International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 05 | May - 2023 Impact Factor: 8.176 ISSN: 2582-3930

Vriddhiyaan- Smart Shopping carts using Raspberry Pi Systems

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ABSTRACT: According to ICSC the average wait time in shopping marts in the United States is at least 135 minutes. One of the main reasons why youngsters these days are focussing on online shopping is to avoid long lines and wasting their precious time. However, supermarkets like D Mart are still popular amongst the people of India for their discounted items. According to a survey done by Ch. Hymavathi and Abhilash Nissankara Rao regarding queues and queue times in Guntur city, Andhra Pradesh, in rush hours, billing counters can get very crowded. As crowded as a line of 30 shopping carts within 8 minutes [5]. This may put tremendous pressure also on retail workers. Hence it would be better if the consumers could bill themselves so that the billing time could be reduced greatly [1] . In the United States, an initiative such as so has been taken however it is on a small scale that is only in one mall in Los Angeles called Amazon Dash Cart. However, the same solution cannot be added in India due to reasons like lack of capital and non-adaptability of other forms of payment in the former one. So here is VRIDDHIYAAN, our very own cart. It's an easy and adaptable solution in the form of a cart in which the consumers can bill themselves and will get a paperless bill on their screen while they are putting their groceries in the cart.

KEYWORDS: shopping, queue, wait time, digital bill, paperless bill, shopping mall, retail, billing.

Introduction

Shopping: In supermarkets, groceries cannot be imagined without big lines and wasting time at the billing counter, especially in a city like Mumbai. Increasing the billing counters would help but there are limitations to that [1]. So VRIDDHIYAAN is a cheap, easily installable solution to this issue.

VRIDDHIYAAN is a project which will enhance the user experience by automating the detection of products It will use the technologies of Computer Vision and Algorithms to ensure the correct process of the addition and subtraction of products. There would be sensors to detect the objects. The project aims to exhibit the final amount on display and to track the expense while shopping. This cart will keep track of all the products and their prices and will generate a paperless bill. All this information will be displayed on the screen.

I. RELATED WORK

1. Smart Cart with Automatic Billing, Product Information, Product Recommendation Using RFID & Zigbee with Anti-Theft by Ankush Yewatkar Faiz Inamdar, Raj Singh, Ayushya, and Amol Bandekar
   Here they explained how RFID can be used to pull out product information and make a shopping cart.
2. Smart Shopping Cart using Machine Vision along with Machine Learning by
   Rakshit Shetty, Darshana Pawar, Rishika Poojari, Ritvik Patel, Dr Jyoti Mali
   Herein they are using an RPI module along with cameras and used machine learning and computer vision so that the cart can figure out the bill. However here there is a need for the cellphones of the consumers for data to be pulled out of the q r code.
3. Automated Shopping Trolley System Using Raspberry Pi Device
   By Ravindra Jogekar, Ruchita Ghodeswar, Payal Kadu
   Priyadarshini J L College of Engineering, Nagpur, India
   Here they have used RFID with a raspberry pi device to automate the cart.
   RFID is to ensure that the product can be scanned and an RPI is used for pulling the data for the same.
   However, this system may increase the prototype cost and hence we needed to do some changes.

II. METHODOLOGY

It is a project which will enhance the user experience by automating the detection of products. The main part of the project is a camera which will be used to detect objects. It will use the technologies of Computer Vision and Algorithms to process the addition and subtraction of products.
Consumers can board products given up to sensor range limitations. This will be sensed by the IR sensor and will be displayed on the GLCD screen. The project aims to exhibit the final amount on display and to track the expense while shopping. This cart will keep track of all the products and their prices and will generate a paperless bill. All this information will be displayed on the screen.

