IoT-based Automatic Sorting Machine

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Abstract- This paper presents an efficient and automated sorting system that uses image processing for the sorting of parcels rather than outdated and obsolete methods. The products are recognized using text labels, QR Codes, and Barcodes whose images are captured by Pi Cam which is then processed via Image Processing. The proposed method involves Optical Character Recognition (OCR) which is processed by Raspberry Pi. The performance analysis shows an 80% accuracy in QR and Bar code detection. Moreover, the final sorted response is displayed on the IoT-based application.

Index Terms- Automatic sorting, inspection, image processing and text detection.

I. INTRODUCTION

The global need for goods is increasing day by day this puts a burden on the manufacturers to automate the processes and the logistics as well for the delivery of goods. This is where automation plays a vital role and makes lives easier [1] [2]. Quality and Inspection improves the quality standard of finished goods in industries where sorting matters the most. Looking at the current dynamics of the industrial sector of our country where manual practices are adopted to pick and sort different products or materials. This has become a very common practice in the industries today, which has led to errors in the inspection of the finished products, decreasing our quality of the finished goods. To eliminate this problem, this project can serve as an economical solution for the industries and helps reduce the production cost of the inspection process in the long run. These developments in the field of automation can also be seen in the parcel delivering businesses like DHL, TCS and FED-EX, etc. These multinationals industries came into existence due to the vast demand for fast delivery by the clients and to deliver the desired goods in an extra quick time. Initially, the sorting of parcels was done by hand which required labor due to which the process was lagging and was not that much efficient. As the need or trends in this industry increased the need for automation was felt. This is where automation in the parcel delivery or the packaging industries came into existence [3] Our project, the automatic sorting system aims to provide a working model to demonstrate the sorting of parcels using image processing to detect bar-code, QR code, and text image on the parcel that is bound to be delivered to different destinations [4].

II. LITERATURE SURVEY

A. Project Description

The main reason or motive behind selecting such a project was to develop a machine having some sort of automation that is easy to operate, simplifies the sorting process, and reduces the sorting expense in the industry. It integrates the hardware including Motors and sensors with the microcontroller. In the proposed project, Image Processing is used for the sorting process by sorting the products having either QR code or Barcode or text on the parcel placed on the conveyor belt. This project demonstrates the real-time sorting of the parcels in continuity [5]. The literature review begins with the study of the design and mechanism of different sorting systems around the world. As discussed earlier about the need for automation and how it started in industries. The different sorting systems used in the world are used largely at the packaging end or in the quality control department where the inspection takes place. These companies employed large human resources for sorting their products which is makes this process outdated and complicated because of human labor capacity of rapid continuity while keeping the rapid flow of the sorted objects in this aspect. Our group studied about different types of conveyor belts based on the material, shape, size, or nature of the project where it is used. The conveyor belts are normally used in the delivery of the products where the products are picked from one place and delivered to the other place. The movement of the conveyor belt is normally carried out by two rollers, out of which one is fixed while the other is movable and is coupled with the main DC geared motor responsible for controlling the movement of the belt. The gearbox of the fixed roller is amassed with the DC motor and the sorting machine can carry a maximum load of up to 10kg while delivering the parcel or material. The main motor comes connected with the actuator to interface with the microcontroller [6] After studying the mechanical design for the proposed structure of the project and conveyor belt, to study about the mechanism for the sorting of the parcels

