AUTOMATIC DETECTION AND SORTING OF PRODUCTS

AKSHAY VARPE
Department of E & TC Engineering, Marathwada Mitra Mandal's College of Engineering, Pune, India
akshayvarpe82@gmail.com

SNEHAL MARNE
Department of E & TC Engineering, Marathwada Mitra Mandal's College of Engineering, Pune, India
snehalmarne517@gmail.com

MANASI MORYE
Department of E & TC Engineering, Marathwada Mitra Mandal's College of Engineering, Pune, India
mansimorye29@gmail.com

DR. MANISHA JADHAV
Department of E & TC Engineering, Marathwada Mitra Mandal's College of Engineering, Pune, India
manishajadhav@mmcoe.edu.in

ABSTRACT
In manufacturing industries, there is a need of sorting objects. Objects may have different shapes and colors or it may be of same shape and color. Thus, different objects and different parameters require different type of processing. Aim of this paper is to classify objects using different image processing algorithms based on the parameters like color and shape. The input for the system will be an image and then processed for detecting the color or shape and accordingly the products will be further sorted using embedded algorithms.

KEYWORDS
Digital Image Processing, Embedded System, Conveyor Belt, Embedded Vision, Open Cv, Industrial Automation, Raspberry-pi, PIC microcontroller, Infrared sensors (IR), color detection, shape detection

INTRODUCTION

In many packaging industries, object counting and sorting is the most important task that needs to be done at final stage. Manual sorting is the traditional approach which is being performed by human operators in industries that involves visual inspection. This approach is monotonous, time-consuming, slow and non-consistent. It has become difficult to hire workers who will perform such tedious task. Therefore, the system is designed and implemented where automatic technique for identifying and sorting the products using Embedded Vision is done. In recent years, the importance of automation has been increased subsequently with the growth of industry. For precision and reduced time, output and accuracy of industrial robots is developed. In modern times with the evolution of robotic industry image processing in many industrial processes has proven its prevalence and dominance [2].
The aim of our proposed system is to test the manufactured component by an automated way instead of testing it manually. It is aimed to reduce human effort, at the same time increase the productivity and accuracy levels that cannot be achieved with manual operations. Therefore, products passing over the conveyor will be detected using camera and the processing on that will be done using Raspberry-Pi, that whether the object is A or B; Raspberry will give signal to the Microcontroller and then the products will be sorted accordingly. Number of products will be counted after being sorted and the quantity will be displayed. The proposed system is designed as a low cost solution for Small-Scale Industries.

RELATED WORK

As part of our pre-study, an elaborate literature survey has been conducted. The literature survey presents an overview on the Automatic Detection and Sorting Mechanism. After analyzing what systems published in the journals, we presented our ideas which were focused on improving the existing system and replacing the complex programmable logic controllers[PLC] by means of computer vision technology. In many processes the human eye is a key factor in sorting and inspection of all kind of objects. In most of these processes vision systems offer possibilities for more efficiency, faster production and better control over product quality. Furthermore, vision systems enable improvement of processes that have already been automated otherwise.
Embedded/Machine vision is a young discipline in the field of science and technology. It has emerged as a useful industrial tool for about 25 years and is growing at a higher speed. The applications of embedded vision in industries have been typically seen in measurements, counting, quality control, object sorting, and robotic guidance. It has become a yielding tool in product inspection and analysis, because it reduces cost, effort, and time with a significant level of accuracy and reliability. With the recent advancement in technology, embedded vision can be applied to extract different properties of the objects such as their dimensions, areas, etc. The application of machine vision has been seen in medical, industrial, and security fields [3].
Open-CV which is a computer vision library used extensively in the industry. We use CPP programming language as it is easy to use and has sufficient speed for our task[7]. Raspberry Pi 3 is a low cost single board computer which is powerful enough to do computer vision at real time based on ARM Cortex-A53 1.2GHz/32-bit quad-core[9]. A simple USB camera which is supported by Raspberry Pi is used to capture the real-time image.With recent advancements in technology highly efficient semiconductor

ICs were developed , based on these advances in IC technology Microchip provides 8-bit,16-bit and 32-bit microcontrollers with powerful architecture and complete documentation [8].

