Smart Laundry

Design Document

Team 21

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Table of Contents

1 Introduction

1.1 Project statement

The goal of this project is to bring clothing washers and dryers into the internet of things at an affordable rate. Our approach is to make a device that senses on/off states when upon attachment to a broad range of laundry machines. The data gathered from the device will then be accessible from within an android mobile application. This allows for laundry machines to be brought into the internet of things and along with it many more benefits (ie. increased throughput, money savings, etc.). Ultimately our solution will increase efficiency for owners of upgraded machines and the users of them as the addition of devices to existing machines can easily be implemented commercially.

1.2 Purpose

The goal of this project is to bring more efficiency to the owners and users of laundry machines. By allowing many existing or new laundry machines to be brought into the internet of things there are many benefits. On a commercial level, owners can enhance their outdated machines. By attaching our internet connected sensing unit to existing machines, customers can more efficiently access the machines because they will know the availability in nearby stores. On top of this, other commercial businesses such as hotels and laundromats can track when their machines are being ran and how much resources they take up. This provides a valuable opportunity for big companies to further analyze the expenses and efficiency of their operations.

The smart device that we are creating allows anyone with internet access and a laundry machine to be able to track their laundry. This can be used to notify them when laundry is done, how much water is being used, as well how much electricity is being used. Giving anyone the ability to become better informed about their efficiency, and at the same time improve it.

1.3 Goals

- Develop a machine state sensor that is easily attachable to laundry machines
- Have the developed device easily connect to the internet and send data to a server
- Store each sensor's data in a database
- Have an android app that can pull data from the database and display it in a user friendly way that can easily be understood and used
- Have a screen where owners of the device can go to see different statistics such as water, chemicals, and electricity used
- Incorporate machine learning to be able to predict availability of laundry machines

2 Deliverables

- Device(s)
    - The delivered device(s) will be easily attachable to washers and dryers with the capability to sense a broad range of machines in order to tell if they are on or off. The sensing device will also be easily configured to use local wifi.
- Configured database
    - The delivered database will store various stores, machines, and users of the smart laundry app.
- Configured server
    - The delivered server will be able to gather information from nearby machine state sensing devices and then store it into the delivered database.
- Functioning android mobile app
    - The delivered mobile app will allow for users of it to easily access specific stores and their machine availability.

3 Design

Table 1 in the appendix shows the various solutions brainstormed relating to the creation of the mechanism to be attached to washers and dryers. It lists the possible implementations regarding local server communication, mounting, power, and sensing.

3.1 System specifications

After discussing as a team we came to the conclusion that a machine attachable device would be most accepted if it did not require any alterations to be done to the machine. Different machines would require different alterations of various complexities. The easiest and least intrusive way for our device to be used would be to mount it onto the outside of the machine without having to alter anything within the machine. This lead to a team decision that the proposed design be one that does not require any physical alteration within the machine.

3.1.1 Non-functional

- Machine learning (predictive scheduling)
- The system must track how many loads of laundry are completed
- Battery backup
- Live feed
- Live map
- Database GUI
- Extra Database tables
- Social media plugins
- Outage reporting
- The app is responsive
- Tracks water used
- Tracks electricity used

- Tracks detergent used
- UI for breaking down machine/location(s) statistics

3.1.2 Functional

- There must be a Physical Device that
    - is mountable
    - has sensors on it
    - is able to connect to internet
    - is set up to be able to interface with a router on site
- There must be a Database that
    - is a central database
    - stores sensor information
    - interfaces with a server
- There must be an off-site server that
    - interfaces with the database
    - receives post requests from devices
    - receives post requests from mobile app
    - receives get requests from mobile app
    - sends information to the mobile app
- There must be a mobile app that
    - is used by users of the laundry facilities
    - receives information from the server
    - sends post requests to the server
    - sends get requests to the server

3.1.3 Standards

Our team is following a couple standards when developing a solution to the stated problem we are solving. The device that is being made uses standard wifi(802.11) to communicate with a nearby server. As the mobile application is developed, it will follow a MVC like coding architectural standard. The way the architecture is set up is to be a dependency injected model view controller. With this code structure it allows for “black box” development. It makes development go smoother and gives the application as a whole an easy to understand architecture. With this standard, the database does not need to be implemented right away in order to develop a functioning app.

