Laundry Alarm

Team 8

Thomas Mayer (tmayer5)

Marcin Horwat (mhorwa2)

Michelle Lamblin (lamblin2)

TA: Hershel Rege

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1.1 Introduction:

People often forget about their laundry and in shared laundry rooms this can back up the machines and cause issues. Also, if you forget about your laundry and leave it soaked or wet for long periods of time you can damage your clothes or get a very foul smell on them that won't come off. That can be a costly mistake especially for students who already live on a small budget. The exact number will be different for everyone, but according to award-winning financial planner Pete Dunn, "the average american spends around 5% of their budget on clothing. If your monthly take-home pay is $3000 for example, then you should spend around $150 per month on clothing. [2]" Therefore, one load of laundry can be worth $100 or more in clothing depending on how much clothes you are washing. Another issue that can arise, especially in busy laundromats or coin laundry stations, is that if someone doesn't pick up their laundry then the next person can't start their load and that delay is money lost for the business or coin operated unit. According to the T&L equipment company, "The average wash costs you $2.50 and the average cost to dry is $1.25. This is typically 50% of your washing machine revenue. So, on an average day laundromat X has 20 machines x 4 uses a day x $2.50 per use = $200 and another $100 for the dryers. That would equal $300 profit on a typical day. [3]" If congestion becomes an issue and you are machines get backed up to 3 uses per day for example, then you are looking at a $240 profit on a typical day. That would be a $60 loss per day and it could be worse if congestion gets worse. Our solution is to create a device that will notify the user when their laundry (washer or dryer) have completed their task and it's time to pick up your clothing.

We believe that our product would be a perfect solution for everyone from students in dorms or apartments to large businesses that run multiple coin operated machines. Dorm/apartment laundry rooms are always busy and people often forget or leave their load in the washer or dryer for long periods of time even though the job was complete. The same issue can arise in busy laundromats. Our product will help eliminate congestion and traffic in laundry rooms and help people save time by notifying them as soon as their laundry is ready for pickup.

A device like this is currently not available on the market, except for brand new (expensive) washers and dryers that have a feature like that built in. Our solution however, would work on all models simply by plugging your washer or dryer unit into our device and getting notifications on your mobile device. This would be more cost effective than buying a brand new fancy dryer that can cost up to $1000. You would just plug your appliance into our device and you will have that great feature for a fraction of the cost.

1.2 Background:

According to Lucinda Ottusch, the lead home economist at the Whirlpool Institute of Fabric Science, "If you let your wet clothes sit long enough, you'll have to deal with not only the mildew smell in your clothes, but also possible stains and patches of rotten fabric. [1]" Depending on the quality of clothes you own, this can cost you up to $100 in clothing that could be ruined. This would be a very costly problem especially for students who are already on a tight budget.

Also, according to Pheena Kenny, who works with the The Asthma Society of Ireland, "The moist environment of your washer encourages mold and mildew to release spores. This can cause problems for people with conditions like asthma. "Normally, when people breathe in these spores, their immune system helps get rid of them by coughing or sneezing. If you aren't sensitive to mold, you may never even experience a reaction [1]". According to the center for disease control and prevention about 1 in 12 people in the United

States (about 25 million) have asthma, and the numbers are increasing every year [7], so our product has the potential to help millions of people with allergies.

One existing (DIY) solution to this problem that we discovered online is a vibration sensor that is mounted on the outside of the machine. That however is not a good solution because calibrating the vibration sensor would be very difficult for the wide variety of washing machines on the market. Every machine would vibrate at a different frequency and magnitude, so it would be impossible to make a universal solution using vibration sensors. Vibration from nearby machines would also interfere with measurements. Another thing is that many new washing machines have advanced vibration dampening so newer more expensive models would not work with vibration sensors at all. Our device, which will measure current draw, is a universal solution that will work with any model, whether it's 30+ years old or brand new.

