

SMART REGISTER FOR DISABLED WORKERS

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Background

Over time the cash register has evolved in the retail industry from mechanical to digital. The cash register has assisted many retail businesses over the years and has become a valuable tool for many businesses worldwide. Cash registers in time have been modernized to display change, count and detect currency using a sensor or camera.

Types of cash registers

There are 4 main cash registers which are currently dominating in today's markets. Electronic Cash Registers (ECR), Point of Sale (POS), Mobile Cash registers and Cloud Based Registers.



Figure 1: Different types of Cash register used in the industry

- 1. Electronic Cash Register (ECR):-** ECR's are the basic form of the cash register and have been in service for many decades. It consists of a cash drawer, receipt printers, and barcode scanners which are necessary for the basic inventory operations. ECRs are still affordable options for many retailers that want a system with basic sales operations, low setup costs, and ease of use.
- 2. Point of Sale (POS):-** The Point of Sale register has brought many changes by adding more flexibility and customization to cash registers such as inventory & employee management, franchising, sales reports & metrics, eCommerce integration, sales, promotions, and discounts. Overall the POS system gives business owners a more powerful tool to run their business, improve efficiency at the customer lines and minimize errors and mistakes.
- 3. Mobile Cash Registers:-** Like the POS system these registers cost less than traditional desktop registers. Mobile registers can be easily moved around the retail business allowing for a faster checkout process.
- 4. Cloud Based Cash Registers:-** Cloud based registers are the most recent advancement made to cash registers. The cloud based system is entirely software based and has greater

flexibility and connectivity. The cloud system can be accessed by any system with internet connection.

Objective Statement

Our overall objective is to utilize techniques within our fields of study to develop a smart cash register along with a system to provide an easy method for people with disabilities. We will use computer vision and machine learning/deep learning in order to process this data and classify new images that are presented through the actual use of the register. We also need some software development to actually write the code for all of these functions as well as the interface and to integrate the hardware components of the physical register with the microcontrollers that will process the images and data. By doing all of this, we hope to achieve a working system that will change the lives of a few workers within a cafeteria and hopefully improve their work life in such a way that makes them more productive and benefits all who are involved.

Rationale

Throughout the initial phases of our project and the ideas we planned on implementing, we had to account for many different aspects of the design and what would be the optimal decisions to complete a successful project. We had thought of utilizing barcode scanning and software to assist in computing prices of items, but this would not be original and still poses issues of mentally disabled workers having to manually count currency which is the opposite of what we are trying to achieve. When doing research on already existing POS systems, we found that many of them utilize a user interface which is incredibly friendly but only an optimal solution for a retail setting in which cashiers may not be necessary (such as a restaurant). We definitely took inspiration from the GUI present on these systems as they are relatively similar to the kind we are incorporating within our system. However, the use of these systems is very dependent on the ability of the person behind the system which proves to be problematic when targeting this sort of technology towards people with mental disabilities.

Design & Development

Here we will elaborate on the hardware and software implementation and how both will work cohesively with each other

Hardware Implementation

Hardware data is very important for the conceptual concepts so that we can understand the system and how to execute the objective accordingly.

Circuit analysis:

For the circuit analysis we use multisim which is similar to P-Spice to create the digital counter circuit used for the cash register. The simulation on multisim allowed us to have a better understanding on how the circuit works, how to build it and what parts we need to get. The digital counter consists of a synchronous counter which uses 8-switches which

control the flow of electrical current within the circuit. Frequent divider to allow the system to count the currency and faster output.

Circuit Contains:-

2 -synchronous 4- bit counter: SN74HC163 synchronous operation is provided by having all flip flops clocked simultaneously so that the output change coincident with each other

2- 4 bit magnitude comparator: ans is used to compare two binary numbers each of four bits