3.2 PROPOSED DESIGN/METHOD

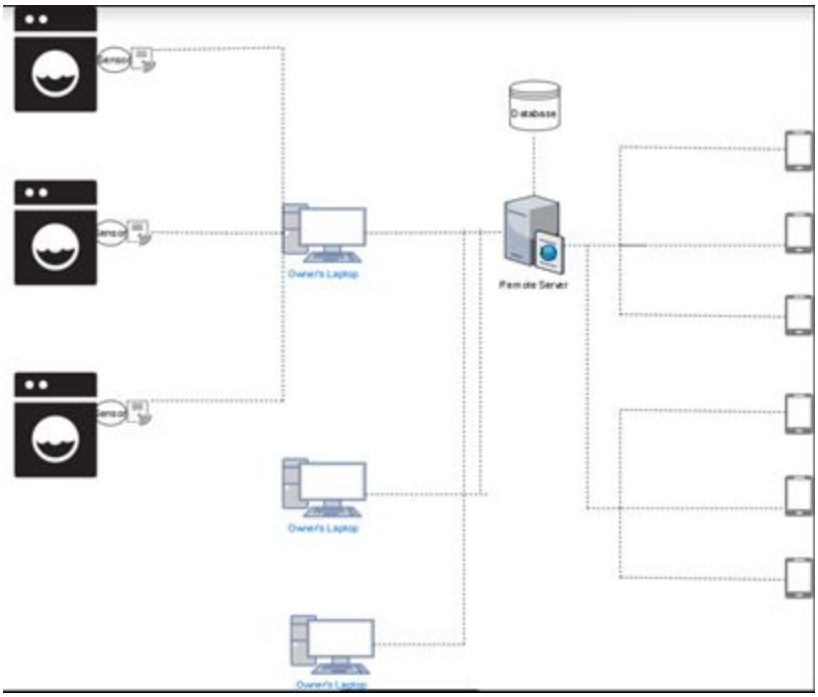

Figure 1 .: An architectural diagram of our complete system

As shown above, the proposed design has a machine state sensing device that is attached to the outside of the a machine. This device will be developed so that it can reliably measure the vibrations of the machine it's mounted on in order to know if it is in use or not. Our sensing mechanism will then be able to communicate to a local server within close proximity of the laundry machine. This will allow for the state of machines to be sent to that local server to analyze the data. When the local server runs the data through an algorithm that we develop, it will be able to determine if specific machines are running or not. The results will then be sent and stored into a central database containing all of the machines and stores using a smart laundry sensor. This database allows for the mobile app to query it and relay store/machine information to a user pertaining to a user specified store and machine.

To effectively sense the machines on and off state we decided to go with a _____(to be determined) sensor. The sensor is then onboard the microcontroller that is wifi enabled to communicate with the local server. We also went with the design decision to have a microcontroller that needs to be plugged in at all times rather than having some sort of battery to it.

3.3 DESIGN ANALYSIS

Strengths of proposed solution:

- Non intrusive to laundry machines
- Easy to add our solution to most machines
- Machine specific wiring research is not needed from us or machine owner
- Can't run out of power when plugged into an outlet at all times
- Cordless/clutter-free communication between sensing unit and local server

Weaknesses of proposed solution:

- No 100% guarantee for state of machine
- Needs an available plugin in close proximity
- Machine state sensor has the ability to be stolen since it is on the machine exterior

Observations from testing the proposed solution:

We have not entered our prototype testing phase yet.