by the robotic arms placed on the structure to to interface with the microcontroller for the movement of flipper arms. To detect the parcel under the raspberry cam so that it captures the image on top of the parcel and sends it to raspberry pi for image processing, study about the proximity sensors which send low signals to the microcontroller when an object comes into its visual range area [7] [8]. These were the parts of our project to perform the tasks after recognition of the image on the parcel by image processing. To perform the image processing, started studying about different techniques used for image processing in automation systems and come to the conclusion to use OpenCV for detection while OCR for text recognition and Bar library for barcode and QR code scanning [9] [10]. The sorting system is employed for inspection from farming products to pharmaceuticals to ensure the quality of products without delivering flawed items to the consumer. Some researchers and industrial experts declare that the sorting systems can organize various materials automatically without human interaction. This simplifies the inspection processes around the globe which takes lots of time and human power [11]. The step by step approach or the graphical representation of our project (Flowchart) is shown in Fig.1.
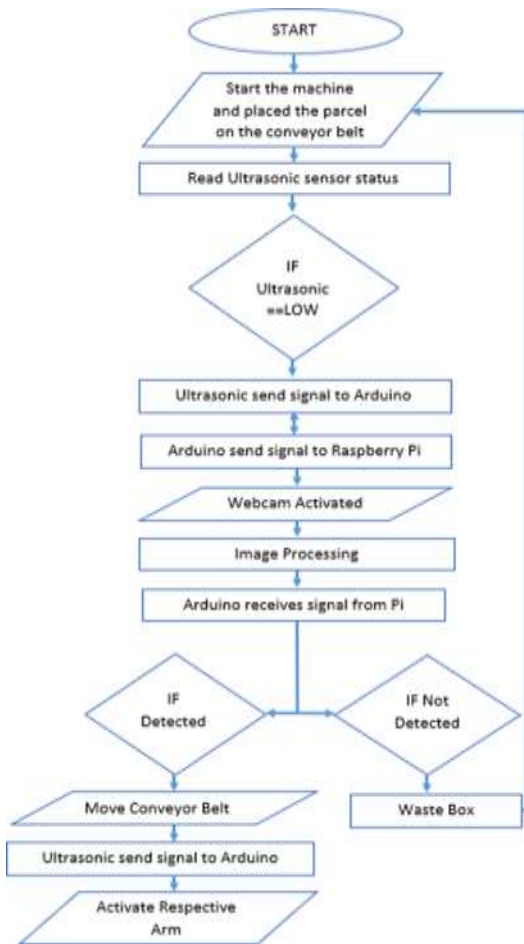
deliver the parcel to their switches that image processing takes place and the machine performs the sorting. The block diagram of the system is shown in Fig.2. The recognition part for the parcel detection has location gadgets, which consists of a vicinity ultrasonic sensor the sensor is used to identify the parcel on the conveyor belt. This hardware has numerous points of interest. For instance, their capacity to recognize objects [12]. They sense liquid levels, compound mixtures, and so forth of any item inside the reach. Secondly, the main motor is a DC Geared Motor is used to control the movement of the belt while the other three DC-Geared motors are used to control the movement of the arms. In the proposed system two relay modules having four relays on each, two relays on each module are connected together as an H-Bridge in order to control the direction of the motor the relay is activated by a separate low power signal from micro-controller, these motors are operated at 12-Volt. The complete schematic diagram of the system is shown in Fig. 3. Furthermore, an Ultra-sonic sensor is placed on each arm to identify the respective parcel and move the products into the destination boxes with the rotation of arms. Lastly, an LCD panel is mounted on the top of the electronic section to view the destination of the product [13].
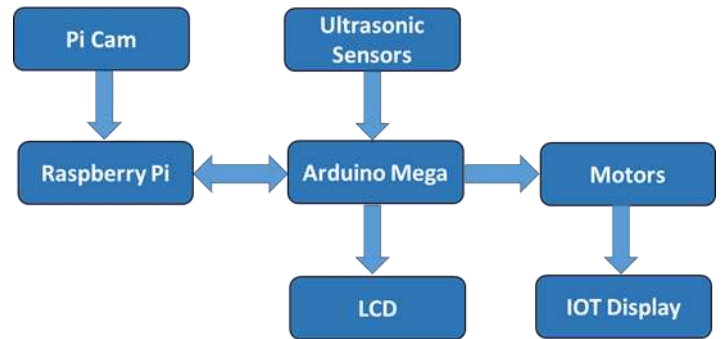

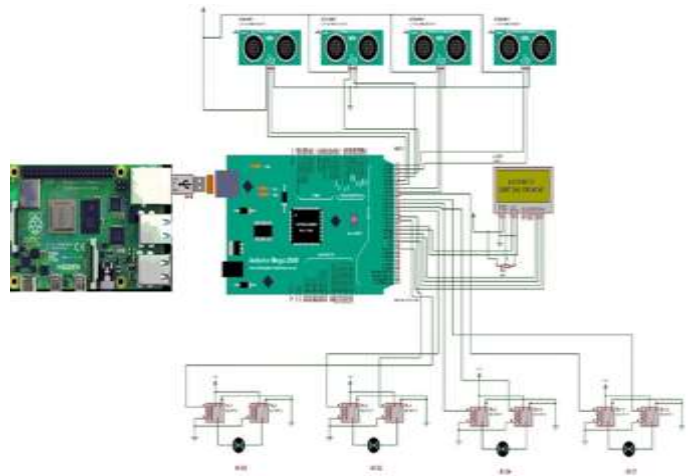Figure 2. Block IoT-based Automatic Sorting Machine