4 hex- display: shows the hexadecimal digit corresponding to the four bit input

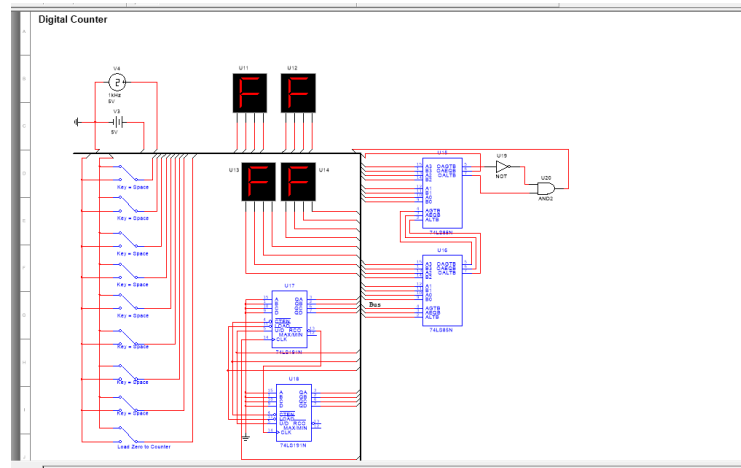


Figure 2: Digital counter layout

We designed the cash tray using a 3-D software modeling program called Tinkercad. We had to design it in a way to incorporate the bills and coins the store will be using. Each slot where the bills will be placed need to be around 3 inches to incorporate enough room for the bills. The coin slots will be 1.5 inches. The cash tray walls will have a thickness of $\frac{1}{8}$ inch.

