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Prototype Model for Defect Inspection of Vials

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Abstract--- *This paper presents a prototype model for defect inspection of medicine vials. The proposed model for inspection of medicine vials assures that the quality of vials were met with the required standards. Because product quality is the essence of enterprises, especially pharmaceutical products which are closely concerned with people's health; hence product quality testing is a significant part of the production process. It is inevitable that various defects emerge during the pharmaceutical manufacturing process in the medicine vials which may greatly affect the product quality and reduce the productive efficiency. Even a minor defect on the surface of the vial may cause a chemical reaction and contaminate the chemical composition of filled medicine. When the defect is significant, the chemical reaction may drastically happen due to environment exposure of the fluid and may remain unchecked in many cases. This in turn becomes a life threatening to already suffering patient to whom the medicine is to be injected. Pharmaceutical drug vials need to be inspected in order to ensure that the vial meets predetermined specifications and does not harm the patient.*

Keywords--- *Vials, Automatic Inspection, Image Processing, Defect, Calibration.*

I. INTRODUCTION

This paper presents a prototype model for automatic vial inspection system which uses machine vision to inspect the vials for the possibility of defect or damage on the surface. The vials filled with medicine fluids may have defect (like cracks, scratches, dents, black spots, wrinkles, bubbles and other defects) on the surface due to various reasons. The damage may happen during the process of manufacturing, or during the process of transportation or due to any other reason. Container/closure defects can potentially lead to a breach in sterility. Introduction of particulate matter into the vials during the process of manufacture makes the drug potentially dangerous leading to its contamination [1]. Even it can pose a life threatening health issues.

These particles other than gas bubbles are foreign/extraneous in nature and usually un- dissolved, present unintentionally in the solutions [2]. The environmental factors (such as dust, fibers, personnel), packaging components (like rubber closures, silicone, plastic, latex, polymers, silica, glass vials), manufacturing process related factors (such as filters, metal), or it may be related to formulation (like undissolved material, precipitates, agglomerates, drug/ excipient incompatibility issues) etc. can be the sources of such particles [3]. The glass delamination which is caused by the formation of glass lamellae over the product shelf life has been cited as a reason for recall of such product [4]. These defects distinctly imply that the vials are not perfectly manufactured and have the risky situation of leakage or environmental exposure which should be picked out before putting them into use.

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II. PROTOTYPE MODEL

The proposed prototype model for vial inspection is shown in fig.1. This model is designed for the inspection of filled medicine vials.

