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Smart Shopping Cart using Machine Vision along with Machine Learning

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Abstract - *As the Internet of Things (IoT) is relying on the exchange of information, this research work progress through machine vision, which is an emerging technology and one of the most critical technologies in the current computing world. This emerging technology can find its applications in various fields ranging from healthcare, construction, smart shopping, hospitality to transportation and many more. Technology has changed so much, so is the rate of people of all ages who are attracted to electronic gadgets. This research work focuses on generating a bill for the shopping cart. The main idea is to save customers time by providing digital billing system and hence maximize shopping experience in supermarkets using machine vision along with object recognition. Fast and reliable communication plays a major role in the success of smart shopping applications. In a "Just Walk Out" shopping scenario, camera is installed on the cart to monitor shopping activities so that items in the cart can be tracked and checked out.*

Key words: Smart shopping cart, Machine Vision, Machine Learning, Raspberry Pi, OpenCV, TensorFlow.

1. INTRODUCTION

Individuals have constantly created innovation to bolster their requirements from the start of humankind. The fundamental reason for the development in innovation is ought for more independency and this leads to improving tasks and making regular one simpler and speedier. One significant task that individuals invest maximum measure of energy is in shopping. Today, most shopping centre makes use of those traditional shopping baskets and shopping trucks for their customer. The customer must then place each item in their cart, which they need to buy and they must sit tight in the long queue for payment of bills at the counter. This method of check out is a troublesome and time-consuming process which thereby lead to a heavy crowd at the counters.

To beat these issues and to enhance the current framework, we have composed a Smart Shopping Cart. This can be done possible by basically using Machine vision to identify the items placed in the cart, a Raspberry Pi module to process the data and update the database and LCD display to show the customer their cart contents and bill. At the end of the shopping process a bill is generated on the consumer mobile phone and they can make payment using mobile phone application, this will help in eliminating long queues at the counter.

2. LITERATURE REVIEW

A barcode scanning system proposed in 2016 aimed at assisting shoppers in determining the total bill they are about to pay, which they can send later to the shop's server using WIFI connection. Aside from this, the model provides other features such as displaying product information, price, and discounts on an LCD screen. However, the proposed model did not mention ways in how they will intend to implement the scanning system and how they will limit shoppers from overcrowding the scanning area. This approach only unclogs the cashier area but draws the shoppers in the scanning area.

In [1], M. Jayshree et al. they explained that the barcode will be scanned within fraction of a second and the integrated items weight measure will be checked by the load cell module that is maintained at the base of the cart and the weight measure will continuously ship to the database. With the load additionally the product number is dispatched to the server. So, from this paper we get an idea of how weight sensor would synchronize with the system and it will give an idea of the addition or removal of the product and will generate the bill accordingly.

In [2], H. Zhang et al. have developed a medical label barcode acquisition and identification system based on deep learning and its feasibility is also verified. This system exhibits high real-time performance and decode rate which meets the actual engineering application requirements. The method used in this paper can solve the positioning difficulties like distortion, fouling and obstruction (blocking the view) these situations are difficult to solve by traditional methods. Hence the combination of neural network localization and traditional image processing has effectively improved the decoding ability of software to deal with linear distortion Data Matrix code.

In [3], Ms Visalatchi et. al. they explore the model for visual object recognition. This model was extensively tested to operate in various kind of situation such as non-plain, real time, complex, and changing environment. The

system is also capable of recognizing objects that are in varying sizes and the recognized object are converted into an audio format along with their location. It also tags the objects and shows their location within the image and its accuracy. Thus, the proposed system aims to provides intelligent vision (object recognition) using TensorFlow and neural network algorithms. It visions at object recognition and pattern analysis with minimized localization error, implements dynamic threshold, improvises efficiency and enhance better performance.

In [4], Adithya. R et. al. they implemented a smart, efficient, productive, safer and low-cost Li-Fi system in shopping malls. The system is capable of using Li-Fi, RFID and VLC system to eliminate the hassle in the present shopping system. Their system is potent and capable of removing shopping woes in the current system. Li-Fi technology is the latest boom in the field of communication technology which when implemented in present shopping system provides the best possible shopping experience. It is their belief that the model shopping system proposed will become one of the most promising technology in future generation.

In [5], Ragesh et. al. design a deep learning based automated billing cart. The system that they have designed can detect only 3 objects namely, Potato, Tomato and Carrot. The accuracy of the object detection is 70%. In that project they proposed a new, hassle-free shopping experience. The system has been mainly designed for edible objects like fruits and vegetables. The RFID tags that are being used nowadays, can't be stuck to edible objects like fruits and vegetables Also, in India, Barcodes and barcode readers are the widely used method for shopping. Practically, Barcodes cannot be given to each and every vegetable and fruits that the customer wants to, using object detection for this purpose, gives the customer a freedom to buy and pay for exactly what they want.

