DEDA Entrepreneurship Project

PreserveIt!

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Design Brief

Target Consumer

Homeowners of all ages who have access to smartphones and senior citizens (60+ years old) who do not have access to smartphones

Designers

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Problem Statement

Countless food products are disposed of before their expiry date. Not only is this wasteful, but also costly as the same products are bought more frequently. Furthermore, some food products are kept in refrigerators beyond their expiry date. This takes up space and is dangerous for individuals to unknowingly consume.

Design Statement

Design a device that will use computer vision to detect expiry dates and other information from products put in the refrigerator. Program a compatible mobile app that records this information and notifies users when their food products will expire.

Constraints

- Project must incorporate skills from current engineering and computer science courses
- Product must be profitable to investors
- Product must have a clear target consumer
- Ideas qualified for the showcase in the past may not be reused

Deliverables

- Team:
  - A final documentation walkthrough of the design process.
  - A final document in electronic form detailing design process.
- Individual:
  - Personal contribution from each member

Problem Description

The refrigerator has been a revolutionary tool of convenience in the modern world as it helps preserve our food for long periods of time. However, food kept there expires after a certain point of time. It is difficult to keep track of when each food item will reach a point where it is not safe to consume, as labeled by the expiry date. Consequently, some food products are kept in refrigerators beyond their expiry dates. Not only does this take up space, but it also creates a risk of expired food consumption. In fact, according to the non-profit organization Move for Hunger, "food waste occurs when edible food is intentionally discarded by consumers after they fail to plan their meals properly and store food till it spoils or goes past the expiry date" ("The Environmental Impact of Food Waste", 2015).

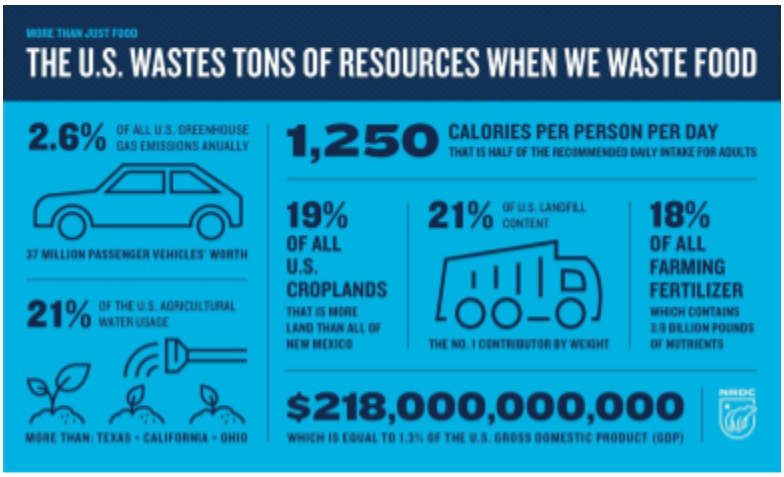


Image retrieved from https://www.nrdc.org/resources/wasted-how-america-losing-40-percent-its-food-farm-fork-landfill

While this is one problem that consumers and household owners face, another phenomenon creates hysteria as some food items are disposed of far before their expiry date. In fact, a report by the National Resource Defense Council found that "up to 40 percent of food in the United States goes uneaten," which is "on average 400 pounds of food per person every year," costing families "$1,800 annually" (Gunders, 2017). This is wasteful and takes a toll on the overall environment, as "food waste that ends up in landfills produces a large amount of methane – a more powerful greenhouse gas than even CO_2" ("The Environmental Impact of Food Waste", 2015). It also creates a costly burden for the refrigerator owner as he or she pays for the same food item more frequently. The problem of forgetting expiry dates can therefore cause wastage of food by disposing of food products too early or too late after the expiry dates. This has an impact on both the consumers and household owners themselves, as they waste food, lose the money they used to pay for the food, and waste money for storing and refrigerating it. The problem also impacts the environment by adding waste to landfills and creating more greenhouse gasses, which could be prevented if the food was consumed in a timely manner. Thus, the modern world urges for a simple method of notifying users when each food item will expire in their refrigerator. Our team aspires to deliver to this demand.