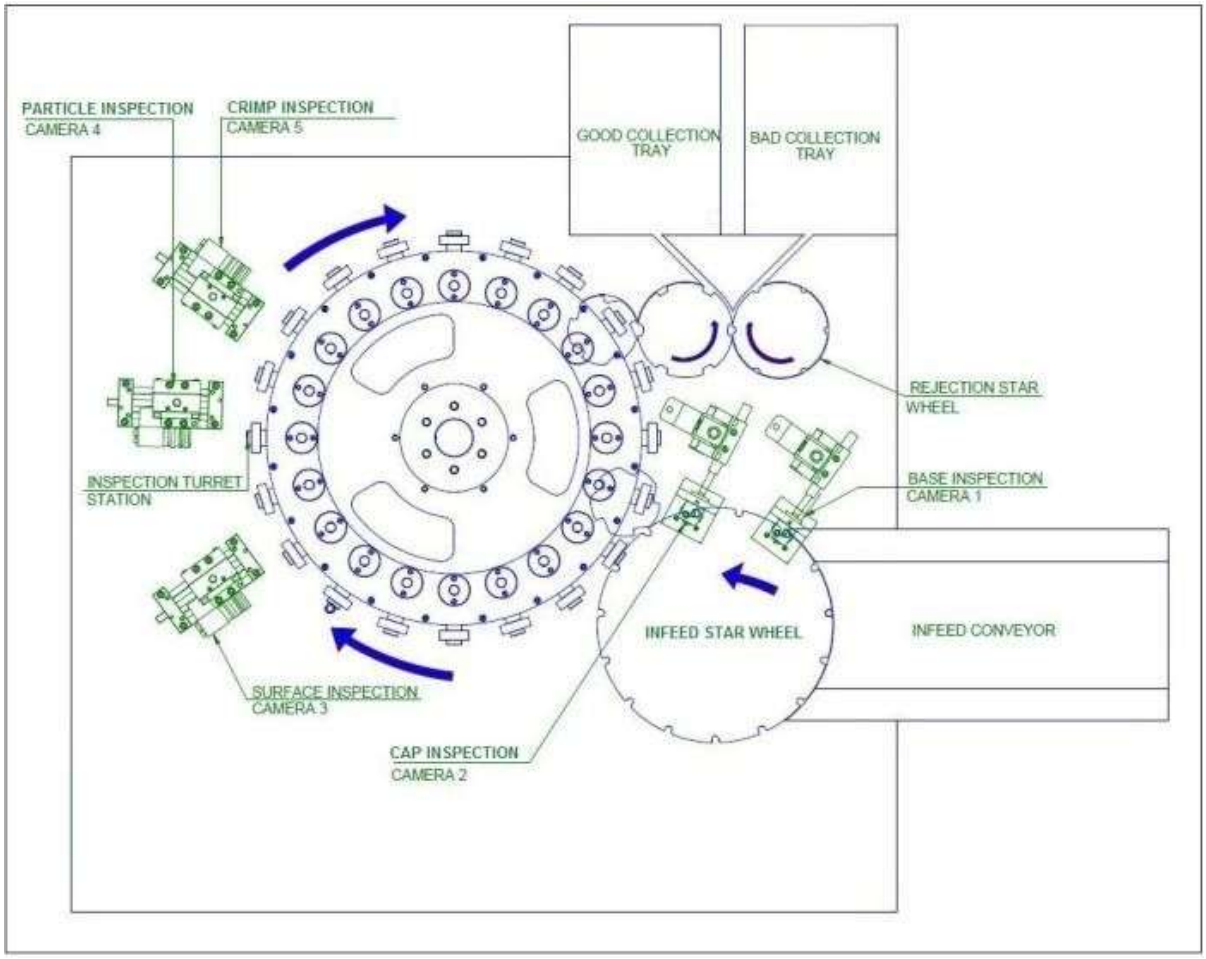

Fig. 1: The Prototype Model for Vial Inspection

The calibrated model contains a conveyor in-feed, through which the vials enter into the inspection system. The model has an in-feed star wheel which rotates and places the vials into the inspection turret station. The model makes use of special cameras to capture the image and to process them with the help of the built in algorithms. There are 5 cameras deployed at various places for the inspection of vials. Each set of camera inspects certain part of the vial where possibly a defect can be found. Camera-1 and Camera-2 contains non rotating bottom tray where as Camera-3, Camera-4 and Camera-5 contain a rotator bottom tray. The rotating bottom tray holds the vial at the time of inspection on its either ends – that is at the top and at the bottom - and helps the vial to rotate around so as to capture its image. During this process, several images will be captured so that no any part is left without its details being taken. The so captured images undergo various stages of image processing steps such as image acquisition, image pre-processing, image segmentation, feature extraction and defect classification. The pre-processing of the captured image takes place in which the digital image is improved in order to enhance the details. This step is applied for accurate inspection of container defect. Then the segmentation process takes place, where the image of

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the vial is isolated from the background of the scene. The defect is detected based on the intensity variations of the image within image segment. This step follows the feature extraction/selection procedure where significant features of the vial image are quantified in order to find the defect accurately and to classify them from the rest.

If any vial found with any defect, it is moved to the bad collection tray, otherwise it moves to the good collection tray. There will a star wheel placed on both the ends while the vial enters the system and leaves the system. The star wheel through which the vial enters is called in-feed star wheel, in which 2 cameras are deployed. From the in-feed star wheel, the vial moves into turret where the rest 3 cameras are deployed.

Camera-1

Initially the vial enters the system through the in-feed star wheel. When the vial enters the unit, first the base of the vial is inspected as shown in fig-2.