In [6], Sakorn Mekruksavanich et. al. design a smart shopping basket based on IoT applications. This type of smart shopping system will provide a highly beneficial way for customers to avoid the inconvenience that they normally encounter while shopping, especially during the holidays. By simply using the application on their smart phone or device, customers will be able to handle all of their shopping needs within the retail environment by using the system described in this research. Because the items are immediately scanned upon being placed in the shopping basket or cart and the bill is digitally created and transmitted to the consumers e-mail address that has been registered, time can be saved by not having to wait in a long line at the cash register. Therefore, the strong potential of an IoT system that is able to be implemented in supermarkets and shopping malls can be seen.

In [7] O. Boyinbode and O. Akinyede, have explained "Why Firebase is the Best Mobile Backend as a Service?" tristatetechnology.com, argue that barcode readers used in Nigerian supermarkets lead to inefficient use of time. They observed that shoppers have to wait for 20 to 30 minutes in the queue. In their model, they proposed to replace barcode readers with RFID readers due to the laser's sensitivity and low reading failure rate. the obvious drawback of the study is the cost of implementation and unintentional sensing of items due to proximity to the reader.

A team of researchers [8] from the University Technical Malaysia Melaka, would like to help supermarket owners to save cost in procuring barcode devices by replacing them with webcams. Using MATLAB, the barcodes in images capture by the camera are processed. Data extracted is displayed in a graphical user interface and queried against the database. The study indicated the difficulty in the design of the algorithm due to different types of barcode systems.

3. EXISTING SYSTEM

In the existing system, the concept of a smart trolley has started taking place, but they are not of the entire smart shopping system in most of the retail outlets. It has become a daily routine to shop and purchase an item from mall and supermarket During these days. In most of these malls and supermarkets, after the customer purchases the items, they will move to the billing counter for paying the bill, where the cashier uses a barcode system to scan the item and generate the bill. This becomes a long and time-consuming process, and it leads to long queues at the billing counters. To overcome the above-mentioned problem, machine vision along with machine learning is adopted on the cart itself of the traditional counter billing system in the proposed smart shopping system.

4. PROPOSED SYSTEM

To reduce the time at the billing counter, an onboard smart item recognizer arrangement has been proposed. This advanced mobile cart will be provided with a camera, Raspberry pi 3, LCD screen, and a weight sensor. First the customer has to scans the QR coder on the cart with their mobile phone to make the link between the cart and their phone, this helps the cart to send the bill details. This keen cart naturally reads barcode of the item which are placed in the cart through the camera input. The camera input along with the help weight sensor determines if the item is added or removed from the trolley. To add an item to the list, the customer has to place the item into the trolly and the camera reads the barcode and collects the data of the respected items get stored in a cloud database. If the barcode is not visible, a

machine learning model is used to detect the item. For removing an item from the cart, the customer just has to physically remove the item which they don't require, while doing so the camera with the combination of the weight sensor detects the changes and does the necessary changes. After finishing shopping process, we come the billing section. In this section, a final bill is generated and displayed to the customer on their devices from there they can also do payment.

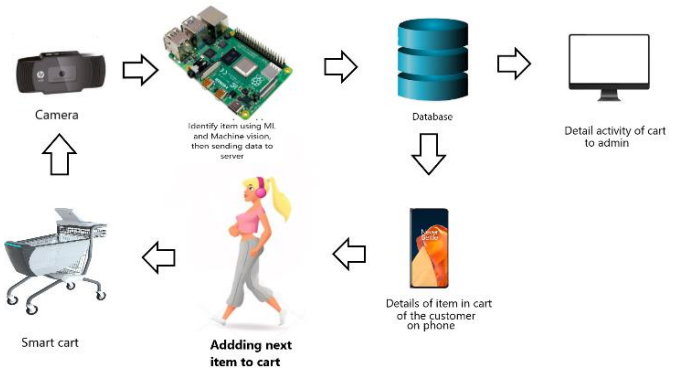

Fig -1: Block Diagram

The Raspberry pi does the barcode reading and the object recognition. This system uses a NoSQL cloud database. Here, the billing information/data are stored in a cloud server in a secured manner. With the help of a cloud database, a live dashboard for the admin of the retail store is created for monitoring the status of each cart.

The steps of the proposed smart cart working are as follows:

Step 1: First the customer has to scans the QR coder on the cart with their mobile phone to make the link between the cart and their phone, this helps the cart to send the bill details.

Step 2: Then the customer places the required item into the cart.

Step 3: The camera with the combination of weight sensor detects the barcode on the item on which the buzzer is played, the barcode number is then updated to the database.

Step 4: If the barcode is not visible, a combination of machine learning and a weight sensor to be used to detect the item.