1. Using IR 2 sensors, it will sense and add/subtract the product.
2. It will scan the given barcode on the product.
3. The second part of the project is to make a database to compare it with the input taken by the software part.
4. Hence Working is explained in three parts:
    1. Software
    2. Database
    3. Hardware

a. Software:

To write code, PyCharm IDE is used as it is compatible software for Python containing a variety of modules and is easy to handle.
OpenCV stands for Open-Source Computer Vision (Library). It is the most used, popular, and well-documented Computer Vision library. It is open source, which means that one does not require a license to utilize the software. OpenCV-Python is a Python wrapper for the original OpenCV C++ implementation. OpenCV-Python makes use of NumPy, which is a highly optimized library for numerical operations with MATLAB-style syntax. All the OpenCV array structures are converted to and from NumPy arrays the first module which is used is OpenCV (CV2) which contains a set of functions to capture the image of the barcode in milliseconds. This module contains functions like motion detection, resizing, blurring, rotating, dilation, threshold, and color changes to capture the data of the image.
The second module used is Pyzbar; this is the major module that will be used to decode the barcode, i.e., the image captured by the OpenCV module. A function named ‘decode’ has the code to take the data from the input which will be used to compare with the database.
The above-mentioned were the functions of the modules present in the Actual code. Half part of the function will be done by modules like detecting the object through the camera and capturing the image and feeding it to the next part of the code. After this block of code, the next block of code will be performed. The data received from the Pyzbar module will be in the form of an ID. The ID will be compared with the database. Data fetched from the database will get printed or displayed on the screen. As per the progress made till now, the detection of barcodes through the camera is possible, also the part where data is being fetched from the image is done.

b. Database:

PostgreSQL is used as the primary data store or data warehouse for many webs, mobile, geospatial, and analytics applications. PostgreSQL can store structured and unstructured data in a single product. To create the database, MySQL/PostgreSQL software is used. It is compatible with our project requirement of database creation.
MySQL/PostgreSQL is an open-source relational database management system. As with other relational databases, it stores data in tables made up of rows and columns. Users can define, manipulate, control, and query data using structure query language, more commonly known as SQL.

As of now, we created the database which consists of Product ID, Name, Type, In stock, Price, Weight, Discount, and Tax. When the store purchases the products, it gets stored in the database, then the id of the required product is compared, and the data of that product is fetched by code and displayed on the screen. A database is created consisting of the above-mentioned columns. This information will be saved in a cloud of the store for purposes of retrieval and using the same for making the paperless bill.
In this, the data that is saved will be shown as soon as the product is scanned through the camera.

c. Hardware.

The hardware that can be used for this product should be up to date. In this, we would have the hardware components. As mentioned in the following: -
Primarily we should focus on the detection of the objects. Since we are using the computer. vision or open CV, we are using cameras for detecting objects. The addition and subtraction of the objects shall be done in the codes themselves. So, for the detection of the objects, we shall use the cameras of the model Raspberry Pi 3 Model B+ Camera Module. The reason for adopting this is the following:

1. The high definition 5MP camera delivers outstanding photos but can also shoot video, ideal for drones or CCTV projects. The lightweight camera module allows for it to be used in more practical roles, such as a hidden camera or even a camera for a Pi phone.
2. The board itself is tiny, at around 25mm x 23mm x 8mm. It also weighs just over 3g, making it perfect for mobile or other applications where size and weight are important. It connects to Raspberry Pi by way of a short flexible ribbon cable. The camera connects to the BCM2835 processor on the Pi via the CSI bus, a higher bandwidth link that carries pixel data from the camera back to the processor. This bus travels along the ribbon cable that attaches the camera board to the Pi.
3. The sensor itself has a native resolution of 5 megapixels and has a fixed focus lens onboard. In terms of still images, the camera is capable of 2592 x 1944-pixel static images and supports 1080p30, 720p60, and 640x480p60/90 video.

Specifications and features of Raspberry Pi: -

- Fully Compatible with Model 3B+ Raspberry Pi
- 5MP Omni Vision 5647 Camera Module
- Still Picture Resolution: 2592 x 1944
- Video: Supports 1080p @ 30fps, 720p @ 60fps and 640x480p 60/90 Recording
- 15-pin MIPI Camera Serial Interface - Plugs Directly into the Raspberry Pi Board
- Size: 20 x 25 x 9mm
- Weight 3g

Coming to the board that is to be used we are using Raspberry Pi 3B +which features a 1.5 GHz quad-core 64-bit processor, 4GB of RAM, wireless networking, dual-display output, and 4K video playback, as well as a 40-pin GPIO header helping us process the pictures of the product placed in every frame. Along with that, we have a touchscreen display for the display of the data and generation of the paperless bill.