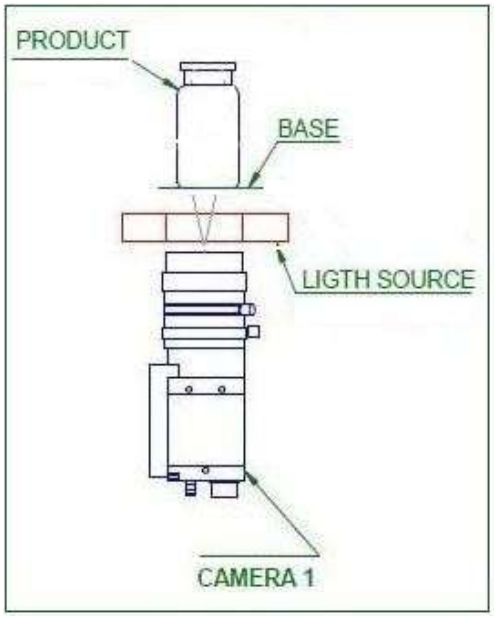

Fig. 2: Camera-1 for Base Inspection

Various types of inspections are made here. First inspection is for the presence of any particulate matter at the base of the vial. It is very much important to check any un-dissolved foreign particles presence at the bottom of the vial. Then the inspection is carried to check for any glass defect at the base. As the vial is made out of glass material, finally the inspection is made to check for the presence of any glass pieces introduced into the vial during the manufacturing process at the base.

Camera-2

Then the vial is inspected at the cap to check for any possible defects. It is shown in the fig 3. There can be a tilt cap or a foreign cap. A titling is introduced during the time of cap fixing by the cap fixing machine. A foreign cap is nothing but a cap of some other vial or a cap which does not have the features of the standard vials. In both the cases, the vial needs to be rejected.

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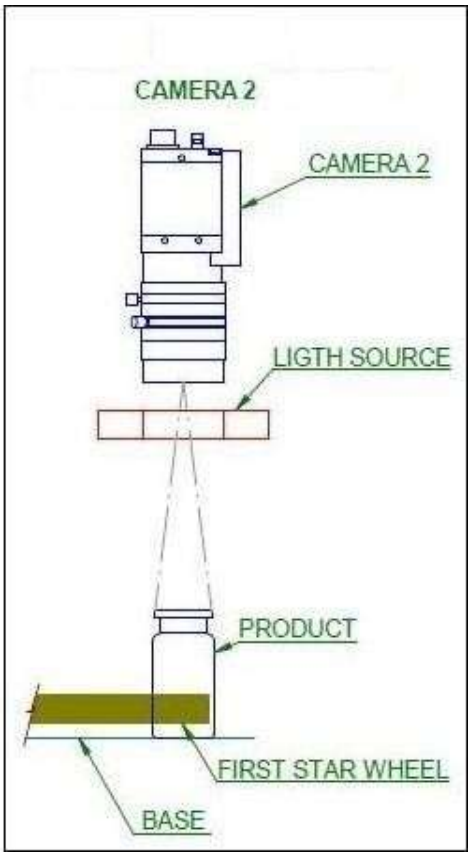

Fig. 3: Camera-2 for Cap Inspection

Camera-3

Camera-3 of fig.4 contains rotator bottom and top disc which help to rotate the vial and help to capture the all around images. Here the surface inspection carried out for the detection of possible glass defects on the surface. Notice that, the light source is placed in front of the camera plays an important role to find out any sort of crack or defect on the surface of the vial. This stage uses feature extraction methodology to find the defect on the surface.

