AUTOMATED BOTTLE CAP INSPECTION USING MACHINE VISION SYSTEM

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***Abstract*- The project work describes the design of automated inspection of bottle cap using machine vision system and sheds light on the working principle and the hardware structure of the system. The inspection of bottle cap is done by using machine vision system via image processing by taking image of the bottle cap in production line. The elements of the system are inspection unit and rejection unit. Microcontroller is used to control the system and it drives the mechanical and electronic components. MATLAB algorithm is used as a programming language for image processing in inspection process. IR module is used to sense the presence of bottles on conveyor. Automatic rejection system is carried out by an arm connected to the DC motor is incorporated into the system. This system can replace the existing conventional sensor based inspection and manual inspection. The system has an extensive social practical value thereby increasing the productivity, improve the quality of inspection, product variety and profitability.**

I.INTRODUCTION

Machine vision system is generally referred to the system which extracts desired features from digital images. Captured input images are the main objective of this system [1]. Application of the vision system in industries in order to automate manufacturing process is considered as Automated visual inspection (AVI) when attempts are made to inspect, control products and recognize the defects by using only images of the products [3]. In fact, human as inspectors are slower and their efficiency is affected by their state of illness, exhaustion or other human shortcomings. In some applications they need sometimes special environments which are dangerous and not conductive for human operation [2]. On the other hand, especially in the manufacturing environment, it is necessary to improve quality control and productivity.

Inspection is carried out by machine vision system via image processing technique is application in beverage and food industries, milk industries, medicine industries and other chemical product industries. In this area, accurate filling, inspection of cap closure, sorting, recycling plastic bottle, recognition between glass bottle and pet bottles, inspection for over-fill or under-fill, verification of label quality and detection of defected products are inspected automatically. Industrial vision system is not able to handle all tasks in every field of application [2]. It means that each system due to its specific requirements and its limitations needs particular techniques that should be taken into account.

The basic components for all bottle visual inspection as for any other VIS is shown. The first step in a visual inspection system is the image acquisition, which is concerned about capturing a good quality image through a camera. Camera resolution, its position, colour of background and speed of the conveyor belt and light has important effect on image quality.

In this paper, we have shown basic principle of bottle visual inspection by presenting different methods and techniques for automation of bottling and the most recent algorithms have been stated. In this paper, we have concentrated on developing a combine algorithm for four quality inspection in bottle cap: Detection of tamper in side view, Detection of tamper in top view, Detection of without cap condition of bottle on conveyor and different coloured cap of bottle on conveyor. So developing such algorithm where four most important parameters of automation of bottling are combined we get an efficient bottling system. Besides we have presented a detailed explanation of image processing of bottle cap detection and new algorithm combining the four parameters

through list of figures. LabVIEW, MV Impact, OpenCV, MATLAB, these software's will provide various digital image processing technique used for obtaining required information from an acquired image. Based on the extracted image the processor will take decision i.e. acceptable or not acceptable. Thus NOT acceptable component will be removed from the production line using ejection mechanism such as actuator or blower.

II. PROBLEM STATEMENT

Consider in any bottles seals and caps are used to protect the product from leakage, spoilage and tampering. Damaged seals or cap have a direct impact on company profitability due to waste, it makes customer rejection and potential liability. The integrity of these seals and caps is also a signal to the consumer about product's safety and quality. Producers must find reliable and cost effective means of detecting these defects and weeding them out before they get into the supply chain.

Conventional sensor based inspection methods have proven to be expensive and difficult to setup the system and change. In fact, human inspectors are slower and their efficiency is affected by their states of tiredness, illness or human short comings, some cases they don't have proper skills and in some toxic and hazardous cases human inspectors are not sufficient. So therefore using of machine vision system for inspection process is overcomes this problem. In industrial inspection system to reduce human efforts and for improves the quality of inspection machine vision system is being developed and automate the inspection process.

III.PROPOSED SYSTEM

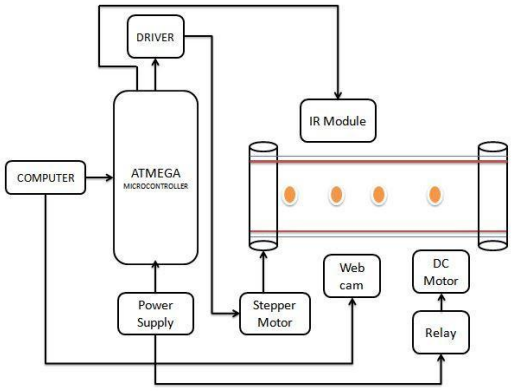

Fig1: BLOCK DIAGRAM OF THE SYSTEM

The bottles pass on one end to another end of conveyor belt. When bottle comes under the sensing range of IR sensor, bottles are sensed by sensor. The camera then captures the image of the bottle cap continuously and sends them to computer for processing. After image processing the computer display the result of the cap image weather the cap is original or defected. According to the image processing result rejection system take action on the defected bottle cap if there is defected bottle cap present on conveyor it rejects from conveyor. The inspection and rejection system are controlled by microcontroller and motors are interfaced with microcontroller through driver circuit. IR sensor used to sense presence of bottle on conveyor and send signal to microcontroller to control the motors speed. The process is then repeated again for every cycle.