4 Testing/Development

4.1 INTERFACE SPECIFICATIONS

In our design there are multiple points where our different encorporated devices will need to be able to communicate with each other. The machine state sensing device needs to be able to send machines' status updates to a local server, this will be done through wifi. Communication between the local server and central database will then happen through the use of a Firebase library that allows for storage of information into the database. The mobile app will also communicate in the same way, using a Firebase library that allows for the storage and retrieval of database information.

4.2 HARDWARE/SOFTWARE

The hardware we are using in our testing phase is various laundry machines. The washing and drying machine models can be seen in table 1 below. By testing our machine state sensing device on various machines, we can adapt a sensing algorithm that can work on a broad range of machine models.

Model	Machine Type
xxxxx	Washer
xxxxx	Dryer

Table 2 .: The table above shows that various washers and dryer models that were used during the sensor's testing phases.

4.2 Testing Process

4.2.1 Sensor Test

Testing of the sensor's capabilities included the following:

1. Successful reading of on/off state of machine when it is running or not running on various machine models
2. Being able to not have the sensor switch the on/off state of the machine's status when it is being unloaded or loaded
3. Not allowing another machine's vibrations that is in contact with subject machine to trigger on status

4.2.2 Communication Test

When testing the communication we will examine the connections made between all stages of the integrated system separately as follows:

- **Sensing unit -> Local server**
    - Confirm that machine on/off state can be transmitted from the sensing unit to the local server through wifi connectivity
- **Local server -> Central database**
    - Confirm data can be sent from the local server to correct location in central database
- **Central database <-> Mobile app**
    - Confirm that data can be received and sent to and from the central database and mobile application

4.2.3 Application Testing

Testing the application on its own consists of navigating throughout the application on multiple devices and making sure it is responsive to what the user is pressing. For our application to be considered "responsive" we are defining it to have no noticeable delay between pressing something and a resulting action being carried out.

4.2.4 Integrated System Test

An entire working system will not be tested until all individual parts outlined above are first tested and confirmed to be fully functioning. The integrated system testing will happen in three stages.

1. First Stage - Using only one machine state sensing mechanism registered to one store
    a. For the first testing stage to be considered successful, the on/off status of the machine must be able to be seen by a user of the mobile app within a minute of it turning on or off. This should be reflected in both the "store map" page and the "machines" page.
2. Second Stage - Using 3 machine state sensing mechanisms registered to one store
    a. For the second testing stage to be considered successful, the on/off status of multiple machines must be able to be seen by a user of the mobile app within a

minute of it turning on or off. This should be reflected in both the “store map” page and the “machines” page.

3. Third Stage - Using 6 machine state sensing mechanisms registered to 2 stores
    a. For the second testing stage to be considered successful, the on/off status of multiple machines from multiple stores must be able to be seen by a user of the mobile app within a minute of it turning on or off at the correct store location. This should be reflected in both the “store map” page and the “machines” page for the user selected store.

5 Results

We have not yet began the testing phase for our prototype. At this time there are no results to be reported.

7 Conclusions

The goal of this project is to bring more efficiency to the owners and users of laundry machines. By allowing any existing or new laundry machine to be brought into the internet of things, their processes can be more closely monitored by anyone who owns or uses the machine. In order to accomplish this goal we will develop a working machine sensing device, expandable database, and mobile application. The way in which each of these elements are implemented is done so that the functional requirements set in place are not compromised and the quality of the non functional requirements are optimized.

7 References

List any references used in the document. These are an essential part of your review so far.

8 Appendices

Communication with local server	Power	Mounting	Sensing
• Bluetooth • Wifi • Ethernet	• Plugged in • AA or similar batteries • Rechargeable battery pack	• Suction cup • Screw onto machine • Glue • Double sided tape like adhesive	• Vibrations • Magnets • Integrated wiring • Sound • Accelerometer

Table 1 .: Above is the table of brainstormed ideas for possible solution combinations