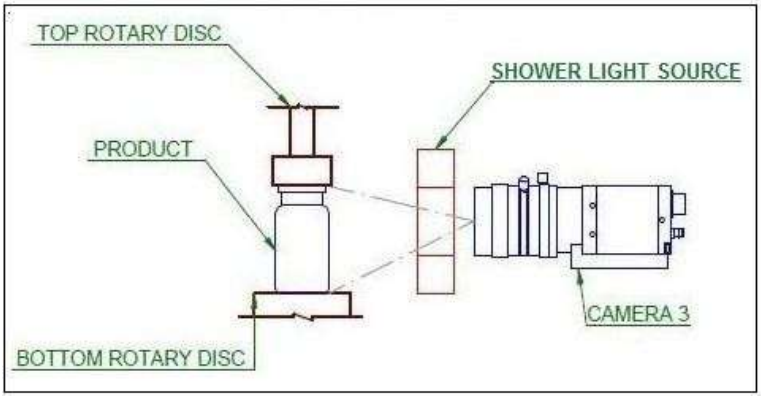

Fig. 4: Camera-3 for Surface Inspection

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Camera-4

Fig.5 depicts the particle inspection using camera 4. It also contains a rotator bottom and top disc which help to rotate the vial and help to capture the all around images for the inspection of floating particle inside the liquid. Here the light source is placed at the back of the vial so that, any floating particle can be easily detected.

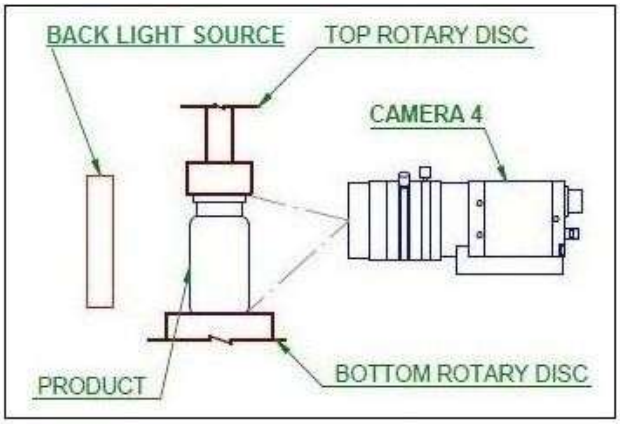

Fig. 5: Camera-4 for Particle Inspection

Camera-5

Fig.6 depicts the process of crimp inspection. It also contains a rotator bottom and top disc which help to rotate the vial and help to capture the all around images.

Presence of any crimp on the cap of the vial needs to be inspected too. If the cap of the vial is not fixed properly during manufacturing process, it will lead to the formation of crimp and exposure of drug to the environment there by causing a possible chemical contamination. So the crimp inspection also plays an important role. Here the camera is placed at 45 degrees so as to capture the image without any bias. The light source is placed in front of the camera-5.

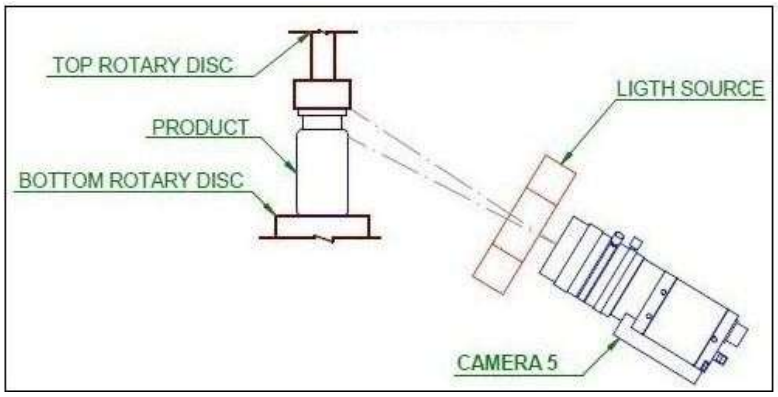

Fig. 6: Camera-5 for Crimp Inspection

During the inspection process, the placement of light source plays an important role. Several light sources are placed at every camera to make a proper check. If any of the camera detects any sort of defect, such vial is moved to the bad collection tray otherwise, it goes straight to the good collection tray.

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III. CONCLUSION

The methodology proposes to use a hardware setup which includes installation of latest high-resolution industry cameras in combination with specially designed optics and LED lighting. The model makes use of image processing algorithms to find the defected vials. The research is done in order to avoid manual inspection which requires enormous human effort resulting in lot of mental stress, eye fatigue and susceptible human error. In general, automatic inspection system not only substitute human inspection but also enhances capabilities by providing accurate outputs as well as high degree of efficiency. The proposed model for inspection of medicine vials assures that the quality of vials were met with the required standards and can be made useful for the automation of enterprises for the commercial use. The model reduces the cost of inspection process by automating the entire process.

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