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# Automatic Tablet Pack Quality Monitoring System for Small Scale Pharmaceutical Firms

Ratish Rao.N[1], Dr.Surekha B[2]

[1]UG Scholar, Department of ECE, K.S. Institute of Technology
[2]Professor, Department of ECE, K.S. Institute of Technology

***Abstract—*** *Quality assurance of packaged products is of critical importance in the pharmaceutical industry so as to overcome expensive manufacturer recalls or potentially fatal accidents. This paper proposes a low cost yet efficient automatic quality monitoring system of tablet packs for small scale pharmaceutical companies. The proposed system inspects tablet packs by installing a camera and by using embedded vision technology. LabView is used to process the image for fault detection, using IMAQ vision toolbox to check for missing tablets, damaged tablets, dimension mismatch and colour difference between tablets. Further, identified faulty tablet packs moving on a conveyor belt will be rejected by the rejection arm automatically upon receiving control signals from the microcontroller.*

***Keywords— Embedded Vision, IMAQ vision toolbox, LabView.***

## I. INTRODUCTION

From past two decades, technology has continuously improved the manufacturing nature. In early days, manufacturing were done manually. Nowadays technology have been ruling the industry, automation has become the most important aspect in today's manufacturing world. Automation has given way for companies to largely produce products at very high speed and with great reliability and quality. Automation has become a determining factor in rating the company's manufacturing ability. Automation is constantly maintaining the standards for the industry and has many advantages such as reduction in production time, increase in accuracy and repeatability, less human error, less employee costs, increased safety and higher volume production.

With the recent directives by the World Health Organization for international exports of pharmaceutical products, inspection requirements have become more stringent. For pharmaceutical manufacturers, there is also ongoing pressure for volume production and quality assurance mechanisms with sorting capabilities.The main aim of pharmaceutical manufacturing inspection procedure is to enable Good Manufacturing Practice (GMP) compliance. A further aim of inspecting quality of products manufactured in pharmaceutical companies is to avoid the danger which will be the result of defected drugs. All Pharmaceutical companies have the same goal of providing safe and good quality drugs to patients. One way of reaching out this objective is by executing stability test that proves to monitoring organizations that a drugs manufactured are safe and effective. Stability test are done on each drug and its package to ensure that the drug will meet the goal of safety and quality for the shelf life indicated. But most of the time, companies focus only on stability studies with not considering package performance as critical importance and not realizing that a stability test failure may have nothing to do with the drug itself, rather the failure can be a result of its packaging. To avoid stability failure and gain understanding of the sensitivity of the dosage, the performance of the drug's package should be studied at the same time the performance of the drug itself is being evaluated. Package integrity can be determined very early in the stability test's timeline. In doing so, a potential cause for failure can be identified and corrected, allowing pharmacy to prevent delays in the launch process due to package failures. This ensures that the drug's packaging is performing as intended and will pass stability. Tablets packaged in blister packs need to be inspected carefully for defects such as the wrong color, size, whether the tablets are broken or chipped and whether there are any empty pockets in the blister pack itself. The Indian pharmaceutical sector, particularly the SME sector is essentially a fragmented with firms having very varied levels of technological capability. Majority of the SMEs have expertise in the anti-infective, anti-bacterial and nutritional supplements segments and very few firms, especially medium scale firms, manufacture specialized drugs. Most of the small firms are largely dependent on institutional selling and contract manufacturing for their survival.

### 1.1 Problems faced by sector:

- Inability to generate investments for required machinery and automation.
- Paucity of skilled labor.
- Lack of consistency and standardization in drug quality requirements.

The machines used to determine the stability of the package of blister packs are generally very expensive ranging from $12000 to $55000 (international wide) and up to several lakhs to crores (nationally) making it very expensive for SMPFs. Percentage list of small and medium scale pharmaceutical units in India are shown in Fig.1.

Hence, to support small and medium scale pharmaceutical firms, this paper proposes an automated defect inspection system at low-cost using Embedded Vision concept. LabView is used to process the image using IMAQ vision toolbox to inspect the following defects:

- Missing tablets/capsules.
- Broken/Damaged tablets.
- Dimension mismatch.
- Colour difference between the tablets/capsules.

While keeping track of total number of defective tablet packs and also the number of tablets inspected for the above mentioned defects, computer send the result to rejection arm via microcontroller as control signals to reject the defective tablet packs moving on a conveyor belt driven by geared dc motor.