1.3 High-level requirements list:

- Our device will have to operate on a wireless network and maintain a data transfer rate as described in the ESP8266 wifi chip of around 2.4 GHz, the rate needed to support wpa/wpa2 and to maintain a proper connection with the parse server in order to send a notification to your computer or mobile device. It will have to operate within a building and have a range of 150-200 feet to the router.
- The device will need a software delay of ~1 minute of zero current (or below threshold current) before sending the alarm when the washer or dryer is in a cycle that isn't maximizing current flow.
- The device will be an affordable solution(< $50) to the problem we mentioned earlier.

2. DESIGN

This device requires 3 main components to function properly: power, control, and the Wifi communication module. The device will be powered from a wall outlet (120V AC) and we will have to implement a AC/DC converter to get an output voltage of around 5V. The AC/DC converter will be used to power the low voltage components of our device like the microcontroller and wifi module. Another thing to consider is that we will have to plug the washer/dryer into our device to both power the washer/dryer and collect current data going to the washer or dryer using a current transformer (CT). The CT will be loaded with a resistor, and the voltage across the resistor will be used as data for the microcontroller. After the data is analyzed, we will send that information over Wifi to a mobile device or computer so we can notify the user when the wash or dry cycles have been completed. The information transmitted out form the microcontroller will be analyzed through temboo and then transmitted to a parse server which will read the information and determine whether to send a popup notification to the laptop/cellular device.