GLCD Display: -

The GLCD commands are used to control a Graphical Liquid Crystal Display (GLCD) based on the number of GLCD chipsets. These are often 128x64 pixel displays but the size can vary. GLCD devices draw graphical elements by enabling or disabling pixels.
A GLCD is an upgrade from the popular 16x2 LCDs, but the GLCD allows full graphical control of the display.
This is where the bill would be displayed.

Specification and Features of GLCD: -

- Colour or mono displays
- Low-power white LED, OLED with or without back-light
- e-Paper with low power consumption
- Driven by onboard interface chipsets am AMD/or interface controllers.
- The GLCDs are very common and well documented.
- Small to large view areas
- Typically requires from 3-pin to 36-pin header connections and 10K contrast pot.
- Typically, have back-lit pixels
- Require memory in the microcontroller to support graphical operations or can be used in text and picture mode.

IR Sensor: -

An infrared sensor (IR sensor) is a radiation-sensitive optoelectronic component with spectral sensitivity in the infrared wavelength range of 780 nm to 50 µm. IR sensors are now widely used in motion detectors, which are used in building services to switch on lamps or in alarm systems to detect unwelcome guests. In a defined angle range, the sensor elements detect the heat radiation (infrared radiation) that changes over time and space due to the movement of people. Such infrared sensors only must meet relatively low requirements and are low-cost mass-produced items. Infratech does not supply such products, Infratech develops, produces, and sells pyroelectric detectors.

Specification and Features:

- The operating voltage is 5VDC.
- I/O pins – 3.3V & 5V
- Mounting hole
- The range is up to 20 centimeters.
- The supply current is 20mA.
- The range of sensing is adjustable.
- Fixed ambient light sensor.

LED: -A light-emitting diode (LED) is a semiconductor device that emits light when an electric current flows through it. When current passes through an LED, the electrons recombine with holes emitting light in the process. Specification and Features: -Long life. The components of an LED and the way that they generate light significantly extend the lifespan of these bulbs.

- Energy efficiency
- High brightness and intensity.
- Exceptional colour range.
- Low radiated heat.
- Reliability.
- Instantaneous illumination.
- Directional lighting.

Working on the actual project: -

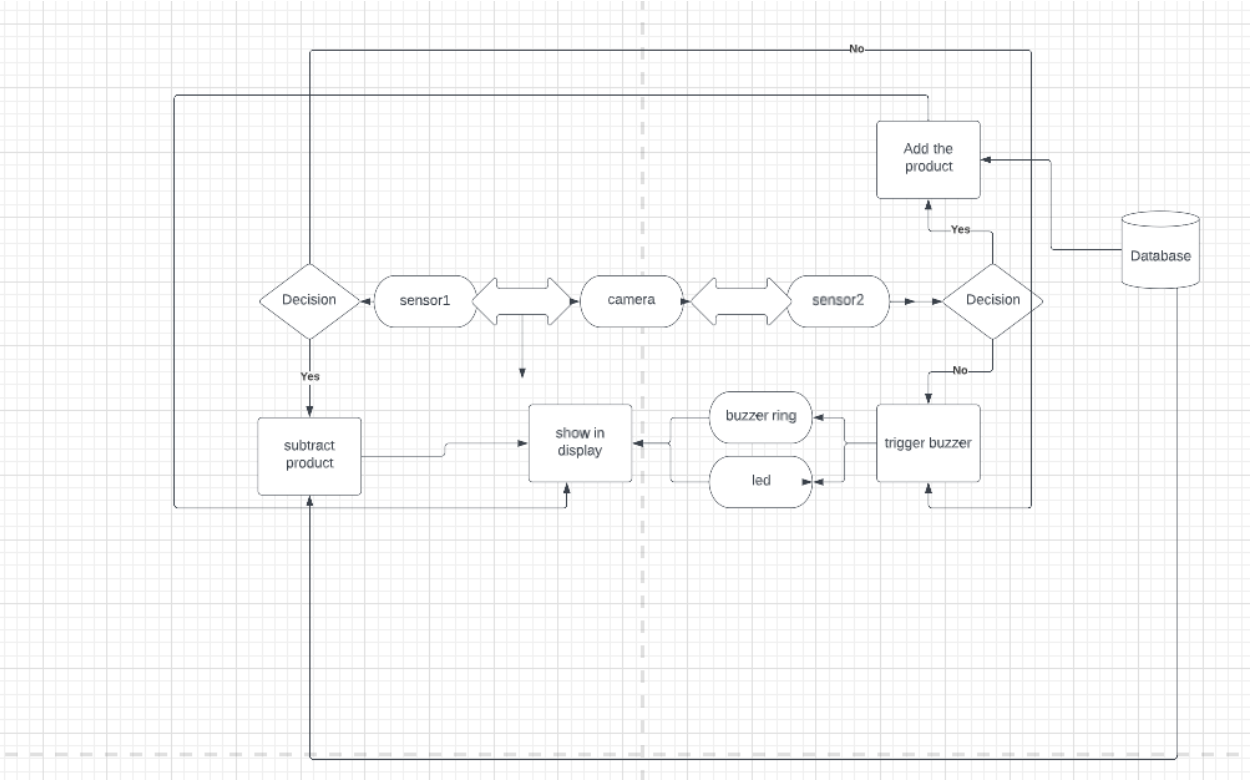
Considering the above-mentioned components, the work is as follows,