A. Working Principle of the whole System

The system inspects different types of defected bottle cap via image processing technique using MATLAB algorithm. The defected cap of different types of defection can be effectively detected by image processing technique and rejection takes place from rejection system. There are two units are implemented for this system.

I. Inspection unit
II. Rejection unit

a) Inspection unit

In inspection unit it consists of microcontroller, IR module, Web cam, driver circuit and conveyor. When bottles comes under the sensing range IR module sense the presence of bottles on conveyor and sends signal to the microcontroller. Microcontroller actuates and sends signal to the stepper motor via driver circuit and controls the stepper motor speed finally conveyor will stop. When conveyor stops web cam capture the image of the bottle in required size and send it to computer for processing. Image processing is carried out in computer and computer display the result of bottles. There are five different cases are inspected in inspection unit

1. Original bottle image with no defect.
2. Bottle cap defected in side view.
3. Bottle cap defected in top view.
4. Bottle present but without cap condition.
5. Bottle present but with different color of cap.

B) Rejection unit

An arm which is connected toDc motor and the DC motor is directly interfaced with microcontroller via driver circuit and this setup is used for rejection system. If the defected bottles are comes on conveyor the microcontroller sends signal to DC motor, dc motor actuates and start rotating, the arm

connected to the DC motor is hit the defected bottle and kick it out from conveyor. This DC motor operates between 12v DC power supply and which is interfaced with microcontroller.

B. Flow Diagram of the System

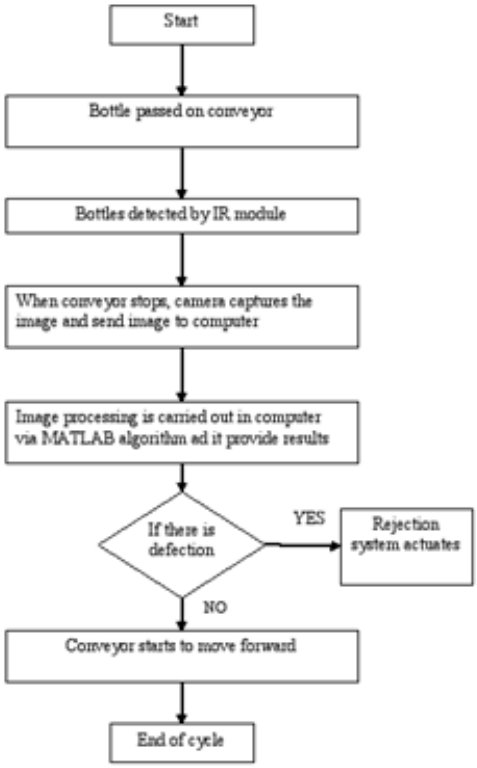

Fig2: Diagram for detect the defected cap

IV SYSTEM SOFTWARE DESCRIPTION

We use MATLAB 14 for system software development. Image acquisition toolbox is used to capture the images from the webcam vision camera interfaced [6, 7] with the PC. The image processing toolbox is used to develop the algorithm to inspect the bottle cap [1,2]. The instrumentation control i.e. ATmega32 microcontroller is used to read the IR sensor signals and controls all driver circuits. The simple MATLAB algorithm is applied for image processing of bottle cap and the image processing steps are explained as follow. Steps involved in image processing of bottle cap inspection:

Step 1: Processing on image:

- Separating R,G,B matrix
- Find the size of the matrix
- Find the pixel of red color in each matrix for tamper detection

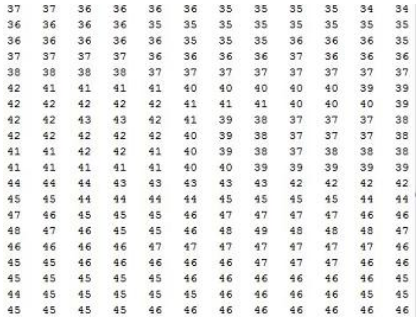

Fig3: Matrix Value of the Captured image shown in MATLAB

- **Edge detection**

  Edge detection is the fundamental step in image processing, image analysis, and image pattern recognition and computer vision technique. There are many methods of edge detection but most of them are grouped into two categories search based and zero crossing based. Edge detection algorithm is applied for input image to detect the edges of the bottle. This shows the skeleton of the captured image hence the defected portion can easily find in edge detection. Here the using of K-means algorithm to find the bottle cap from original captured image to find weather the cap is tampered or not.

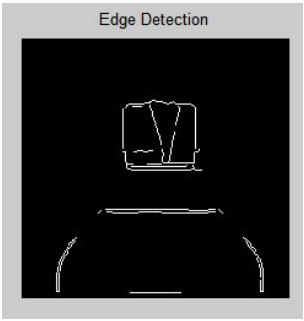

Fig4: Edge detection in sampling process

Step 2: Image clustering index takes place by means of k-means algorithm.