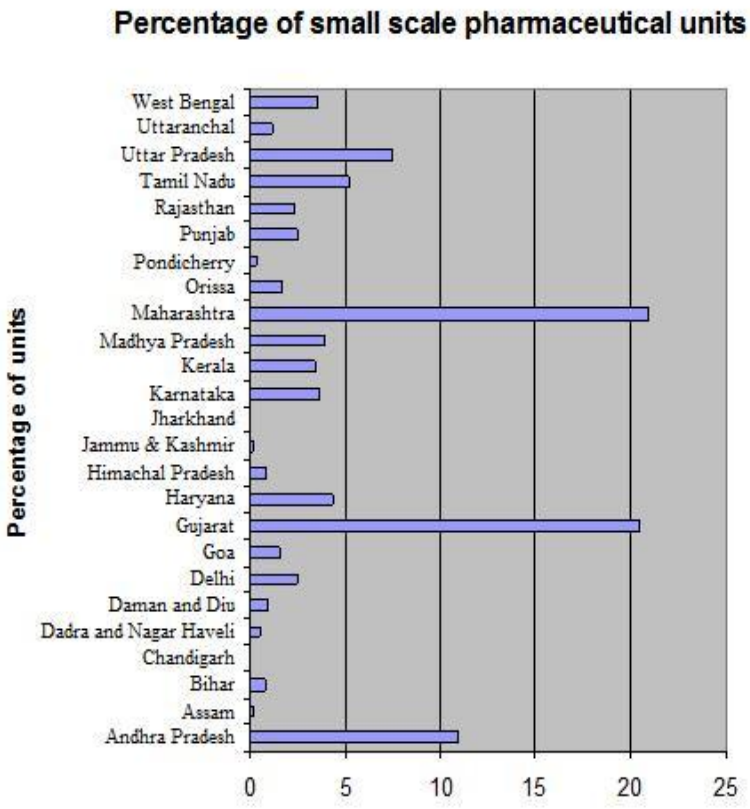



**FIG.1: CONCENTRATION OF SMALL AND MEDIUM SCALE PHARMACEUTICAL FIRMS IN DIFFERENT STATES IN INDIA.**

## II. RELATED WORKS

A good number of algorithms and/or methods exist in the literature for detection of faulty packs.Ştefan et al. [1],used "opening operator" which is a morphological operation to detect the defects present in aspirin tablets. The test image is subjected to segmentation and it is enhanced to remove the noise which helps in processing the test image further. The filtered image then undergoes morphological operation and is subtracted from the original gray image which detects the broken tablets. Ramya et al.[2] proposed a feature extraction technique to indentify the missing capsules and to detect the foils with broken tablets. The image is segmented and then region based statistic method is used to analyze the image based on the region properties. The image further undergoes the feature extraction method to identify the missing capsules in a blister. The blister without defects is effectively identified using the feature extraction method.

In [3], tablets detection using Fourier Descriptors and Support Vector Machines method is proposed, which can detect the defects of tablets individually even after it is sealed. Multi-lights are used to obtain the image of tablets in the blister pack. The images are subjected to segmentation using thresholding method; canny edge detector is then used to obtain tablet shape boundaries. The Fourier descriptors of closed contours are carried out to extract the tablets' feature and a new classification algorithm based on support vector machine is used for quality level of tablets. Munish Kumar et al.[4], detects damaged tablet pack using Rc-algorithm and canny method. The test image is initially converted into its gray scale image, then the image is enhanced to remove noise and make the test image suitable for further processing. Rc- algorithm and Canny edge detection operator is used for edge detection to obtain the tablet boundary. The proposed system efficiently detected the damaged pharmaceutical capsules and tablets.

Manzoor et al.[5], used a statistical method to find the defect in tablets. In order to find the defect, RGB image is converted into gray and then to binary. The noise in binary image is removed by morphological opening. Boundaries of the output are detected after pre processing. Further, to determine the roundness of the tablet, area and perimeter of each tablet are calculated and a metric is used to determine if a tablet is broken or not. In paper [6], technique called morphology filtering and segmentation is implemented for inspecting capsules for any defect present in them.