Figure 3. Circuit Diagram

Figure 1. Flowchart of the Project

III. DESIGN AND WORKING

Firstly, a recognition section was needed in our sorting machine to detect the parcel or package at the belt under the raspberry cam so

A. Mechanical Structure

The mechanical structure of the project is shown in Fig.4. Firstly, the metallic frame of the equipment was designed with a size of 6ft by 1.2ft. The frame comprises of two rollers on either end, one is coupled with the main motor and the other is free-rotating. A PVC conveyor belt is fixed on the rollers so that

the products can be moved to the specific platforms, these platforms are the spaces on the equipment that have arms (Metallic) that are used for the selection of the products to box them in the required zones. The entire structure contains three arms in total and is equally spaced. Secondly, the electronics are safely contained in an isolated container and the camera lens is sprouted outwards so the conveyor belt is visible to the camera for detection.

Figure 4. Mechanical Structure

B. Hardware Implementation

- The DC geared motor or the main motor which controls the movement of the belt is connected with the Arduino Mega digital pins.
- The Arduino Mega reads the analog input from the Ultra-sonic sensor to identify whether the parcel has reached in front of the sensor. The low signal from the sensor means that the parcel has reached in front of the sensor.
- The geared motor controlling the movement of the robotic arms is connected to the Arduino Mega, is used to push the parcel into the destination basket.
- Arduino Mega is connected to the Raspberry Pi via a logic level converter using serial communication. Image processing is done by the Pi while the corresponding actions are done by the Arduino.

C. DC Geared Motors

The DC geared rotary motor which is used is to move the conveyer belt and the arms [14] [15]. The motor is fixed on the structure of the belt and is coupled to the roller on which the belt moves.

D. Conveyor Belt

The conveyor belt is made of special rubber and Polyvinyl Chloride materials and has a 3-ply binding, which is done from the factory where it is made. This has a shiny surface and is good for removing parcels without the parcels sticking on it [16].

E. RASPBERRY Pi

The Raspberry Pi 4 is the main thinking station of our proposed sorting machine. The Raspberry Pi 4 is a micro-processor board that is been used for our project to identify the TEXT written on the box, the QR code, and the Bar code on the box. The identification of the text is done by the OCR (Optical Character Recognition), the bar code and the QR code recognition is done by the QR and Barcode Scanner algorithm. All these processes will be explained in the programming and software section below, selected Raspberry pi to perform image processing in our project due to its speed and execution. Unexpectedly, have fabricated a total work area experience. Regardless of whether you're altering archives, perusing the web with a lot of tabs open, shuffling book-keeping pages, or drafting an introduction, you'll discover the experience smooth and truly unmistakable yet on a more modest, more energy- productive, and substantially savvier machine.

F. Arduino Mega

The micro-controller that has been used in our project is the Arduino MEGA based on the ATmega2560 microcontroller. It is used to control geared motors (arm motors), DC main motor which controls the movement of the belt, reads input from the proximity sensor, and receives the signal from the Raspberry Pi to deliver the parcel to its respective destination box.The camera used here is a raspberry PI Cam having around 8MP resolution. The frame rates per second are efficient. The I/O interface is through USB 2.0. The image sensor is a 1/7" CMOS sensor. This camera is mounted in such a way that it focuses on the conveyor belt at a place where it will keep our parcels. Once an object arrives on the conveyor belt, an image is captured and sent to the Raspberry PI where its processing is done using image processing.

G. IoT Based Application Display

The sorted results are displayed on a smart application that shows the parcels destination address, date and time. This application will also be responsible for the starting and stopping the system at the remote location.

IV. SOFTWARE IMPLEMENTATION

A. Image Processing

Also called Digital Image Processing. It is categorized as a sub-category or field of Digital Signal Processing. It is used to process digital images such as QR codes, Bar-code, and Text Images through an algorithm. Moreover, Image processing or computer vision can be defined as a technical discipline that tries to automate the procedures or processes a human visual system can done by using the Open CV library.