Research Summary

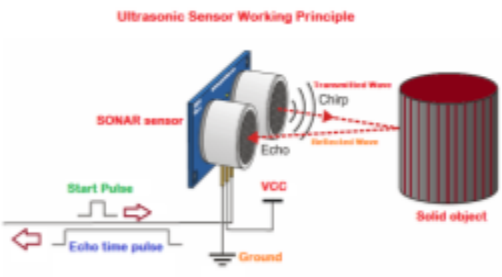
Existing Solutions

There are currently refrigerators in the market that are capable of assigning reminder expiration dates to food items. The Samsung Family Hub does so through the use of “Food Reminder,” its compatible mobile application. The drag and drop interface allows users to select the food items taken inside their refrigerators and set an expiry date. The app then reminds users to finish the food product a few days prior to the expiry date (Eadicicco, 2016). This feature is convenient for individuals who refrigerate various different food items and could lose track of the foods’ expiry dates. However, Family Hub and other refrigerators with this feature cost more than $4,000, which is not a satisfactory refrigerator price for most consumers in the United States and the global market (Bohn, 2019). Furthermore, this feature requires individuals to manually input the expiry dates of each of their products (Eadicicco, 2016). This process is not time efficient, especially for families that stock enough food for every meal in the week.

There are also many mobile applications used to help keep track of expiry dates of food in large quantities without needing to buy a whole refrigerator. The most popular amongst them are Beep and Fridgely (Ehlert, 2016). Both Beep and Fridgely prompt the user to enter their food items into the interface. The apps estimate the lifespan of the food product and add that amount of time to the current time to set it as the expiry date of the food item. The user also has the option to manually edit and reset the generated expiry dates (Ehlert, 2016). The obvious flaw with this approach is that the system fails to account for food items that were bought days before they were inputted. This means that the user would either have to either input the food items on the day of their purchase or manually change the generated expiry date for accuracy.

Ultrasonic Sensing

An ultrasonic sensor is an electronic device used to measure the distance of an object from its location through the use of ultrasonic waves and detection (Tarnita, n.d.). The sensor has two heads: one for sending ultrasonic waves towards the object and another for receiving the reflected waves. By measuring the time it takes for a wave to bounce back, it can calculate the distance of the object away from the sensor. The longer it takes for the sensor to receive ultrasonic waves, the further an object is away from the sensor. The distance between the sensor and the object is calculated using this formula:



Retrieved image from https://www.researchgate.net/figure/How-the-ultrasonic-sensor-works_fig2_264220534

Research Summary (Continued)

$$Distance = time \times \frac{speed\ of\ sound}{2}$$

In this equation, the speed of sound is kept constant at approximately 343 meters per second, assuming that the measurement is done at standard pressure and temperature. Ideally, time is the only variable that changes between different measurements to determine distances.

The ultrasonic sensor has four ports for circuitry: one that connects to the power source, one for the head that sends trigger pulse, one for the head that receives the echo pulse, and one that connects to ground. The middle two ports must be connected to the appropriate pins of a microcontroller. If a Raspberry Pi microcontroller is used, the respective pins must be programmed to send and receive ultrasonic waves. It could then be programmed to display the measured distance on an external display.

Optical Character Recognition

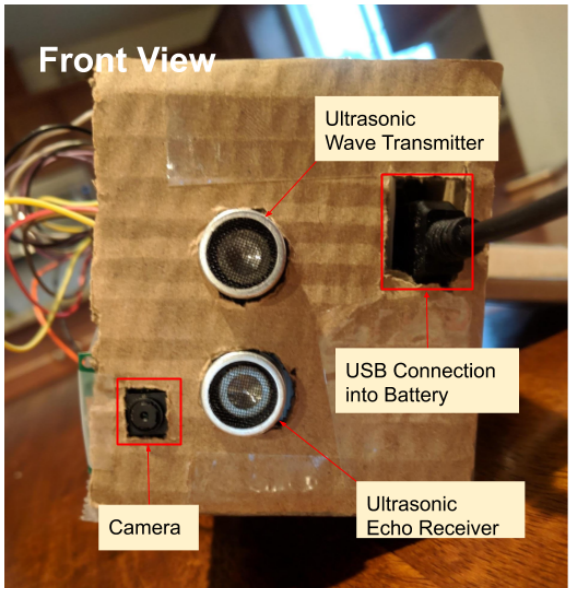
Optical character recognition is the electronic conversion of images of printed text into machine-encoded text (Lee, 2019). This can be accomplished using a digital camera and Raspberry Pi programming. A number of libraries exist to accomplish OCR, one of the most prominent being Tesseract by Google, which is open source. Tesseract supports many languages and is used by Google on mobile devices, video, and Gmail spam detection (“Tesseract OCR”, n.d.). After being locally installed on the device, the library can be accessed using Python to perform OCR on images and live video feeds. However, an alternative solution is the Google Cloud Vision API, which requires requests to be sent through HTTP requests after which results of the analysis are returned in the JSON format.