BLOCK DIAGRAM

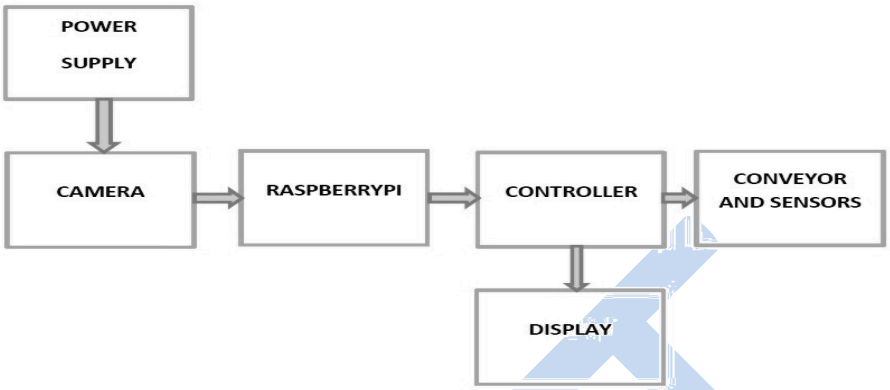

Figure 1 Block Diagram

The detailed block diagram of proposed system is shown in figure 1.

- The Camera is used for image/video acquisition. The video is acquired and then is being processed frame by frame using various Image processing algorithms.
- Image acquired is given to Raspberry-Pi and Open-CV is used as an image processing platform. The Open-CV code written in CPP is trained to examine the parameters like shape and color for identification of products [7].
- The Raspberry-Pi will generate the corresponding signals according to the image data interpreted by Open-CV. These signals are then given to the controller which further handles the sorting mechanism.
- Connected conveyor mechanism is the system used for sorting. These conveyors are driven through DC motors and the motors are controlled by the PIC controller.
- The controller will also perform the operation of counting the number of products and displaying the appropriate count on LCD [10].

