [2]. Since the design involves a laundry basket and trash can, special arrangements regarding water do not have to be made. However, it is important to be aware of such precautions in case wet hands or wet clothes were to make contact with the battery or physical circuitry in general. Besides, it is also important that lithium ion batteries are kept within the safe operating limits when being charged. These safety rates are important to pay attention to because drawing too much current from the charger can potentially cause a fire. To mitigate this risk, lithium batteries used must be of trusted quality as most of them have incorporated circuitry built for protection to ensure safe operating limits [1]. Being electrical engineers, we are expected to abide by the IEEE Code of Ethics and Code #1 states that we agree “to hold paramount the safety, health and welfare of the public” [3]. In addition to that, by choosing to use a certain battery to be used in our product, we are accepting responsibility to ensure the battery matches the demands of our product. To mitigate the risks mentioned, the battery and necessary precautions that need to be taken for user safety will be continuously tested to ensure safe usage. Furthermore, our product will be placed in locations where children will frequent and if precautions are not taken harm could be caused. We will make sure the product is child safe by enclosing all circuitry and not giving children the chance to toy with any exposed components that may cause them harm. This will be done to adhere to the IEEE Code of Ethics #1 that states we agree “to hold paramount the safety, health and welfare of the public” [3]. Therefore, we are responsible for making sure users are not harmed when using our product.

Besides the safety issues that have been mentioned, there are some minor ethical concerns that will be addressed. We are responsible for the data collected indicating whether the chore needs to be done and it has to be accurate to ensure the integrity of this project. This is in accordance to Code #3 in the IEEE Code of Ethics that states that we agree “to be honest and realistic in stating claims or estimates based on available data” [3]. Tests will be conducted to make sure sensors accurately collect and transfer data to the created mobile application. In addition to this ethical code, we will be open to constructive criticism of faults in our implementation from peers, course staff and industry professionals. This idea like many other ideas out there is not perfect and will be susceptible to criticism that will in turn help in the making of a remarkable product. This reiterates Code #7 of the IEEE Code of Ethics that ensures we agree “to seek, accept and offer honest criticism of technical work…” [3].

5 Citations

[1] notes, e. (2019). *Li-Ion Battery Advantages / Disadvantages* | *Lithium Ion* | *Electronics Notes*. [online] Electronics-notes.com. Available at: https://www.electronics-notes.com/articles/electronic_components/battery-technology/li-ion-lithium-ion-advantages-disadvantages.php [Accessed 06 Feb. 2019].

[2] Genuinecells.com. (2019). *Safety Precautions for the Lithium Ion Batteries*. [online] Available at: https://genuinecells.com/safety-precautions-for-the-lithium-ion-batteries [Accessed 07 Feb. 2019].

[3] Ieee.org. (2019). *IEEE Code of Ethics*. [online] Available at: https://www.ieee.org/about/corporate/governance/p7-8.html [Accessed 08 Feb. 2019].

[4]Googins, B. and Burden, D. (2019). *Vulnerability of Working Parents: Balancing Work and Home Roles*. Oxford Academic. [Accessed 16 Feb. 2019].

[5]. Smetana, J. (2019). *Child Development*. [online] Available at: https://www.jstor.org/stable/1130779?seq=1#page_scan_tab_contents [Accessed 05 Feb. 2019].

[6]. Benin, M. and Edwards, D. (2019). *Adolescents' Chores: The Difference between Dual- and Single-Earner Families*. [online] Available at: https://www.jstor.org/stable/353032?seq=1#page_scan_tab_contents [Accessed 10 Feb. 2019].

[7]. Lehman, J. (2019). *How to Get Your Kids to Do Chores* | *Empowering Parents*. [online] Empowering Parents. Available at: https://www.empoweringparents.com/article/ill-do-it-later6-ways-to-get-kids-to-do-chores-now/ [Accessed 14 Feb. 2019].

[8]. Nexus-yfs.org. (2019). *Chores and Your Child's Development*. [online] Available at: https://www.nexus-yfs.org/parents/parenting-blog/articles/chores-and-your-childs-development [Accessed 12 Feb. 2019].

[9]. Markham, L. (2019). *6 Reasons Kids Don't Help Around the House*. [online] Psychology Today. Available at: https://www.psychologytoday.com/us/blog/peaceful-parents-happy-kids/201810/6-reasons-kids-dont-help-around-the-house [Accessed 10 Feb. 2019].

[10]. Ww1.microchip.com. (2019). [online] Available at: http://ww1.microchip.com/downloads/en/DeviceDoc/ATmega48A-PA-88A-PA-168A-PA-328-P-DS-DS40002061A.pdf [Accessed 7 Mar. 2019].

[11]. Sparkfun.com. (2019). [online] Available at: https://www.sparkfun.com/datasheets/Sensors/Pressure/fsrguide.pdf [Accessed 7 Mar. 2019].