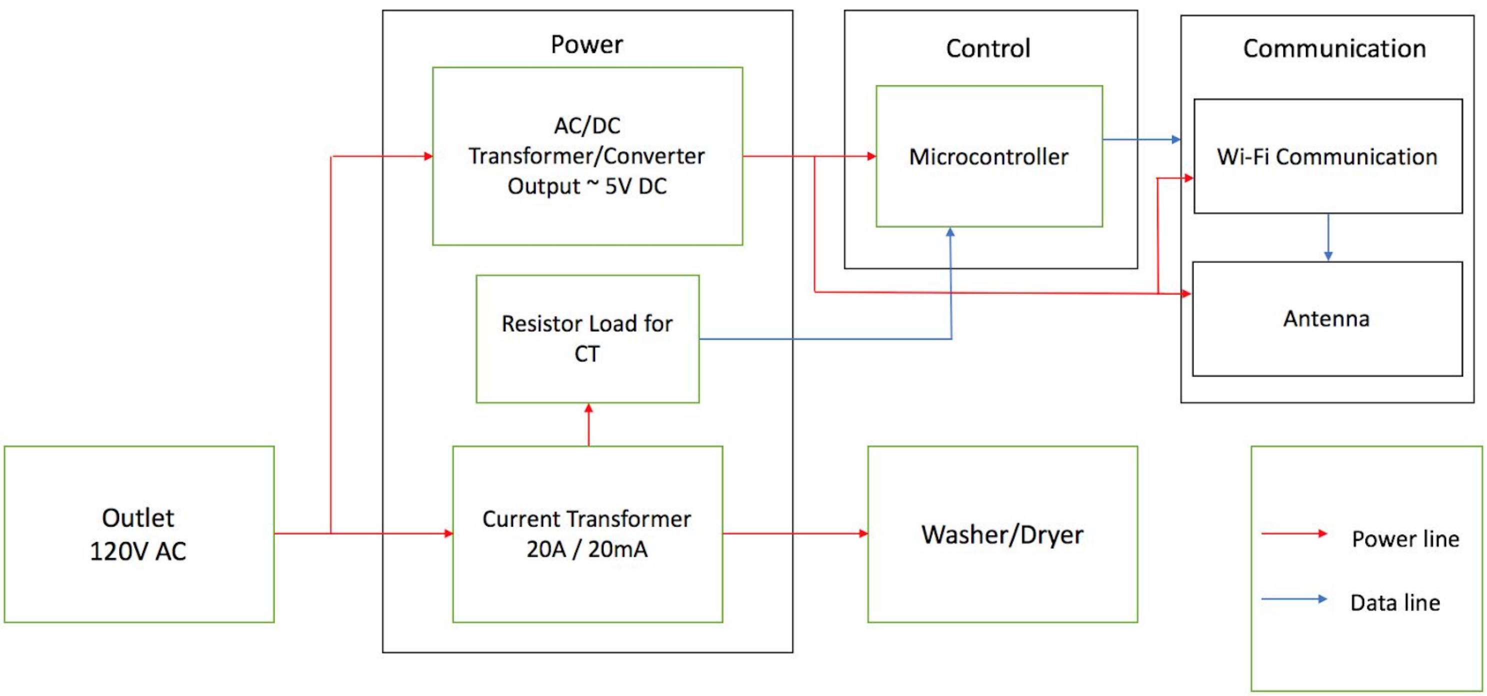

Figure 1. Block Diagram

2.1 Power

120 VAC needs to be stepped down and regulated to provide DC voltage for the microcontroller and Wifi adaptors. Power for the washer/dryer will pass though the current transformer.

2.1.1 AC/DC power supply

Before the current transformer, an AC/DC power supply will be used to provide regulated DC voltage for the system**.** This consists of a transformer, full wave rectifier, and a parallel capacitor to transform 120V AC to 5V DC ±10%. The microcontroller and Wi-Fi communication are the only two devices needing power, so current draw will be low for this power supply.
Requirements: Must be able to provide a regulated DC voltage of 5V ± 10% for every component that requires DC.

2.1.2 Current Transformer

The current transformer will be measuring current after the power supply to avoid including the device current in its measurements. The output of the current transformer will be loaded by a resistor. The voltage across the resistor will be rectified and sent to the microcontroller.
Requirements: *Must be able to measure at least 15A in the primary winding and be compatible with our microcontroller.*

2.1.3 Resistor Load

The resistance used as a load for the current transformer will be calculated to provide 5V DC for the microcontroller at a high side load of 15A. The AC voltage across the resistor will be rectified with a full wave rectifier and parallel capacitor rated for the small load of the microcontroller.
Requirements: *Must provide 0-5 V DC for the microcontroller as an analog input for current data. WIll depend on microcontroller analog input range.*

2.2 Control Unit

The control unit will receive current draw data from our current transformer and that will then be analyzed and determine when to notify the user through a mobile application. If the current falls below some threshold for a certain period (~1 minute → will need testing) the control unit will send a signal to the wifi module and then to the user so they can be notified.
Requirements: *The microcontroller will have to take in data from our current transformer and run autonomously.*