In paper [7], inspection of whether the capsule is defective or not is done by using Bayesian decision system method. In [8], Harris algorithm is used to identify defects and obtain the area of interest by mentioning thresholds, window sizes, and sigma values. Neural network approach is used for classification of identified defects. This method is easy to integrate and it will also remove the necessity of appropriate mechanical adjustments for testing the tablets. In [9], image processing technique like border tracing is used and the capsule is approximated to a circle to perform inspection and a custom system controller to pass the accepted and rejected capsules to the appropriate bin. In [10], Harris algorithm is used to detect defects of capsules like holes, cracks, scratches, broken capsule, double cap, missing cap detection. Corner detection & feature extraction are used as preprocessing and region based statistic preprocessing. An enhancement method makes use of median filter to remove noise from the image. Region based statistics includes area, convex area, perimeter and centroid of capsule.

The proposed work approach cover all the aspects of defects related to shape, size and surface defects of the pharmaceutical tablets. The algorithm can be implemented in various digital image processing environments and can be part of complex automated manufacturing and testing system.

## III. SYSTEM ARCHITECTURE

The prototype of proposed system is shown in Fig.2. It is composed of iball 20.0 HD webcam, 16*2 LCD display, Computer, ATmega8 microcontroller, 5v Power Supply, H-Bridge Circuit and Geared DC Motor. The iball 20.0 HD webcam is used to acquire image of a tablet pack moving on a conveyor belt. It is a HD camera with 720p (1280 x 720) Widescreen resolution, Clear and richer picture with 5G Wide angle lens, 6 LEDs for night vision, with brightness controller. Maximum Video Resolution is 1920x1080 pixels; Maximum Image Resolution is 5500x3640 pixels, Frame Rates 30 Frames per second.

The Microcontroller ATmega8 is used to control the geared dc motor of rejection arm with respect to the result obtained by processing the acquired image of tablet pack using LabView software in computer. The low-power Atmel 8-bit AVR RISC-based microcontroller combines 8KB of programmable flash memory, 1KB of SRAM, 512B EEPROM, and a 6 or 8 channel 10-bit A/D converter.

The device supports throughput of 16 MIPS at 16 MHz and operates between 2.7-5.5 volts. 16*2 character LCD display module is used to display to the ON-OFF status of the microcontroller. H-Bridge is an electronic circuit that enables a voltage to be applied across a DC motor in either direction. This circuit is used to allow geared DC motors to run Clockwise or Anti-Clockwise.

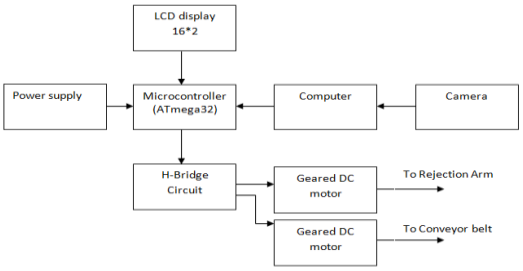
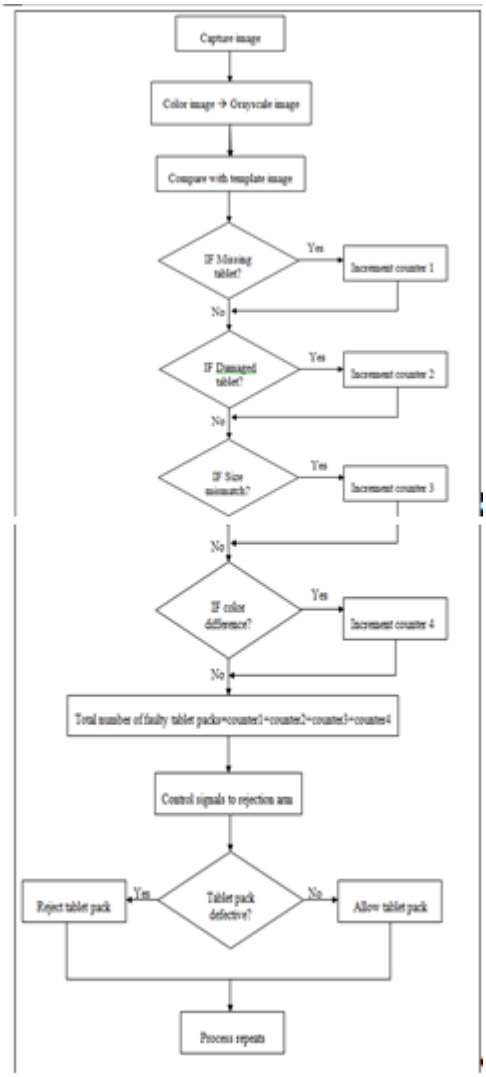



**FIG.2: BLOCK DIAGRAM OF PROPOSED SYSTEM.**

Two Geared DC Motors with different speed capacities is used to control the movement of rejection arm and rotation of conveyor belt. Gear motor is used since it has a gearbox that increases torque and decreases speed.