B. Open CV

The subject (parcel or any other object) detection and recognition technologies have matured in labs, and recently more and more relevant applications and products are being developed [17]. The widely used OpenCV in python makes it much easier to deploy object recognition technologies on a large-scale. Hence, have used a python library in our programming for image processing through raspberry pi, known as OpenCV. This

open-source library is employed in systems to deal with computer vision problems like parcel detection. It is written in C++ language.

C. OCR Technique

This technique helps in the recognition of text in images. The optical character recognition (OCR) alludes to the cycle of separating text from pictures or electronic scanned images. This cycle is otherwise called text acknowledgment [18]. A library called Tesseract is used to extricate (or extract text) characters from pictures [19].

D. QR and Barcode Scanner algorithm

QR code calculation is comprised of two unique stages. The first by methods for similitude change where the novel lattice gets changed in restricted strides to genuine tridiagonal or Heisenberg structure. The primary phase of the QR calculation gets ready for the following stage which is the genuine emphasis- sis of QR which is valuable to the tridiagonal or Heisenberg lattice. One of the significant restrictions looked at by the QR code calculation is the way that the principal stage makes a total 'fill-in' in like manner meager frameworks (a grid that is fundamentally populated with zeros). This, prevents it from being utilized in enormous meager networks since they require inordinate memory. Scanner tags are an exceptionally natural innovation for the vast majority. It was experience on various items, for example, food bundling and delivery boxes, and see them utilized in a huge number of uses including retail and promoting. This work tries to portray the restrictions of a camera-based standardized tag disentangling strategy. The inquiry that is wish to address is what is the goal required and the clamor level allowed in the caught picture to unambiguously interpret a standardized identification. The inquiry adds up to the interesting and stable assurance of the digits for a fixed proportion of the pixel size to the tightest bar width. Under certain conditions, show that the digits are extraordinarily decided whether the tightest bar width is no more modest than a large portion of the pixel size [20].

V. PERFORMANCE ANALYSIS

The evaluation of the project is done by placing the boxes having QR, Bar-Code and text image of different destinations. The analysis is done by:

- Case 1: Box 1
  Bar-code image is pasted on the parcel which results to be the name Karachi after the image processing is done by Pi which applies the bar-code algorithm to detect and recognize the code.
- Case 2: Box 2
  Here the Pi successfully scanned and recognized the QR code on the second parcel box after the relevant techniques used for processing. The box is found to be destined for Lahore City.

- Case 3: Box 3
  The Last parcel has a text image placed on it. After text recognition by Pi, the box is moved into the Islamabad

destination basket with the help of a robotic arm.

VI. RESULTS

A successful IoT base Automatic Sorting Machine which simplifies the sorting process by utilizing Image Processing by reading the text of destination names, QR codes of that destination, and barcodes of that destination where they are meant to be delivered and will separate the parcel according to the concerned destination and display result on app Fig.5 shows the result of QR Code detection. Our sorting machine also has another feature i.e. the parcel removing sorting arm fixed on our conveyor belt frame. It aims to provide a working model to demonstrate the sorting of parcels that are bound to be delivered to different destinations.Fig.6 shows the accuracy of Barcode. QR-code and Text detection using image processing. It demonstrates the importance and benefits of an auto- mated inspection system in the industries where quality- based sorting matters the most. Through this project, paving a way for implementing these automated systems in our industries rather than using traditional and outdated sorting processes which are reducing our product quality standards in the global market due to manual inspection of these products.

Figure 5. Detection of QR-Code

Performance Analysis			
	DETECTION		
S. No.	QR Code	Barcode	Text
1	100%	100%	100%
2	100%	0%	100%
3	0%	0%	100%
4	100%	100%	0%
5	100%	100%	100%
Accuracy	80%	60%	80%

Figure 6. Performance Analysis

VII. CONCLUSION

As the global economy and trade expand as compared to the last decade, the need for automation is felt to increase production with the least time-consuming. This is where automation in the parcel delivery or packaging industry came into existence. The proposed IoT-based Automatic Sorting Machine using image processing is not only improving the efficiency of the manufacturing process

but also simplifies the sorting process. This research work decreases the human resources in material handling, safe time for inspection as a result of which human errors will be minimized. Inspection can be referred to as a strategic process to beat out the competitors, this is where a high-quality based inspection system to sort out the products is significant. Therefore, an Automatic Sorting Machine would successfully solve this problem and optimize the sorting process, resulting from a surge in their production. In addition, the respective sorted outcomes are displayed on the IoT App.

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