2.3 Wifi Communication

2.3.1 Block Diagram for Software Communication

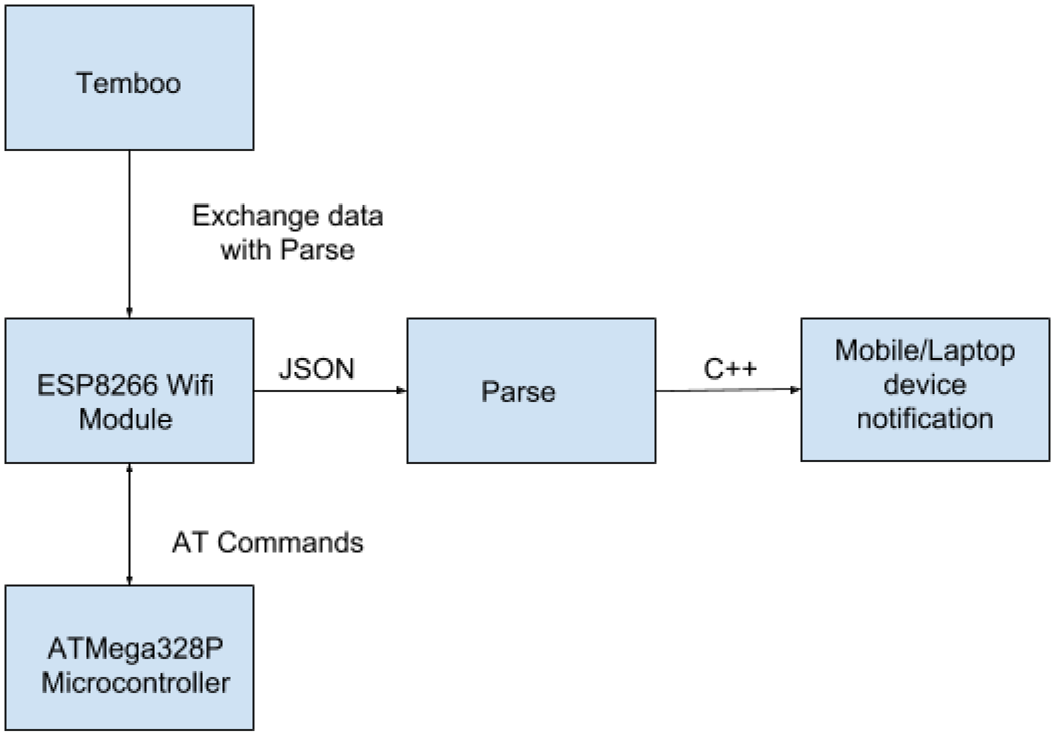

Figure 2. Software Block Diagram

- The ATMega328P will communicate with the ESP8266 module through the use of AT commands, a common protocol used with IOT projects.
- To enable the WiFi communication between the arduino and the cellphone, two third party apps will be utilized. One is “Parse.com” which will enable an environment from which push notifications to an android device can be created, and the other is “Temboo”.
- For the lower level, the Arduino Sketch application will be used to check the digital pin output from the arduino chip to obtain a signal, which will be sent when the Arduino notices a drop in current signifying the stop of a washer/dryer cycle.
- “Temboo” will be utilized to create a set of connections to the outside internet such as “google.com”, and in our case, will be an agent used to send data to “Parse.com”
- Writing a C++ script in “Parse.com” we can send out a push notification to our IOT device

Requirements: *The Android app will need to be able to create a popup notification. The Wi-fi should have a range of ~150 feet. The transmission speed should be able to maintain proper communication to Temboo, so it would need ~2.4 Ghz to maintain this.*

Risk Analysis: Identify the block or interface that poses the greatest risk to successful completion of the project. Justify your choice.

The Wifi component will be the most difficult because we will have to potentially get a wifi chip and integrate it properly on the PCB. In order to establish a proper connection between the ATmega328p and the ESP8266 wifi chip, the code must be able to input the proper username and password to connect to the wifi. This would mean we would either have to find some way to port date from the ATmega from udp/tcp or install a small LED screen on our project to prompt the user for the username/password so the user doesn't have to change the code. The only issue is if we cannot find a wifi chip which allows a fast enough rate of data transfer from the ATmega to the third party software server to notify a user when the laundry is completed, we will instead have to use an ethernet shield or create one ourselves to attach to the PCB.

Failure to complete this module would be detrimental to the success of our project, as the project would lose the majority of its meaning. The whole point of the project was to be able to notify a user in the event their washer/dryer cycle is completed via some sort of popup notification when the user does not hear the end cycle signal. The software side of the project is crucial otherwise the project itself loses its overall meaning and we would just be developing a sensor to detect a change in current for any device as opposed to this specific case.