Refrigeration Dimensions and Types

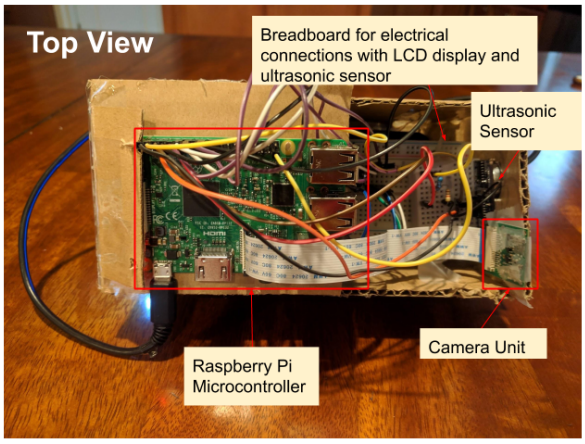
- Refrigerators come in various diff erent lengths, widths, and heights. The important part is that most refrigerators are magnetic since the Refrigerator Safety Act of 1956 mandated that all refrigerators should be able to be opened from the inside (Brennan, n.d.). Manufacturers made to sure to comply with this law by switching to a magnetic system that closes until you need to open it. This means that a magnetic part can be attached to almost every fridge making it accessible to everyone. Sheet metal is used to construct the inner layer of a refrigerator and the amount of nickel content used determines how strong magnets will stick.

Solution Summary

Preservelt! will make an easy to use device that will use computer vision to detect expiry dates and other information from products put in the refrigerator and an app to display these products and notify users before their food products expire.

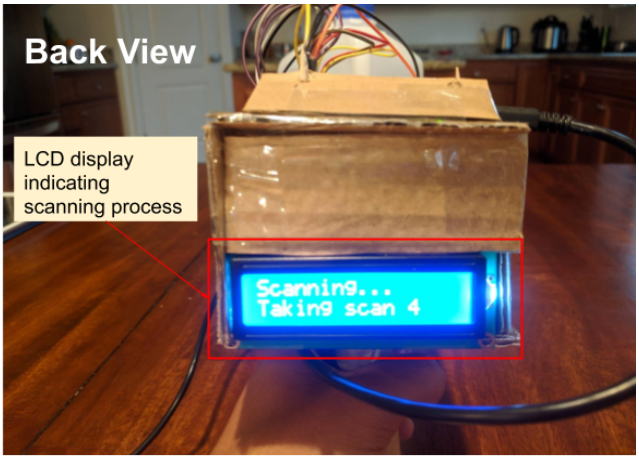


The image to the left of the front view of the product shows the location of the ultrasonic sensor and the camera, as well as an opening for the power source to output power through a micro-usb cable. The user does not interact with this part of the device—it faces away from them and is used to take all the input needed by the device to send information to the app. The two inputs are the ultrasonic sensor and camera: the ultrasonic sensor detects when the device is close to the product and when this is detected a number of pictures are taken by the camera of the product to be processed.

