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Remote Monitoring Device for Factory Inventory Management by Using IoT

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Abstract: Commonly in the factory's maintenance department or warehouse, there are storage rooms available to store goods or spare parts. Eventually, it's not easy, requires much effort, and the warehouse needs more staff to monitor the movement and use of products or assets in their facilities. This manual process could lead to inaccurate stock management and this adds to unnecessary costs to fix the error. In recent years, many warehouse inventory management systems were developed using wireless communication technologies such as Radio Frequency Identification (RFID). The tag information is transferred from the transmitter section to open-source hardware via a wireless link with the aid of the Internet. However, staff still need to monitor the inventory system closely on-site. Hence, to avoid this problem, the automated stock inventory and management using the Internet of Things (IoT) is very helpful because it allows users to remotely monitor product stock without having to go to the shelf where the product is located. Automated stock inventory and management systems using IoT are significant aspects of maintenance and goods-based methodology. The automated stock inventory and management using IoT built on the Internet of Things architecture is developed to track the record of products amount and their respective time stamps for further verification. The NodeMcu acts as a central server, monitoring all the information. The total system can correspond to the information flow and material flow: Thingspeak, which provides a convenient interface for the user to track the products. The developed system results in a very low-cost system. It works dynamically compared with the existing present warehouse inventory management systems.

Keywords: Remote Monitoring, Inventory, Factory, IoT

1. Introduction

Inventory management is essential to any business as it helps them prevent stock-outs, manage multiple locations, and ensure accurate record-keeping. An inventory management system makes these processes easier than trying to do them manually. The existing inventory Management system uses Ms. Excel to store stock data. However, using Excel to track essential qualities of items increases the

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likelihood of data entry errors, especially if user inventory frequently moves from location to location. Also, having a single Excel workbook limits user access. Excel lacks real-time inventory and limits the user's ability to analyze historical data quickly [1].

The most common problem faced by factories in maintenance management is poor inventory management, which affects the organization's performance [2]. Ngubane et al [3] also stated that it was found that a lack of inventory management skills has prohibited manufacturing SMEs from being powerful competitors in the manufacturing industries. This problem occurs due to several factors. One of them is poor documentation or store records. As Boyer [4] has claimed, the processing time of manual documentation and posting records is long, and there are high chances of misplacing the figures or wrongly recording the information. As a result, the accuracy of the inventory record will be affected and cause discrepancies.

According to Raman, DeHoratius, & Ton [5], inaccurate inventory record has reduced ten percent of an organization's profits. The common causes leading to the inaccuracy of company inventory records are inventory shrinkage, errors in inventory transactions, and keeping the inventory in the wrong place. The shrinkage of physical inventory means the physical inventory has been stolen, damaged, expired and spoilt. The researchers have proven that the rate of physical inventory shrinkage is 0.6 percent for the employers of manufacturing organizations

The proposed system is designed to eliminate the need for manual stock calculation from time to time so that the store record always has to date the amount of inventory in the store. The approach has features such as statistics, remote monitoring, and much more. The system is composed of a device that works with a load cell sensor that gives the user complete information regarding the stock they have. The device also will fully integrate with the Internet of Things (IoT), which differs from a traditional Internet which encompasses more than just computers and phones connected to other computers and phones. The Internet of Things (IoT) eventually connects everything to everything else, as well as the traditional Internet. There is something for everyone from street lights and autos to plants and animals, the weather, tennis rackets, your clothes, and more. They will all be linked to the Internet and one another. With the Internet of Things, everything has a link to both the Internet and the rest of the world. Because this new Internet of Things has the potential to offer up a universe of possibilities that did not exist before,

For this project, IoT technology will be implemented in the factory during maintenance management, mainly dealing with electronics parts such as stock items, pneumatics, and aluminum brackets. IoT technology will transform the manual way of calculating and stocking inventory into a fully automated one. The manual way of inventory management can still be relevant. However, it consumes much time, and sometimes miscommunication happens. By having automated inventory management, all the problems can be solved quickly and boost the productivity of work. Employees and users can view any information regarding the inventory stock in real-time using a smartphone. All the data is there for the user view. An alert email will also be sent if any stock has a low volume, which is convenient for everyone.