SYSTEM FLOWCHART

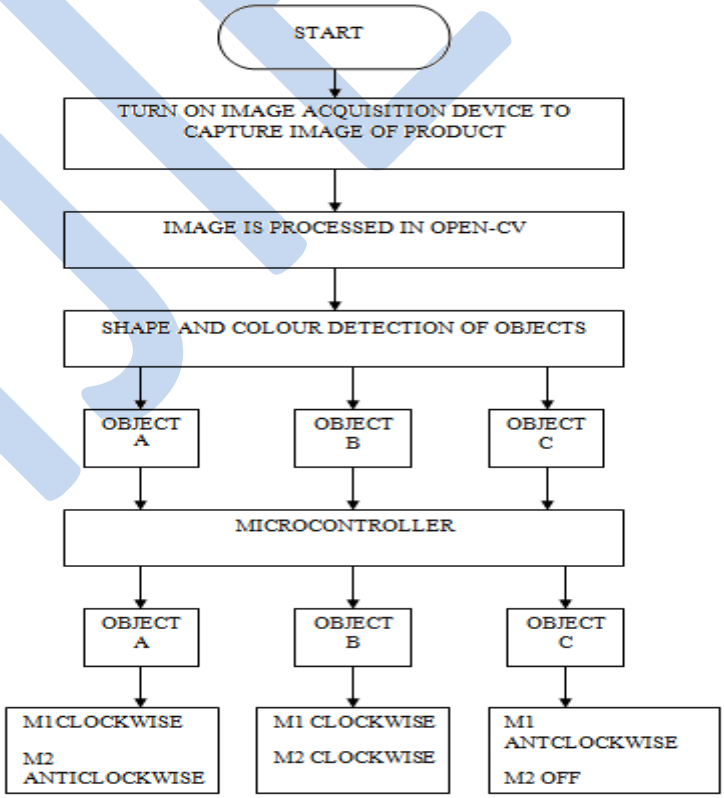

Fig 2 System Flowchart

Step 1: Start
Step 2: Turn on the camera and acquire image
Step 3: Image is being processed in Open-CV. Color detection is processed by using color thresholding and shape detection is done using contour mapping. The objects are differentiated as objects A, B and C
Step 4: Data of each object is sent to microcontroller through UART
Step 5: Motors are controlled using microcontroller and according to the object the conveyors are controlled and the objects are being sorted and further they are counted at the output.

SPECIFICATION OF THE HARDWARE AND SOFTWARE SYSTEM

A. Camera: -Camera used for the system is a Logitech Webcam B525 with HD video quality of 1280 x 720 pixels consisting of additional features as Autofocus and Built-in stereo mic.
B. DC Motor:-DC motor is a rotary actuator which has various applications in industry. DC motor is specified by its RPM and torque (kg/cm). For this system, 300 RPM and 3kg/cm torque motor is used to bear load. DC motor works on direct current.
C. PIC Controller:-PIC microcontroller P18f4520 developed by Microchip is a 8 bit microcontroller. The MP-lab IDE is used for programming the PIC. It supports various programming techniques like C language and Assembly language programming [8].
D. Infrared Sensors (IR) :-IR sensor is a combination of IR LED and Photodiode followed by simple comparator circuit using op-amp 358. It can efficiently detect any object passing the beam of IR-LED; the beam is reflected by the object and strikes the photodiode further generating a high output signal.
E. Raspberry-Pi:-Raspberry-pi 3 uses a Quad Core 1.2GHz Broadcom BCM2837 64bit CPU with 1GB RAM. It also consists of Wi-Fi and Bluetooth Low Energy (BLE) on board 40-pin Extended GPIO along with 4x USB 2 ports, 4 Pole stereo output, composite video port, full size HDMI, Micro SD port for loading the operating system and storing data [9].
F. Motor Driver:-In order to control the DC motor bi-directionally and initiate start and emergency stop for conveyor system motor drivers are deployed. Motor driver also provide easy control over the RPM of motor making it easy to synchronise the motors to required speed. Motor driver L298N can provide 1.5Amps continuous current with precise speed and direction control is preferred for the current system design.
G. Power Supply:-12 V, 5 amps for motors as each motor draw 1 amp of current and 5 Vis needed for the controller and Infrared sensors (IR).

EXPERMENTAION

Experiments were performed using raspberry-pi in open-cv, for shape detection template matching, edge detection and contour mapping many such algorithms were performed. Out of these contour mapping is finalized as it gives higher efficiency. Color detection was performed using template matching, object tracking and color thresholding and finalized color thresholding out of these algorithms. Raspberry-pi and PIC communication is done using UART. Motor driver was designed using MOSFET, however heating of MOSFET due to improper switching resulted into failure of the system. Then motor driver design was finalized using L298N IC.

RESULTS

The final results were satisfactory, color detection using color thresholding and shape detection using contour mapping gives 88% accuracy. Sorting mechanism is made more efficient by using IR sensors and counting of objects is done using the same.

CONCLUSION

According to the design and algorithms proposed in the experimentation, we come to a conclusion that detection of products using Digital Image Processing and sorting them which are passing over conveyor using a controller. The products are sorted with high correctness, good repeatability and high efficiency. Using Digital Image Processing in the system, we can detect the products based on shape and color. Further the products are sorted according to its type into different conveyors for packaging. The main advantage of this system is to reduce human efforts and increase productivity by using advanced technologies such as embedded vision which is a combination of Digital Image Processing and Embedded systems. For future scope in this system the connected conveyor system can be replaced by a robotic arm. The products can be distinguished with different additional characteristics such as texture, size, etc.

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