inspection was done and system was trained for that and therefore system becomes adaptable.

3. Methodology Used

3.1. Image Acquisition

It is the first step in the method. Image is acquired through digital camera. The object for which presence-absence detection is to be performed are generally moving on conveyer belt. Therefore to avoid motion blurring aperture of camera should be maximum and exposure time must be minimum. The camera should be properly triggered so that horizontal movement of object in each image is minimum.

3.2. Region of Interest Extraction

Region of the Interest(ROI) is the fixed area in the image over which parameters will be calculated. The ROI must be selected such that it must cover the feature or component on the object of which presence absence is to be detected. Also the ROI must be selected such that it can handle movement of object in the image. The ROI should be such that it captures presence and absence of feature or component on object. ROI must be such that it captures maximum change in intensity when that component is Present and when that component is absent.

3.3. Parameter Extraction/Feature Extraction

After extracting ROI from captured it is transformed from RGB color space to HSV color space and then ROI image in HSV is separated into H-plane, S-plane, V-plane. Each plane captures specific property of image. The H-plane captures color information, S-plane has color purity, color saturation information and V-plane has brightness information. Therefore average and root mean square values are useful to detect presence-absence of feature or component in that ROI. From each of these planes average values and root mean square values are calculated as follows,

$$H_{Avg} = \frac{1}{M\,N}\sum_{r=1}^{M}\sum_{c=1}^{N} H[r][c] \quad [1]$$

$$H_{rms} = \sqrt{\left[\frac{1}{M\,N}\sum_{r=1}^{M}\sum_{c=1}^{N}\left(H[r][c] - H_{Avg}\right)^2\right]} \quad [2]$$

Where H_{Avg} and H_{rms} are average and root mean square values in H plane , $H[r][c]$ is the intensity at r^{th} row and c^{th} column of H plane of size M X N that is the size of ROI is M X N.

Similarly the average and root mean square values in S plane and V plane can be calculated. The RMS value is variance of pixel values and is discussed in [8] reference. It is used for contrast measurement and it shows variation in the pixel values from average value.

3.4. Parameter Selection and Decision Making

Total there are six parameters calculated three average values and three root mean square values. Out of these six parameters few parameters will show large variation and other parameters will not show significant variation in value when component or feature on object whose presence-absence we want to inspect is present and when that component is absent. Out of these parameters, the parameter which shows maximum variation, margin in its value when component is present and when absent on object must be selected for decision making.

The parameter can be used for decision making if the parameter values range in present condition do not overlap with parameter values in absent condition. Therefore training samples are required to select parameter for decision making. For these training samples all the parameters are calculated. Then minimum and maximum value of parameter when component whose presence-absence to be inspected is present and when that component is absent are used. If parameter range for present and absent condition overlap then that parameter is neglected. Let P be one of six parameter calculated then overlap in that parameter's range for present and absent condition can be found as

$$P_{Overlap} = 1\ if\ \{(P_{Prmin} < P_{Abmin}\ P_{Prmax})\ or\ (P_{Abmin} < P_{Prmin} < P_{Abmax})\}$$
$$= 0\ if\{(P_{Prmax} < P_{Abmin})\ or\ (P_{Abmax} < P_{Prmin})\} \quad [3]$$

Where $P_{Overlap}$ indicates overlap for P^{th} parameter out of six parameters, $P_{Overlap} = 1$ indicates overlap present, then neglect that parameter and $P_{Overlap} = 0$ idicates no overlap, that parameter can be considered for selection. Also P_{Prmin} and P_{Prmax} is minimum and maximum value of parameter when component or feature is present on object. P_{Abmin} and P_{Abmax} is minimum and maximum value of parameter when component or feature is absent on object. These values are calculated for set of training samples. The parameter satisfying overlap condition are candidates parameters for selection. Out of these parameters satisfying overlap condition final parameter for decision making is selected based on margin provided by it. The parameter which provides maximum margin is selected for decision making. The margin of parameter is calculated as follows,

$$P_{margin} = (P_{Abmin} - P_{Prmax})\ if\ P_{Prmax} < P_{Abmin}$$
$$= (P_{Prmin} - P_{Abmax})\ if\ P_{Abmax} < P_{Prmin} \quad [4]$$

After selecting appropriate parameter a threshold value is required for decision making. A threshold value for decision making is calculated by using worst case scenario parameter value that is by using maximum or minimum value of parameter in present condition and maximum or minimum value parameter of parameter in absent condition. The threshold for selected parameter is calculated as

$$P_{th} = \frac{P_{Prmax} + P_{Abmin}}{2}\ if\ P_{Prmax} < P_{Abmin}$$
$$= \frac{P_{Abmax} + P_{Prmin}}{2}\ if\ P_{Abmax} < P_{Prmin} \quad [5]$$

Where P_{th} is threshold for selected parameter

After selecting parameter P from six calculated parameters, threshold P_{th} for that parameter, decision making about presence-absence of that feature or component in ROI can be done by using $if\ldots.else$ statement. The figure 1 shows the flow diagram of the above discussed presence absence detection method.