Solidification: Clustering is a process of grouping of similar data, objects and images in correct order. In clustering the solidification process takes place by means of only black and white color filled to the image. White color is filled to the cap portion and black color filled to background of image for processing. In solidification filling of black and white color shows defected portion clearly. This image has binary numbers of zeros and ones are clearly shows the defected portion easily. Zeros are shows the defected portion and one's are show the remaining cap portion.

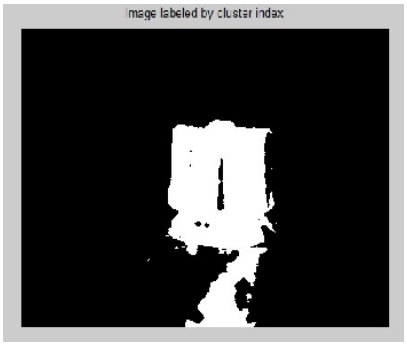

Fig5: Solidification in clustering index

Step3: After solidification it displays the segmented caps in colors by overlapping the original color to the particular cap portion of the clustered image. The original color shows and compares the defected region of captured image matrix values and binary value. After the image is indexed, only the indexed original image is displayed on screen. In below picture shows the defected region clearly by overlapping with original color of the image.

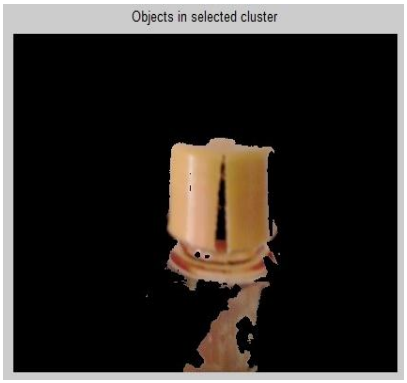

Fig6: Overlapping with original color of bottle cap

Step4: In region properties detection it will calculate the area of the defected cap and compares with predefined value original cap length, width and diameter. Finally the area and threshold value of the detected cap is compared with region properties of original cap.

Fig7: Image segmentation in processing

Step5: Display image information in final output of image processing it display the image information of the defected captured image by calculating the area of the captured image and compare with the original image area. If calculated area is less than predefined value of the original image then the cap is considered as defected. If the area of the captured image is equal or greater than the predefined value of original image then it will considered the product is pass.

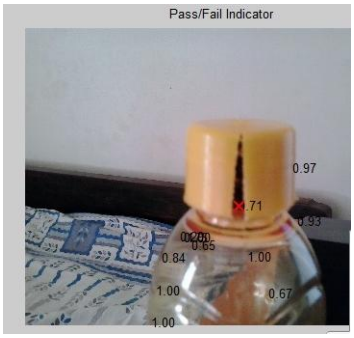

Fig8: Display output information with region properties

V COMPARISON BETWEEN EXISTING WORK & PROPOSED WORK

Existing work	My work
Title: PLC Based level detection technique	Title: Micro controller based bottle filling inspection System
Very high cost due to PLC	Less cost due to Controller
Complex algorithm	Easy idea(using RGB matrix)
It supposed to check level of bottle	It supposed to inspect the level and if bottle is partial filled or empty it will further go to refill.
It is not for Quality Control	It is inspection system for Quality Control

VI COMPONENTS FOR MACHINE VISION SYSTEM

A typical machine vision system will consists of most of the following components

One or more digital or analogue cameras with suitable optics for acquiring images, such as lenses to focus the desired field of view onto the image sensor and suitable, often very specialized, light sources, Input/output hardware(e.g., digital I/O) or communication links (e.g., Network connection or RS-232) to report results. A synchronizing sensor for product detection (often an optical or magnetic sensor) for image acquisition and processing, controlling devices like microcontrollers or PLC

controller, motors for moving conveyor to transports products from one end to another and some form of actuators to sort, route or reject defective part or products from production line, a program to process images and detects relevant features.

VII RESULTS

Fig9: Display of output with no defect

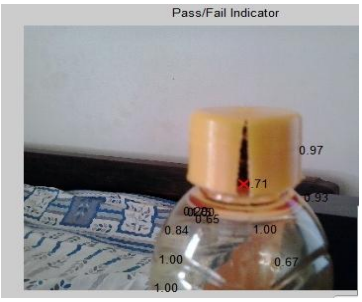

Fig10: Display of output with defected cap

Fig11: Display the output of Defected bottle

Fig12: Display the output of without cap bottle

Fig13: Display the output of different colored cap

VIII CONCLUSION

The above work presents an automated inspection of bottle cap using machine vision system, which has the capability to inspect bottle cap in different views and detect defects. This is achieved by using image processing technique. The present work provides a great deal of applications in the field of low cost automation by using microcontroller based vision system, especially in inspection process where there is a need for improve quality of inspection. The programming to this system developed is flexible, quickly and easy to understand. Even there is no need for the operator to change the program even if different types of defects, this reducing the time required to change the program. This will increase the total quality control and eliminate human inspector effort. This concept can be used in food industries, beverage industries, milk industries, medicine industries, mineral water and chemical product industries etc.

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