2. Methodology

2.1 Remote Monitoring Block Diagram

The hardware part of this project is the microcontroller board, NodeMcu, and the load cell sensor. The load cell sensor is placed under the enclosed box. These positions measure the weight of the stock items that will be put in the enclosed box. The software used in this project is Arduino IDE software. The IoT platforms deployed are ThingSpeak and ThingView applications. The system starts when the load cell sensor detects a weight measured by the load cell sensor. The measurement of obtained weight is sent for the Analog to Digital Conversion process through NodeMcu to obtain the digital value of the exact

weight of the object. The NodeMcu will process the information obtained. The conversion between weight and number of stock items is calculated and displayed on the OLED. At last, the total weight measurements and total stock items available are displayed on the IoT platform, which is on the ThingSpeak application for the developer interface and the ThingView application for the user interface. Figure 1 illustrates the block diagram of this project.

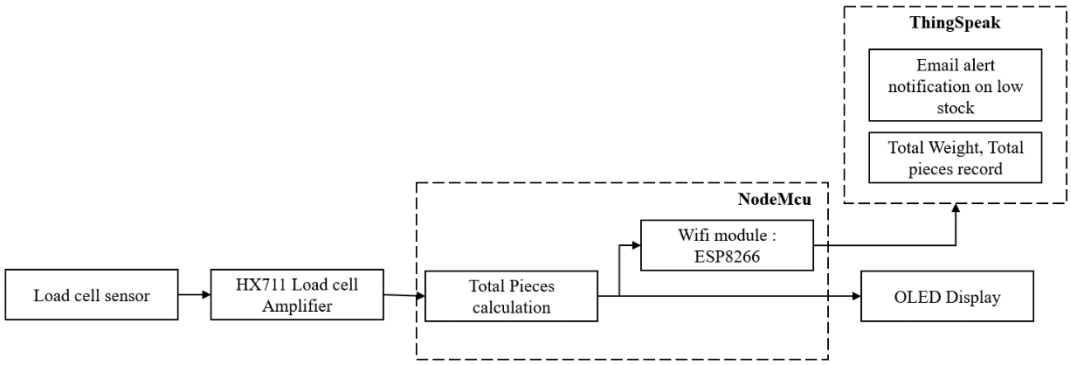

Figure 1: Block diagram of remote monitoring device

2.2 System Flowchart

Figure 2 shows a system flowchart that revolves around the system's working process from start to end. First, when the device starts, it will try to establish the connection to the network settings in the coding. The error message will display if the NodeMcu cannot establish the connection. Next, the load cell will calibrate, which is set to tare. Then, the load cell will measure the total weight of the stock items and an HX711 amplifier module that acts as an analog to digital converter and process the information to the NodeMcu.

After that, NodeMcu will do a calculation set in the coding for the weight conversion value to the stock items amount. OLED will display both the weight and amount of the stock items, and this process will continue to display the total amount of stock items and the total weight of stock items at OLED to the ThingSpeak application. This process will continue to loop, so the total amount of stock items are always up to date.

After ThingSpeak receives the data from the NodeMcu. ThingSpeak will display the current data information of stock items value in date and time. Next, if the threshold set is reached, ThingSpeak will trigger Webhooks to send the email to the user. This function is to alert the user amount the current stock items stock is running low. If the amount of the stock items is within the threshold, no email alert is triggered.

2.3 Electronic Setup

Figure 3 shows the schematic diagram of the remote monitoring device that was demonstrated by using Fritzing software. The schematic shows the detailed part of the hardware involved in this project. The hardware part consists of NodeMcu, the central brain that instructs other hardware to perform specific tasks. Next is the HX711 amplifier module that will process the data received by the load cell, which is analog, and convert it to digital. Furthermore, it amplifies the voltage generated by the load cell and sends it to the NodeMcu.

After that, the load cell sensor measures the amount of weight that has been applied to it. Lastly, the OLED display acts as the main screen to display the outcome value measurement of devices, such as total weight and stock items.