Step 5: After finishing the shopping process a bill is generated on the customer's devices.

Step 6: Customer gets redirected to the payment page from completion of the shopping process.

This complete framework is indicated in Fig 1

5. HARDWARE DESCRIPTION

5.1 Raspberry Pi4

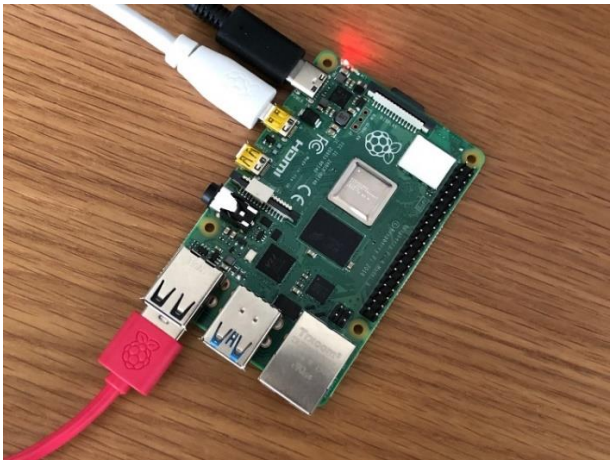

Fig -2: Raspberry Pi4.

The **Raspberry Pi 4 Model B** as presented in Fig. 2, Used in this project comes with all the necessary hardware specifications. It has a 1.5ghz quad core processor Wi-Fi Bluetooth ethernet micro-HDMI port USB c port it has 2 to 8 GB ram its compact in size which is perfect for this project it has 2 USB ports it is the mainboard in this project where everything will get connected. The Raspberry Pi 4 Model B is the latest version of the low-cost Raspberry Pi computer. The Pi isn't like your typical device; in its cheapest form it doesn't have a case, and is simply a credit-card sized electronic board of the type you might find inside a PC or laptop, but much smaller.

5.2 Buzzer

Fig.-3: Buzzer indicates the sound.

A Buzzer as presented in Fig. 3, is little but useful device. It is 5V two pin devises that is use to alert or an indication to the process been carried on. In this project we are using this as a indicator for the custom that the item they placed in the cart has been registered successfully.

5.3 Loadcell

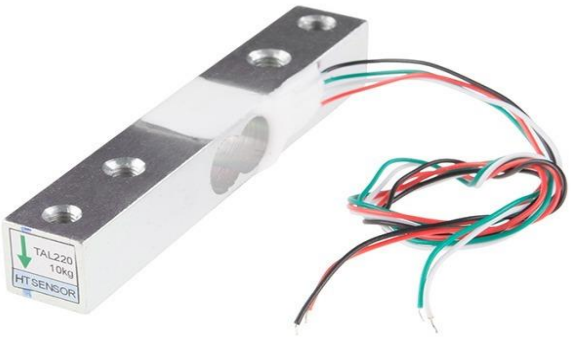

Fig -4: Block Diagram

Load cells in Fig:4 are sensors that detect force (mass, torque, etc.). The applied force in the load cell gets converted to electrical signal. This straight bar load cell (sometimes called a strain gauge) can translate up to 10kg of pressure (force) into an electrical signal. The roll if load cell in this project is to help in verify that the item is scanned before it is placed in the cart and also help in the process of detection when a customer removes an item from the cart'

Load cells are also known as "load transducers," because they convert a load (force) into electrical signals.

5.4 Led light

Fig-5: Led light

A **light-emitting diode** (**LED**) Fig: 5 is a light source that emits light. when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The colour of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor.

5.5 Display

Fig -5: Display

Display, Fig: 5. The mid-sized 7-inch touch screen display TFT LCD can display all different kinds of information including data, text, curves, icons, animation images, or videos. It has a resolution of 720p which will be sufficient for this project. In this project it shows the product name along with is price on the lcd which have been placed in the cart. When the custom completes his/her shopping process then can click the bottom in the screen for the initiating the check-out process. The total cost of all the products is displayed on LCD.

5.6 Camera

Fig-7: Camera

Camera, Fig: 7. We are using a raspberry pi camera module which has 8mp, it has a high resolution of HD 1080p video and it is compact perfectly suited for this project. It is a mini camera which can be used to fit in compact spaces and capture details of things. In this project we have used this camera to decode the barcode and as an input for ML model.

6. CONCLUSION

The application of this type of smart shopping system will be highly beneficial way for customers to avoid the inconvenience that they normally encounter while shopping, especially during the holidays. Customer will be able to minimize queuing time during payment in the cashier. The mobile application enables shoppers to view valuable product information before purchase. The machine vision system also helps in tracking

unpurchased products and prevent possible loss of items. Also using object detection, gives the customer a freedom to buy and pay for exactly what they want.

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