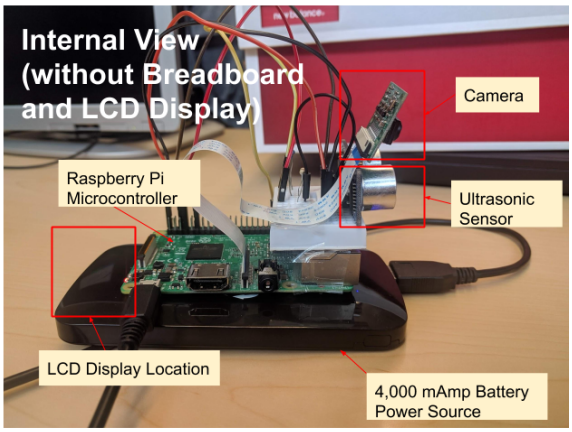


The top view in the left image shows the Raspberry Pi mounted on top of the device, and although it cannot fully be seen, the breadboard located within the device. After the inputs receive the data, such as the camera, the signals are sent through the cables to the Raspberry Pi, which takes care of processing the data. It makes a request to the Google Cloud Vision servers using the API and receives the labels of the product in the picture taken, as well as the text on the products, all of which are detected by the API.

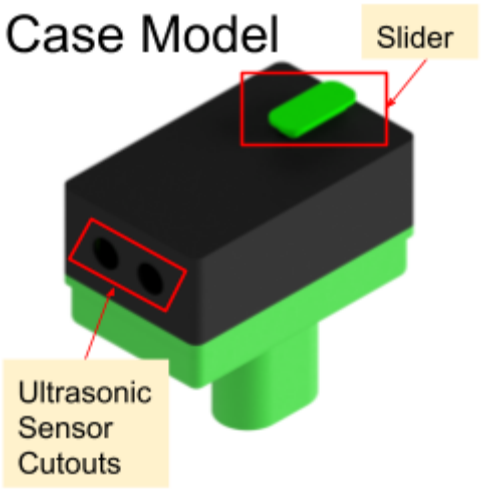
Solution Summary (Continued)



In the back view shown in the image to the left, the LCD display is shown. The LCD is a grid of 16 by 2 units, each being to display its own character. 16 pins on the LCD display are connected to the Raspberry Pi for backlight power, display power, contrast, and 4 pins for receiving the character data in bits to display. These are managed by GPIO (general purpose input output) pins.

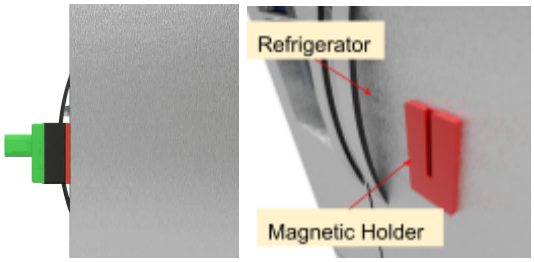


The internal view shown to the left shows a more detailed version of components encased within the cardboard case of the device, including the rechargeable battery pack, the breadboard of the ultrasonic sensor, and the camera. The camera is wired directly to the Raspberry Pi and the wires for the ultrasonic are connected to GPIO pins.



The 3D rendering of the overall device shown to the left was modeled in Autodesk Inventor. It shows how the final product would look, with holes for the ultrasonic sensor and camera as well as an attachment on top to attach to a refrigerator. This gives the overall device a sleek, modern, and simple look that aims only to satisfy its purpose of scanning food products.

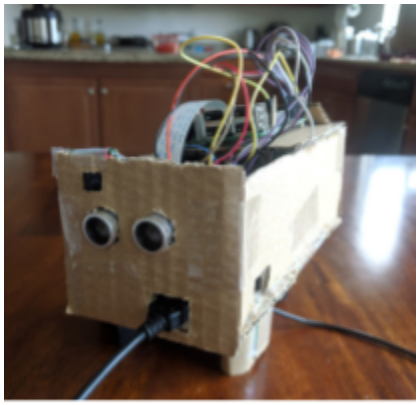
Solution Summary (Continued)



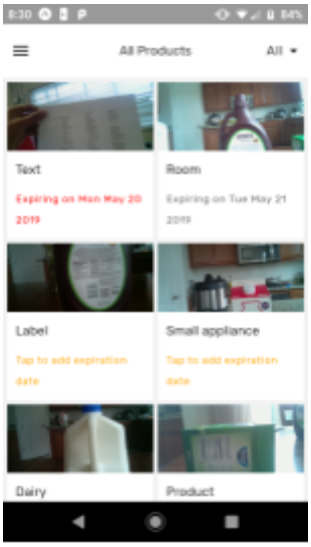
The 3D renderings shown to the left show the holder for the device attached to the refrigerator as well as how the device slides into this holder and fits securely. This is to make sure that the device is in a certain place when not in use and secured properly.