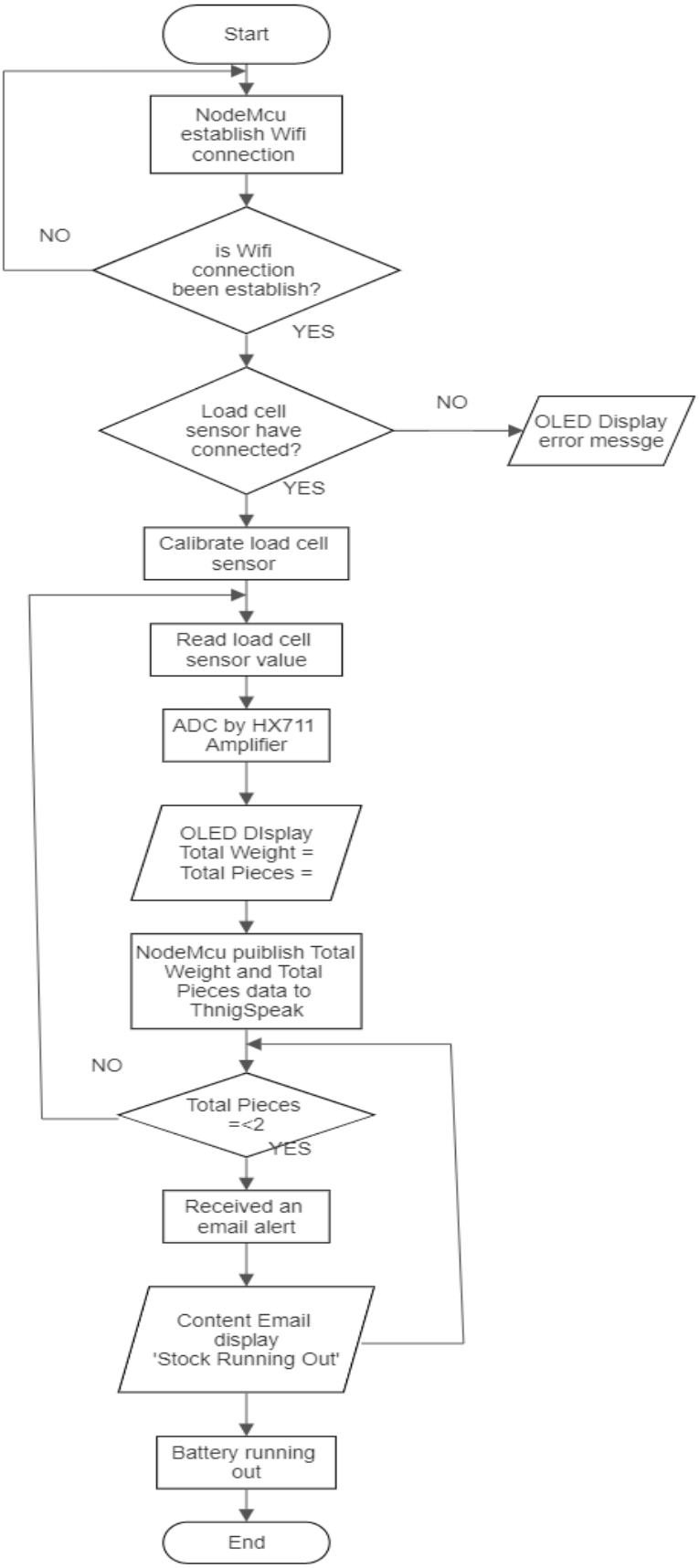

Figure 2: System flowchart

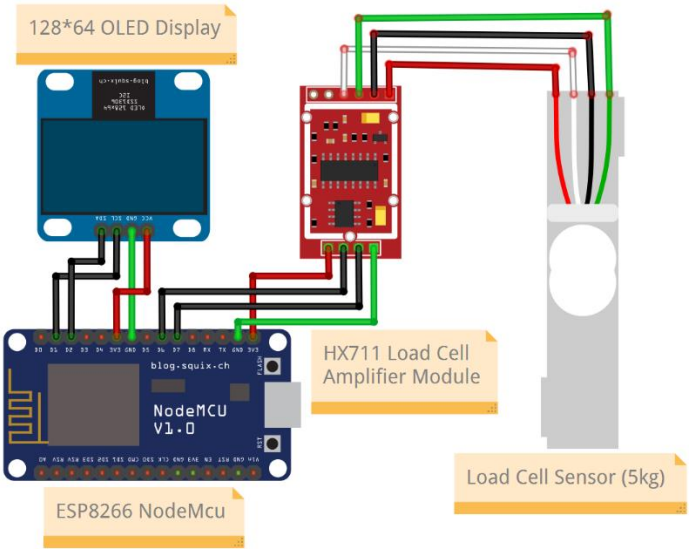

Figure 3: Schematic Diagram of Remote Monitoring Device

3. Results and Discussion

3.1 Prototype Setup

Figure 4 shows the final prototype of the remote monitoring device for inventory management. The project is first designed on the breadboard before being sold to its respective pins. These steps ensure all parts are working correctly and are easier to troubleshoot if any electronic items are damaged. The load cell sensor is an important part that needs to be thoroughly checked physically and internally. Next, the constructed compartment must be strong enough to hold any items the load cell sensor can hold. In this case, it is 5kg. They are using 3d print as a base support for the compartment. It can be stated that the compartment is strong enough to hold that kind of weight.

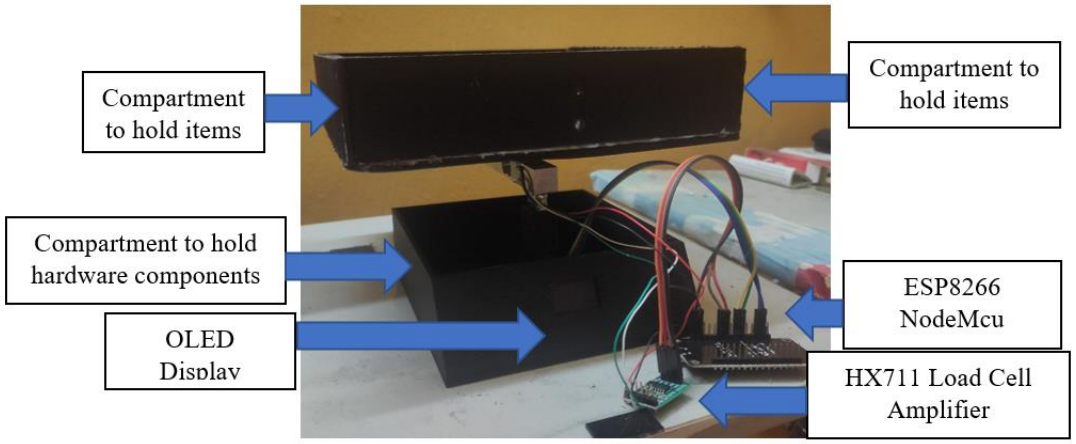

Figure 4: Prototype of remote monitoring device for inventory management

3.2 Data Monitoring on IoT Platform

The IoT platform is observed based on the performance of both the ThingSpeak application and the ThingView application in displaying data that the load cell sensor has received. The data of the load cell sensor are visualized into two different widgets simultaneously. For example, the total weight in the compartment is 847g which means that seven items are left. One of the items is a weight of around 120g, then 2 items should get around 120g. Table 1 shows the weight of the items during the test of the

prototype. From the table, an error of about 8g can be seen. This weight measurement can be seen from the example in Figure 5.

Table 1: The weight measurements of different numbers of items

Weight (in gram)	No. of product	Total items left
8	0	0
128	1	1
249	2	2
368	3	3
488	4	4
608	5	5
728	6	6
847	7	7