### 3.1 Flowchart



### 3.2 Algorithm for tablet inspection

**Step1.** Capture image

**Step2.** Input image→gray scale image (using LabView IMAQ vision toolbox)

**Step3.** The test image and the template image already saved in the system are compared pixel by pixel.

**Step4.** If the template image pixels are greater than that of test image pixels then the tablet is faulty.

**Step5.** A counter is incremented for each defected pack.

**Step6.** Four counters are updated according to which parameter the tablets pack has been found to be defected.

**Step7.** The information is sent to microcontroller via UART port.

**Step8.** The microcontroller controls the rejection arm accordingly.

**Step9.** The procedure repeats.

## IV. RESULTS

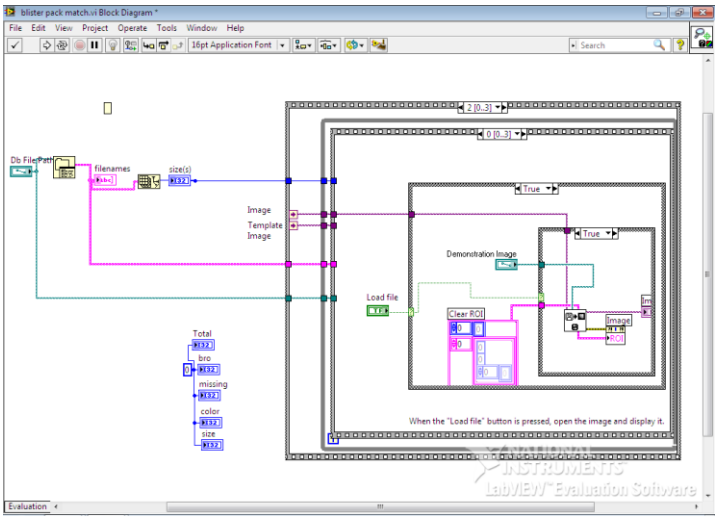



**FIG.3: LABVIEW GRAPHICAL PROGRAM MODEL**

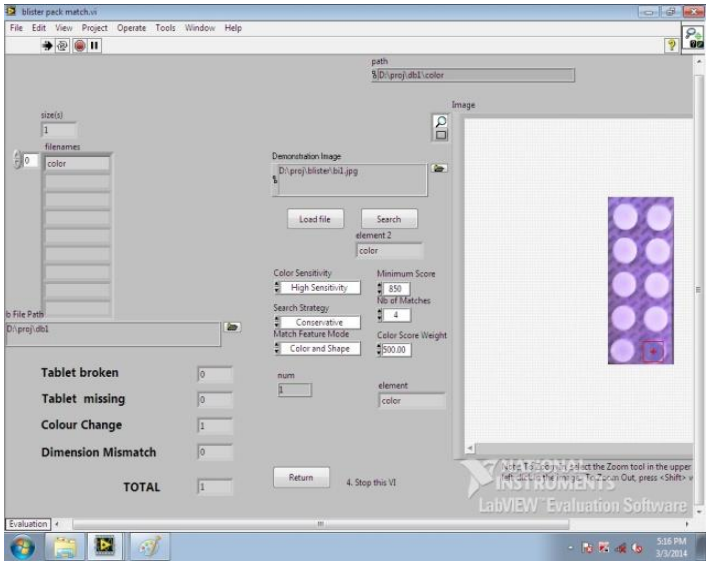



**FIG.4: SIMULATION RESULT (MISSING TABLET)**

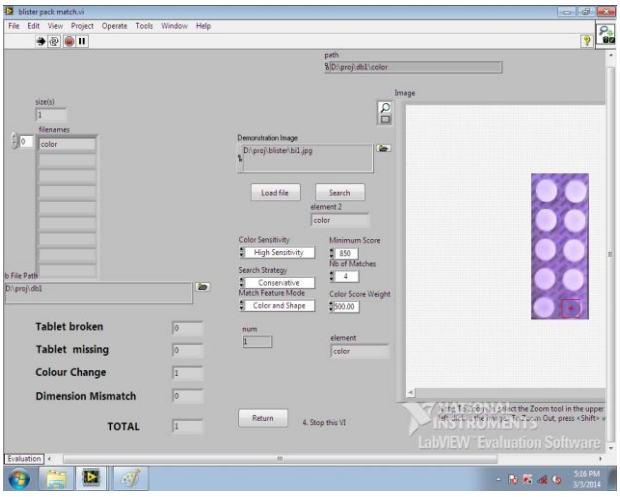



**FIG.5: SIMULATION RESULT (COLOR DIFF.)**

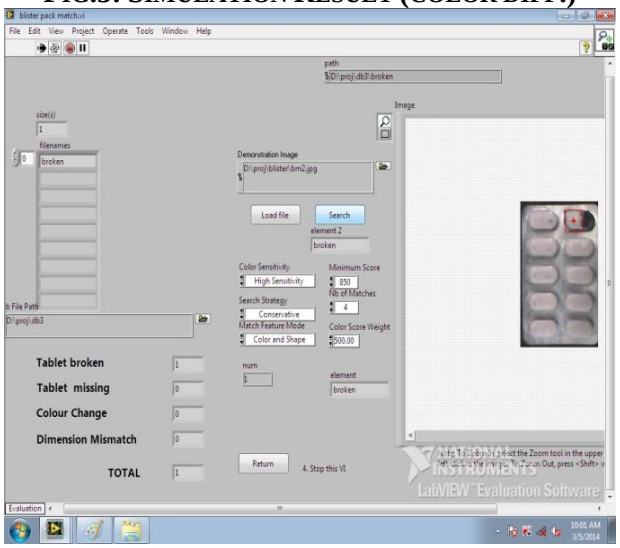



**FIG.6: SIMULATION RESULT (DAMAGED)**

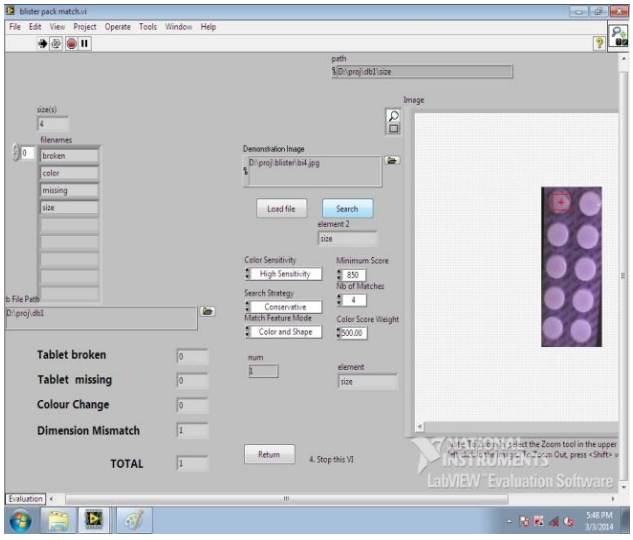



**FIG.7: SIMULATION RESULT (SIZE MISMATCH)**

The information from the processing was sent to microcontroller via UART port (USB to UART converter is used in between computer and microcontroller).The microcontroller ATmega32,which is supplied with 5v power supply and