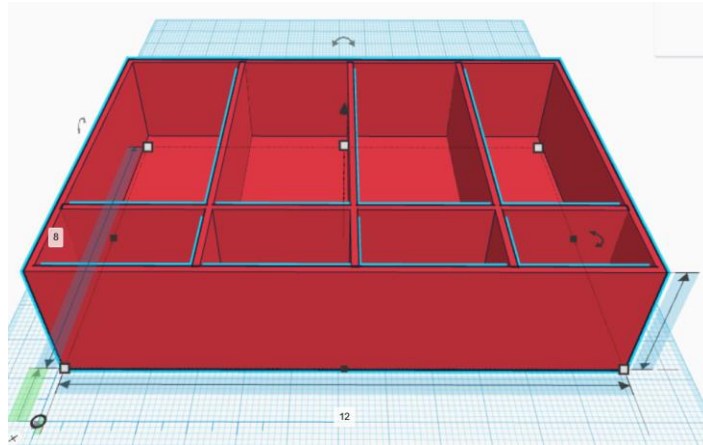


Figure 3: Cash Tray model in Tinkercad

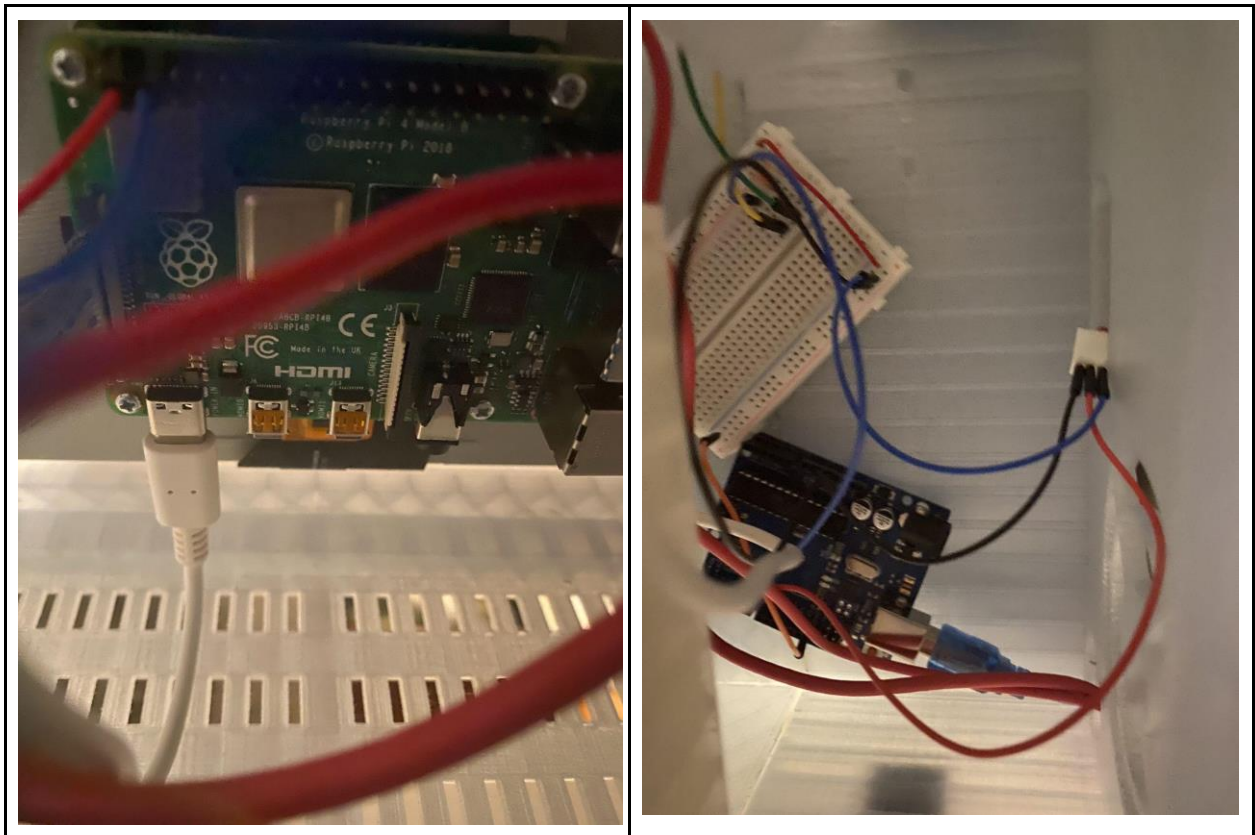


Figure 4: Hardware Circuit/microcontroller

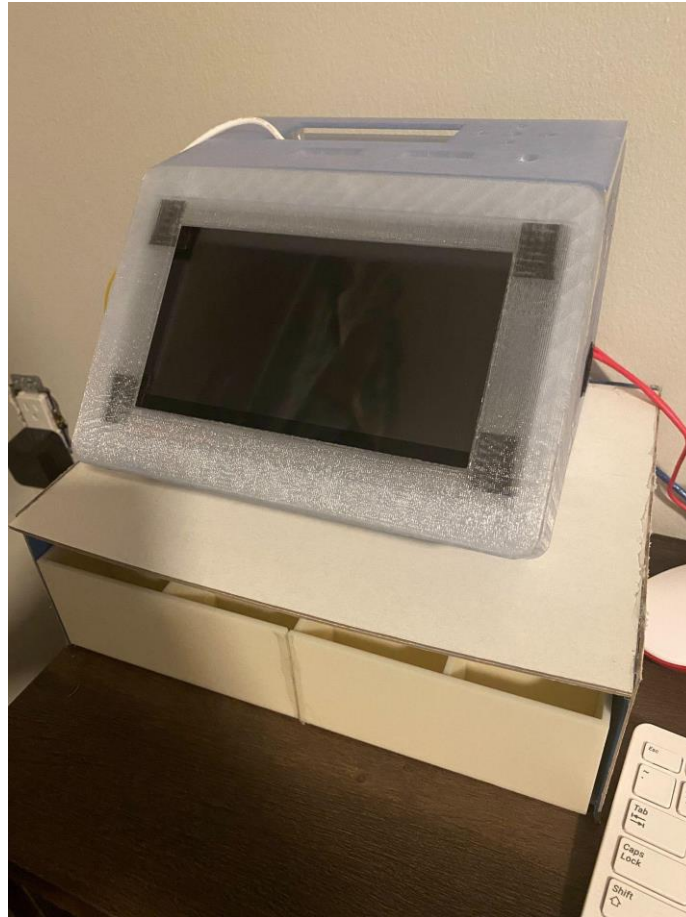


Figure 5: Cash register overview

Software Implementation

In the application/user interface, we used the javascript based react framework which is utilized for creating web applications. We also utilized C# for the backend and all of the logistics that were necessary in our software. We were able to deploy the application using the .NET platform from microsoft. After executing the code, we are brought to a login screen where the user can input their id and password. After logging in, we arrive at the main window which has tabs for order, transactions, and logging out. If you logged in to the admin account, you also have access to updating the inventory of the cafe. Items can be selected and after checking out and entering the cash tendered, we provide a visual representation of the change that is necessary to be provided, truly providing a simple

experience for the worker in question. With our database integration, we can also see that this system is quite efficient for a retail workspace setting just as we were requested to achieve.