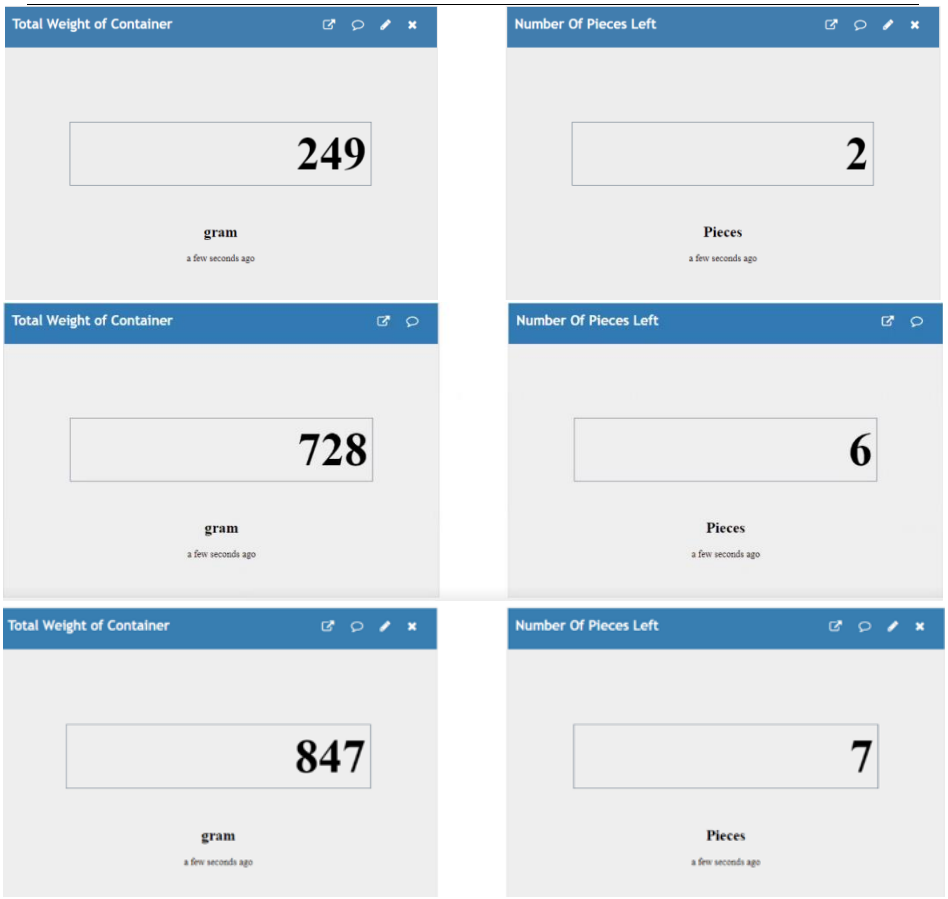

Figure 5: Weight measurement of items using prototype

3.3 Data monitoring App on SmartPhone

ThingShow is a freeware developed by ThingSpeak and is available to download from Google Play Store. It can be connected to a private ThingSpeak channel by providing a channel ID and API key. In ThingShow, the view layout can be configured according to personal preferences. Figure 6 shows the ThingSpeak application's original layout and customized layouts for management. ThingShow has the same function as ThingSpeak but it's only available and can be accessed through a smartphone. As the

figure below shows when the items left are 7 pieces which have a total weight of 847 grams. By using ThingShow, users can monitor items' status anytime, anywhere by just using a smartphone.

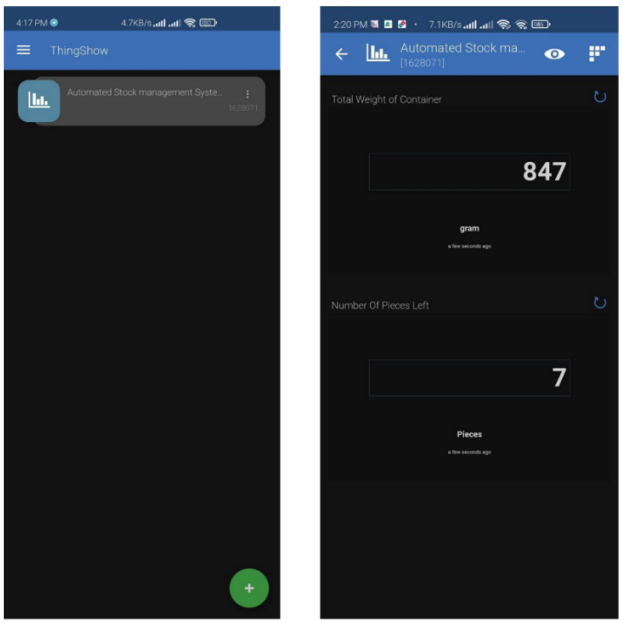

Figure 6: ThingShow application

3.4 Auto-generated Email Alert Figures

As shown in Figures 7 and 8, the feature of generating email automatically was configured on the IFTTT platform. IFTTT also known as 'if this, then that' provides services that act as the trigger for one or more automation involving the app use. In this project, ThingSpeak acts as an app while the stock items' low levels act as the trigger for the email alert. The email will be generated when the stock reaches a certain threshold. In these cases, an email will be generated when the stock value reaches two or below, which means that the stock is in critical condition or low.

