Smart Storage Check System

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1 Introduction to the Problem

Suppose you are a store manager in charge of the chocolate section. You need to see when there is not enough chocolate to display. So, you need to get chocolate from storage and get it to the section. But if you don't know the amount displayed, you need to go to the section and get informed.
Or, you are a storage manager. You need to see when there is not enough chocolate in the warehouse. To be informed, you need to go to the warehouse and inform yourself and order manually.
This will increase time waste and overall cost. Also, this is not an efficient way to be informed.

2 Our Method to Solve the Problem

We developed a system to measure the weight of the chocolate storage and calculate how many pieces exist and visualize the data via Thingspeak. Thingspeak can be achieved from both computer and IOS app and uses HTTP protocol. If there are chocolate pieces fewer than a predetermined value, the system will inform the user via email using IFTTT. After that, the user can be informed of the storage and decide whether to order a new chocolate package. In the processing part, first, we assigned our hardware devices. We used LoadCell as our main sensor to measure the weight and ESP8266 NodeMCU as the internet connector. We also used HX711 Amplifier with LoadCell for calibration. We added an LCD display to the system to see outputs. LCD Display will be embedded in the storage packet to help us inform. In our test case, we determined one Petito chocolate as 6.5 grams. We stored 10 Petito chocolates. We coded that if there are fewer than 5 Petito chocolates, the system will send an email to the user using IFTTT and its connection to Thingspeak. We coded the system simple so the end-user can change the product to, for example, Ülker Çikolatalı Gofret, and arrange the stock system for that product. We tested the system with both chocolates and also Airpods for testing if the calibration and measurement are true. We tested with two different items but our main case is for Petito chocolate.

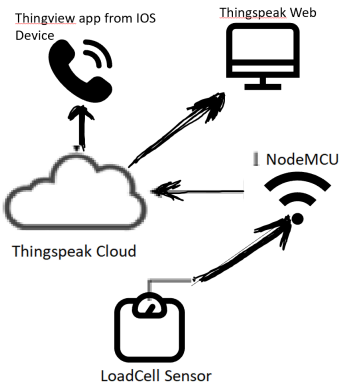

Figure 1: The proposed system

2.1 Hardware Design

NodeMCU, Load Cell, HX711 Load Cell Amplifier Module, Connecting Jumper Cables, 3.3V Power Source - Computer in our case, LCD Screen,

	Measured Weight (g)	Pieces
Petito	61	10
Petito	49	8
Petito	31	5
Petito	18	2
Ülker Çikolatalı Gofret	72	2
Apple Airpods	46	1

Table 1: Testing results table.

2.2 Software Design

We used Arduino libraries:
Wire,
ESP8266WiFi: For NodeMCU connection,
HX711ADC: For calibration,
EEPROM: For storing calibration values.
LiquidCrystal: For LCD methods.
We used Thingspeak as our cloud server, data are visualized there. It can also be reached from both computer and IOS App.
We used IFTTT to send an email to the user when stocks are lower than a predetermined value.

3 Results and Analysis

In our results, overall we get true values. In the first several tests, we had issues with calibrating the LoadCell. We get - values but we solved it by calibrating it every time before we use the system. Sometimes the weight is +-0.2, and we get very little difference. This error is not considered since it's a very little error and surface area, the development of LoadCell balance can be the error reason.
We used LCD Display to show measured values but because of our lack of equipment, missing component Potentiometer, and using a different kind of LCD Display, we couldn't see the display. We got a high-resolution display by adding more resistance to the circuit in one of our tests which we also recorded as a video but then we changed hardware and couldn't get the same result later. If we used a proper potentiometer and I2C LCD we would get better display results. In real-life applications, display on storage would be a good add-on.
We calculated the piece value by dividing the total weight by the initial weight, the weight of one chocolate. But this part doesn't work well in our system because of using float data type and also because of calibration value errors. We chose the best result by getting the test with the lowest difference in math.
We used Thingspeak Cloud Server for data storage and data visualization. We used this instead of other apps because we were familiar with it and also we thought the types of different graphs and widgets could be useful in our project. Another benefit is that we can access the cloud via the IOS app Thingview. We used a numeric display widget and a total weight graph. These are two user-friendly GUIs.

Our best result is measured value = 61 and piece = 10. One piece of Petito chocolate is 6 grams. In order to bypass the big difference errors in math, we didn't include float or double values.
We tested the measured value = 29 and piece = 4. In this scenario, the app sent an email to the user's mail with the information "StockLessThan5". This trigger occurs when there are 5 pieces present too. The email is sent every 15 seconds because the measurement delay is 15 seconds.

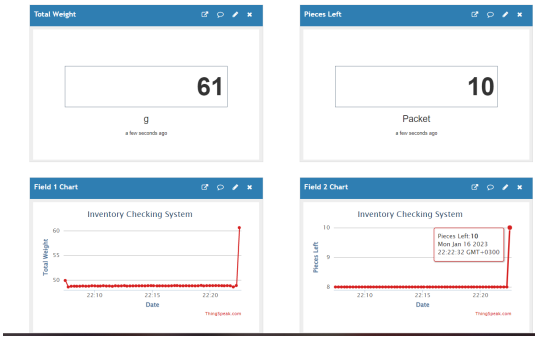

Figure 2: Best test value visualization

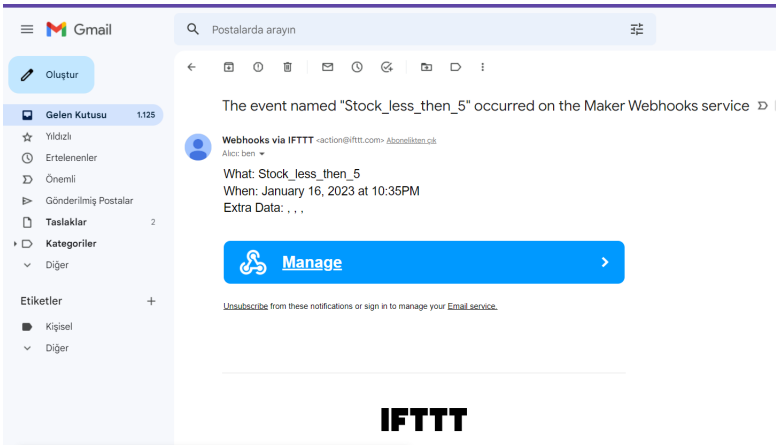

Figure 3: Email trigger

4 Conclusions and Future Work

In summary, we understood the method for measuring, visualizing measured values, and creating triggers for an unwanted situation. We had slight hardware-related difficulties, but coding part and making IoT-related connections were not so hard.
We think that there can be several upgrades for this project. We think we can add a self-order function in the future. Now, the system sends an email when there is less than the wanted value but instead of only informing the user, we can add an option to order a wanted amount of packages automatically

or by user confirmation. The system can get input from the user about how many packages they need, or even calculate the amount needed and help the user using data analytics.

We also thought this system can be used for not only packaged products, like chocolate, crackers, etc, but can be used for open beans, and legumes (which are bought by the customer themself). In this case, the system will tell when there is not enough food in the container and inform the person in charge to fill it. Or we can use this in the textile sector for measuring buttons. There are so many real-life use cases for this system.

We think that by making most of the storage management with computer-aided information technologies and using IoT technologies we can decrease cost and time waste.