Step1:
After assembling the machine on the cart, when the product is kept inside sensor 1 will sense the movement occurring inside the cart.
Step2:
After sensing the movement by sensor 1 then the camera detects the barcode.
Step3:
After detection of the barcode, sensor 2 will sense the movement passed through the barcode.
Step4:
After passing all three cases in sequence as mentioned in the algorithm it will fetch the data from the given database.
Step5:
After this, if the product matches the data available in the database, then it will add the product.
Step6:
If the user wants to eliminate the product, he/she will have to pass all three cases in sequence through descending order so the product will get eliminated.
Step7:
The product will get added until and unless it doesn't intersect the range of the sensor 2.
Step8:
The final product which is inside the cart will be displayed on GLCD.
Step9:
After the user proceeds to check out, the final bill will be displayed on GLCD.
Step10:
It depends on the user how the user wants to pay the bill either online or by cash giving the bill number on the cash counter.

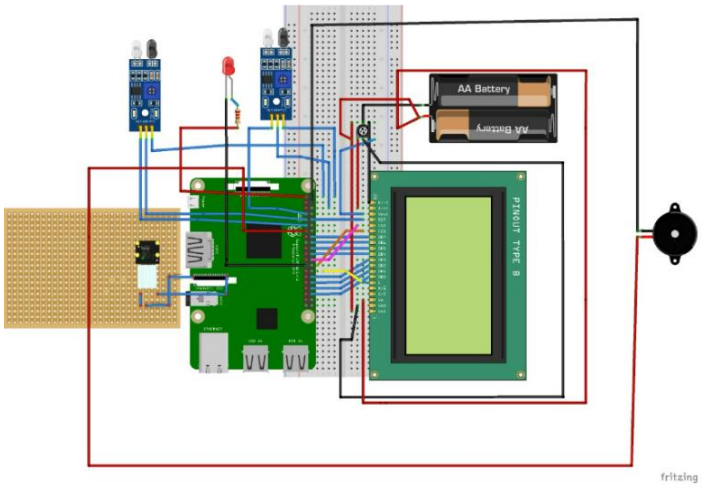
Understandably, the possibility of human error can be reduced greatly as the entire process is automated. However, for cost-effective purposes, we have the other method that we are using as the semi-automated method.

In the automated versions, the entire process of ensuring the addition and subtraction would be taken care of using Open CV and 2 camera modules. However, adding two cameras to one module would not be possible unless and until there would be an Arducam Raspberry Pi Multi-Camera Adapter or we would have to add in USB-based webcams.

BLOCK DIAGRAM OF CIRCUIT



Block Diagram



Planned Circuit diagram.

III. CONCLUSION

With lesser efforts taken by consumers and shopping cart workers, Vriddhiyaan becomes an easier way to deal with long lines and shopping wait times.

One of the biggest aims of VRIDDHIYAAN is to ease up the shopping experience of the average user.

With the available systems in shopping malls, the consumer must pick and choose the items they want and wait in long queues to pay for the same.

However, with VRIDDHIYAAN, the shopping experience will be very easy as the bill is generated as and when the consumer puts products in the cart.

Also, bills generated will be paperless and hence, VRIDDHIYAAN will help us conserve the environment.

Future scope

Customer need not have to wait for barcode scanning at all. Customers can put the products and remove the products without scanning it manually and that would get reflected on the bill.

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