3. PHYSICAL DESIGN

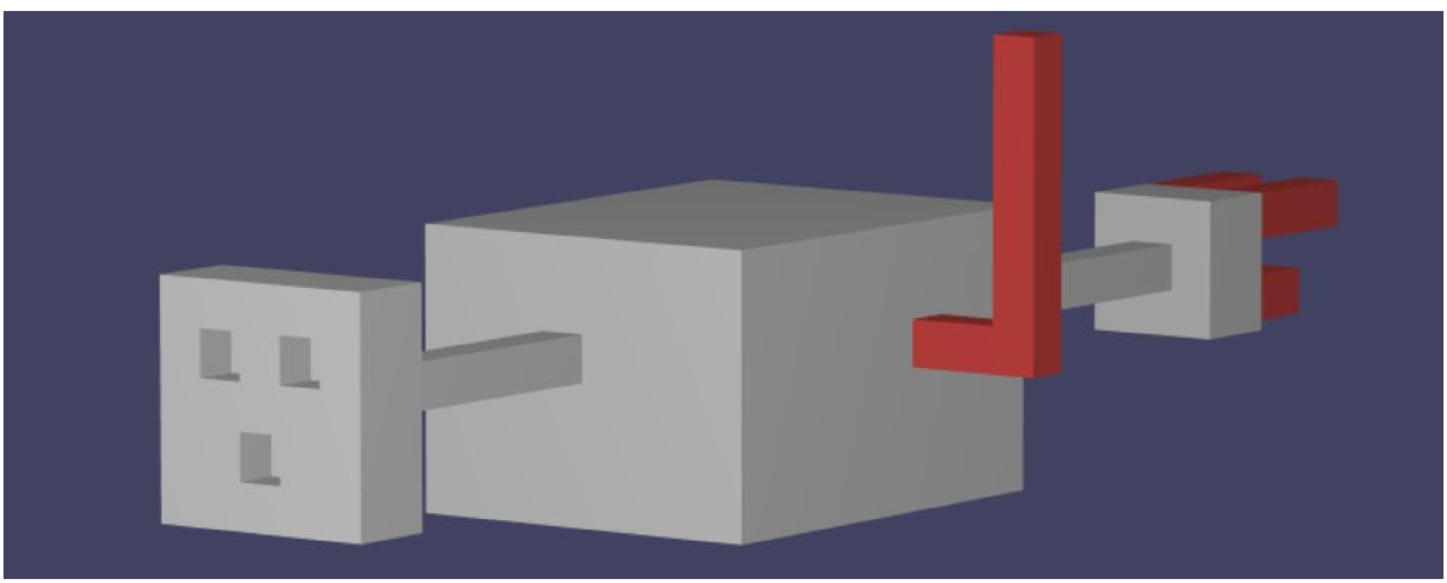

Figure 3

Figure 3

The image in Figure 2 depicts a rough 3D model of our design. The look is similar to that of a laptop charger with an inlet and outlet on either sides of the box, which we estimate will be around the size of a tissue box at most. Attached in red on the box is the wifi antenna which will be used to send a signal upon completion of the washer/dryer unit.

ETHICS:

The primary concern for our project with regards to safety is the 120VAC outlet power we will be working with. We need to ensure that the process of lowering the DC voltage to a limit our PCB is safe. The live 120VAC power will cause concern and we will need to take the proper caution when working with it live. As per the lab safety standards, we will make sure to check for any damage to the outlet/wires and will not bring food/drinks into the lab to avoid potentially getting liquids on any electronics and prevent damage to the electronics.

Along with taking extreme caution while using 120VAC, we will also follow Section 6 of the IEEE code of Ethics[5] while working with voltage converters and regulators and to keep true to Section 7 of the IEEE code of Ethics[5], making sure our work is compliant with ethical designs and sustainable development practices when working with 120VAC.

In terms of malicious interception of signals, the system could potentially be hacked, we intend to avoid this by creating a user and password authentication requirement when we enable wifi on the network so a potential malicious user would not gain an easy access way into a user’s personal wifi.

SAFETY:

High voltage must be properly insulated to prevent an internal short or user from being electrocuted. Wires used to transmit power from the wall outlet to the washer/dryer will need to be rated to carry 15A or more. Our device will have to be properly grounded.

According to the United States Department of Labor Occupational safety and health Administration, "Grounding a tool or electrical system means intentionally creating a low-resistance path that connects to the earth. This prevents the buildup of voltages that could cause an electrical accident. Grounding is normally a secondary protective measure to protect against electric shock. It does not guarantee that you won't get a shock or be injured or killed by an electrical current. It will, however, substantially reduce the risk, especially when used in combination with other safety measures discussed in this booklet.”

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