Employee ID

1	2	3
4	5	6
7	8	9
	0	

Passcode

1	2	3
4	5	6
7	8	9
	0	

Figure 6: Employer log in

Order				
ID	Picture	Name	Price	Order Quantity
7		chips	\$5	2
8		chocolate cake	\$3	1

Subtotal: \$13
Tax: \$1.14
Total: \$14.14

Pay with credit card

Pay with cash
Cash provided






Order								
ID	Picture	Name	Quantity	Price	Total			
7		chips	12	5	0	<input type="button" value="increase"/>	<input type="button" value="decrease"/>	
8		chocolate cake	10	3	0	<input type="button" value="increase"/>	<input type="button" value="decrease"/>	
9		chocolate	5	12	0	<input type="button" value="increase"/>	<input type="button" value="decrease"/>	
10		cookies	4	3	0	<input type="button" value="increase"/>	<input type="button" value="decrease"/>	
11		deli	15	20	0	<input type="button" value="increase"/>	<input type="button" value="decrease"/>	<input type="button" value="delete"/>

Figure 7: Item order list

Order


Transactions

Log Out


Admin

Order


2X 1 dollar bill



1X quarter



1X dime



1X penny




Figure 8: GUI main screen

Algorithm

Upon extensive research, we found the use of Canny Edge Detection to be the best method for our Paper Currency Recognition. Our algorithm will perform a nominal paper detection process using image processing with canny methods amongst others to implement in Python programming language. Template Matching, Canny Methods and Feature Extraction are our main methods which include built-in algorithms into their Python functions that we will be using to scan our currency. Following our flowchart of the algorithm, template matching of image reference, region of interest (ROI) of nominal value will be extracted so that it can be used in any orientation of the paper currency image. The ROI of the nominal image is processed by canny edge method and spatial transformation to strengthen the image features. Feature extraction will then be used to process the template image and decide nominal currency.

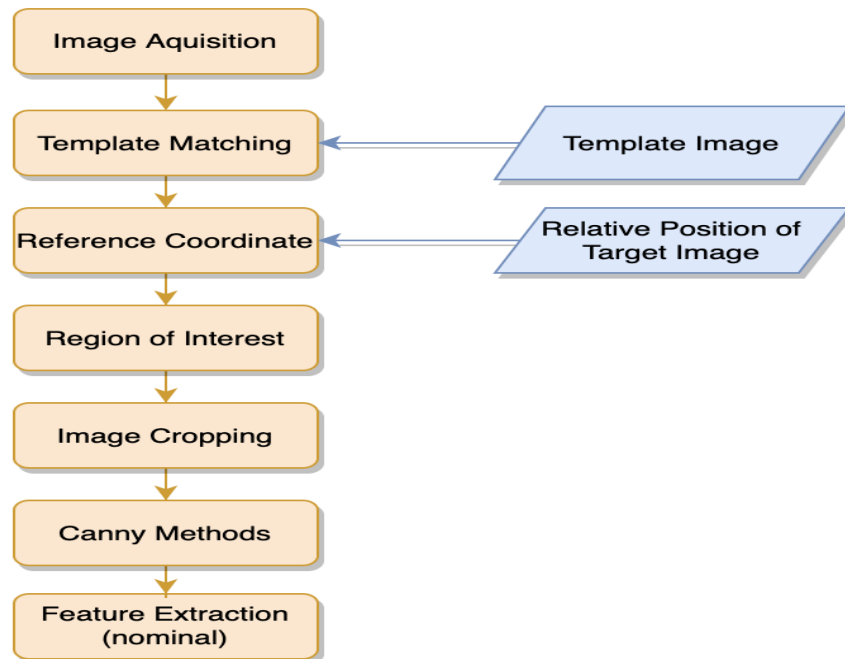


Figure 9: System Flow Diagram

Database

We will use SQL Workbench as our software database which will be connected to the application using Python. In this database, we will have about 5 tables, login, user, orders, order details and the products which will all be filled with the correct data to then connect to our application which uses tkinter to display onto our LCD screen for the user. Our dataset will begin with the 1 dollar bill up to the 10 dollar bill and include coins as well. We will begin with a smaller dataset of just 1 dollar bills compared with 10 dollar bills before we expand in order to understand the efficiency of our method for currency recognition and to see if we can obtain

accurate results. The sample dataset includes hundreds of images taken from an iPhone camera of the different dollar bills (\$1 and \$10). We have taken into account the need for specific angles, wrinkles, different lighting and background(bright and dark) in order to achieve the most accurate results. If this method of data collection is not effective as we keep moving on with other forms of currency, we will also move to data augmentation to offer a more diverse set of images that will be a good way to further train our model and hopefully achieve a higher accuracy.