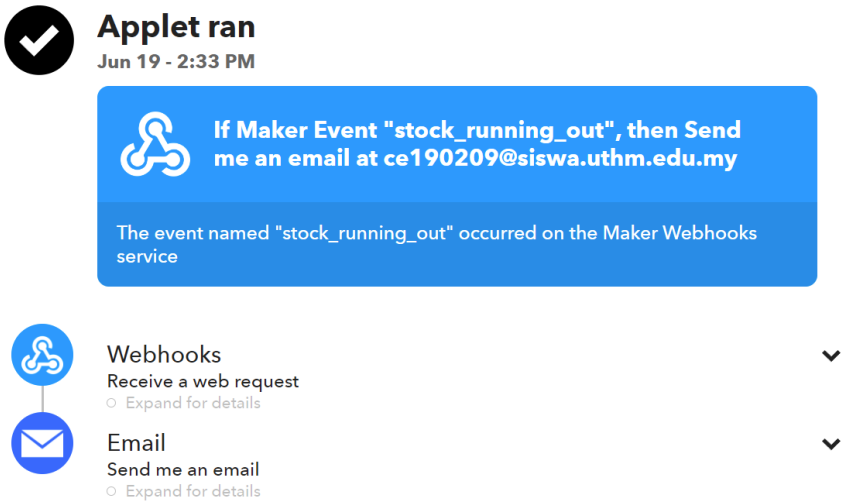

Figure 7: Configuration of Auto-generated Email on the IFTTT Platform

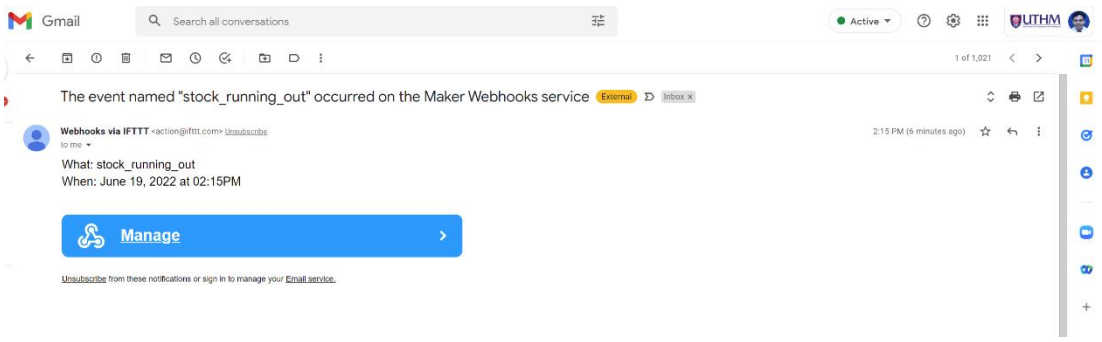

Figure 8: Example of an email alert received when stock is in low quantity

4. Conclusion

To conclude, this project has some limitations on weight measurement. Each device can only operate on one type of product. The products will have the same weight to ensure the system's precision and conversion of importance. Thus, the performance of the system can be maintained. Furthermore, the users need an available and stable network. This ensures that connectivity between the NodeMcu and cloud platform can be maintained throughout its usage.

In a nutshell, the project is significant. It can be applied not only for factory inventory management use but also can be widely used for places that stock and inventory, such as convenience stores and malls. This remote monitoring device can help replace the old method of calculating stock or checking up on stock by just viewing the available stock available on the set cloud platform. Not only that, but this device also can alert the user when a particular stock is in a low amount by sending an email to the respective user account. This device is beneficial, so the user is constantly updated with the current stock amount and can order in advance when the stock reaches a certain threshold.

Acknowledgment

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