is connected to 16*2 LCD display to display its ON-OFF status, sends the control signal to geared dc motor(30 rpm) which is connected mechanical rejection arm to push off the faulty tablet pack moving on a conveyor belt connected to one more geared dc motor(10 rpm).

## V. CONCLUSION

The proposed system was analyzed with different type of samples such as defective and non-defective tablet packs and also different kinds of tablet packs such as clear PVC pack, colored PVC pack and opaque tablet pack. The table-I list out the result obtained for different type of tablet packs.

**TABLE 1- RESULT OBTAINED FOR DIFFERENT TYPE OF TABLET PACKS**

| Condition | Detection | | |
|---|---|---|---|
| | Clear PVC pack | Colored PVC pack | Opaque pack |
| Missing Tablets | Yes | YesYes | |
| Damaged Tablets | Yes | Yes | No |
| Size Mismatch | Yes | YesYes | |
| Color Difference | Yes | Yes | No |

The defective blisters were easily identified. With iball 20.0 HD webcam the system was able to inspect 60 tablet packs per minute. Required system speed can be achieved by use of higher resolution and better image sensory camera. This prototype is a solution for small scale pharmaceutical companies where the inspection of tablet packs are done manually. With advantages of proposed system being Low cost investment, Efficient in rejecting faulty packs, Portable.

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