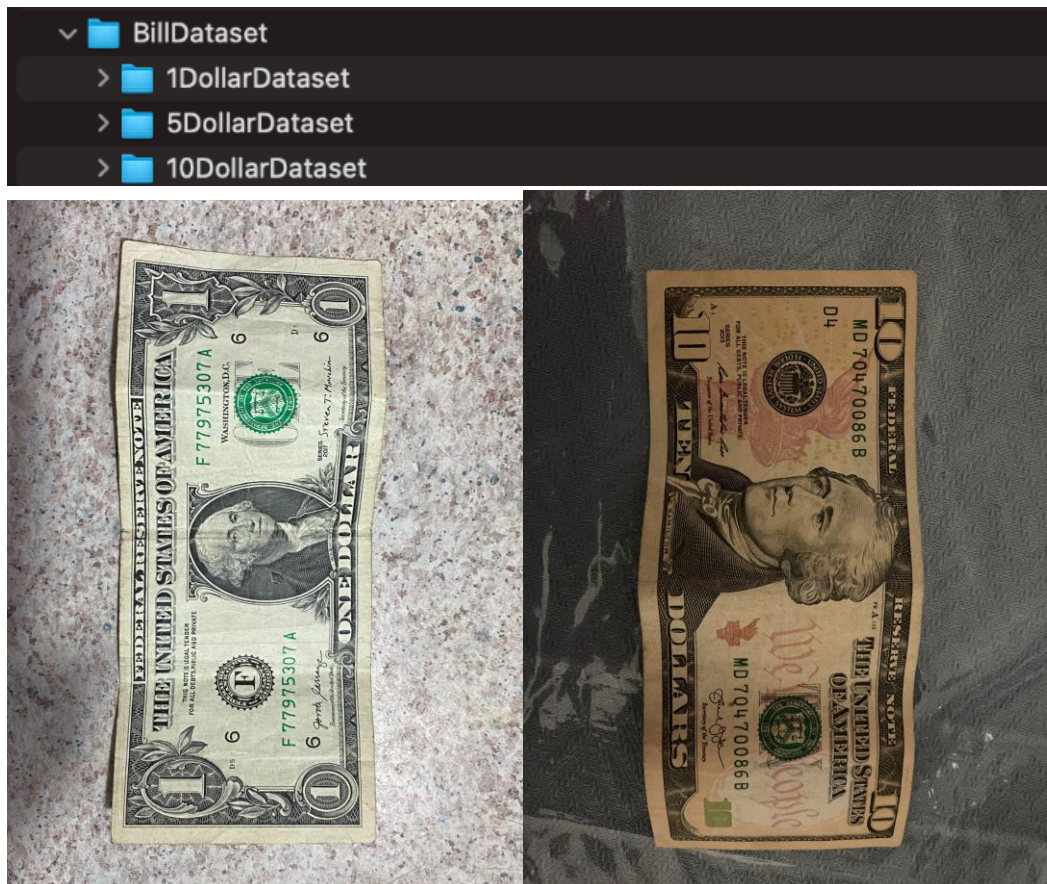


Figure 10: Datasets for currencies 1, 5, and 10

Evaluation

Overall, when it came to our system we tested each part making sure the entire system would work accordingly. Our team wanted a scanner to work flawlessly with a card for authentication therefore we made a circuit with red and green LEDs to grant or deny access. We wanted to prevent any type of voltage shorting with the hardware so we ran a few sample tests. First, we started with the “hello world” as an example and see if it is properly displaying on the LCD screen, however, we ran into multiple issues seeing as there was a wrong resistor. Therefore, as a solution we changed the voltage from 200 ohms to 220 ohms and the system

worked accordingly. We also had to test many microcontrollers and at one point we even considered building our system for better compatibility, but after extensive research and trying out other boards we managed to find the proper board. Furthermore, a team member interviewed his uncle who is disabled and wanted to find any implementations with the smart register that would be more convenient for disabled workers. To minimize any type of risk in the hardware we wanted to simulate the circuit in a circuit analysis program making sure we have the correct amount of voltage in our system. The software implementation was very risky seeing as we are implementing machine learning to identify the value each bill has. This has to work in correlation with the hardware and use the different modules (cameras and sensors) while the algorithm is still learning to get a very small discrepancy. We also had to take into account the different types of environments and currency that this system would need and provide the proper data set in order to train the model to a high accuracy.

Overall the interaction between our team and the agency was very collaborative. While meeting with them we were able to identify the problem/issue they were having and come up with a solution. The CREATE program has been an absolute pleasure for us and we had a great time participating in the program.

Discussion

Overall our aim was to develop a product that will help those with disabilities work more productively and efficiently in the workplace. Our product is meant to ease the work conditions for those who are disabled and make the work environment safer.

Video

<https://www.youtube.com/watch?v=0rH7ftm4RGs>

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