Overall Summary

The PreserveIt! device satisfies all the requirements of the target consumer and approaches the problem while minimizing cost, maximizing simplicity, and effectively working with the refrigerator that the end user already owns. The Raspberry Pi retails at about $30, the RPi camera at $15 dollars, the ultrasonic and LCD display at a total of around $10. In case of mass manufacturing, a more simple microcontroller can be used and printed circuit boards (PCBs) instead of the breadboard, minimizing the size of the device as well as reducing the manufacturing cost to about $25. Additionally, this device is compatible with the PreserveIt! mobile application, in which all the scanned expiry dates are stored. After the image is taken by the Raspberry Pi, we use Google's Firebase service to store the image and information about it on the Firebase Firestore database. Then, using React Native, a mobile application framework based on NodeJS, we made an app that could retrieve this data from the Firestore database and display it on the app. This application organizes this data and notifies the user when their food items will expire based on the expiry dates. It also gives the user the option to manually edit expiry dates and names of products.



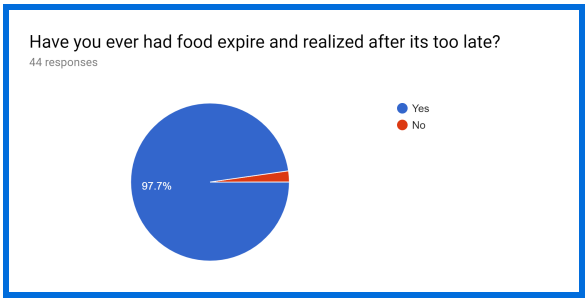
The Prototype



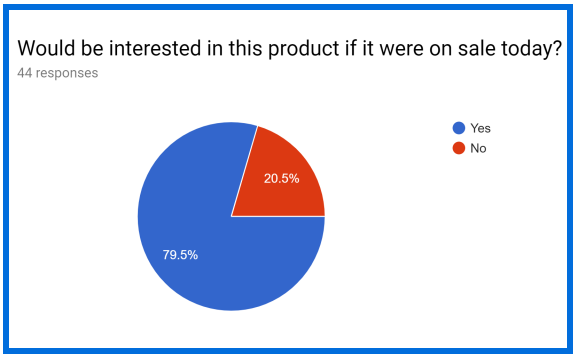
The App

Product Analysis

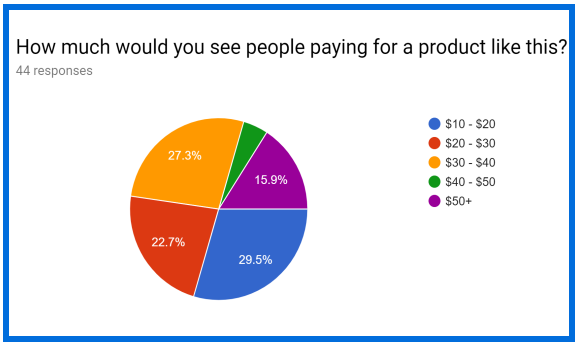
After creating our solution, we created a survey to assess how our product would perform in the market. Because a random audience of Dublin High School students were surveyed, the data is only representative of Dublin High School students, a subset of our target audience of individuals who use refrigerators. Overall, the survey data shows that the demand for our product is high among Dublin High students and the average expected cost, as reported by the respondents, is greater than the manufacturing cost. This means that selling our product would be profitable. Furthermore, if this product were to be made using printed circuit boards instead of breadboards, the manufacturing cost would substantially decrease and the profit margin would be greater.



Assessing Needs
Almost all of the respondents have encountered a problem that our product intends to solve. Our product can potentially appeal to the needs of most students from Dublin High.



Assessing Marketability
Approximately 80% of the respondents would be interested in our product if it were on sale today. This means that it would be easy to sell this product if we were to market it.



Assessing Cost
The expected cost of such a device is extremely varied as the responses are widely distributed. Most respondents expected such a product to cost between 10 and 40 dollars. The cost of manufacturing is less than 25 dollars, with the motherboard costing around 15 dollars and the sensors totalling to a cost of 10 dollars. This means that if this product were sold, we could make a profit.

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