# Design and Development of Selection System and Leakage Detection System for the Respiratory Mask

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*Abstract*— Many industries, companies work in the poisonous, harmful environment. For the workers who work in such industries, respiratory mask is needed. Respiratory mask is useful for workers to avoid such harmful gases. The aim of this study is to provide the system which selects an appropriate mask for the face of workers using image processing technology. By using such advance technology, workers can wear best suitable mask without any risk. This paper also proposed another system for the detection of leakage occur inside the mask. For the selection process, Canny Edge Detection Algorithm is used. For the leakage detection indication is given by the system if leakage is found. The system is advantageous over time, cost, processing speed and implementation.

***Key words:*** Respiratory mask, leakage detection

## I. INTRODUCTION

In many industries, Respiratory mask is very essential as protective equipment in order to protect from harmful and poisonous gases. Industries such as Oil and gas, Petrochemicals, Power, Mining, Steelmaking, Metals, Fertilizers, Nuclear power plant are continuously producing harmful/poisonous gases and particles. This poisonous gas is very dangerous for human. To avoid the inhalation of such gases, respiratory mask is needed [3]. Such harmful gases must be avoided in order to avoid hazardous conditions. This precaution can be possible with the help of selection of respiratory mask. But this mask must be fitted well for the protection from harmful gases. Hence it is important to use selection process of multiple sized respiratory masks. Commonly 6 types of face shapes are observed which is Round, Oval, Diamond, Long, Square, Heart as shown in fig.1 below. Hence each worker may be of having different face shape. Hence for all types of shapes suitable mask is selected. This selection test is done with the help of fit test which is existing technique [3][4], determines fit factor for all the types of masks which is time consuming procedure. Fit factor is determined by certain test and mask is selected based on the fit factor record for each wearer. Thus, it is a complex technique which uses certain particles or aerosols for the calculation of fit factor. In order to make it simple, selection system is proposed in this paper which select an appropriate mask with the help of advance technology that is Image Processing.

Sometimes, after the completion of selection process, leakage may occur in the mask [2]. Leakage will permit inhalation of toxic or harmful gases. Leakage formation is hazardous to workers during work in the industry. The manufacturing company provides these types of mask based on the regularly observed face shape. But if some changes occur on the face shape of wearer, leakage will generate. Most of the leakage generates around the chin and nose area of the face. Existing system provides fit test for the leakage detection. Fit test is carried out in laboratory test chamber where certain gases are passed [6]. Thus, it is also complex process and requires more time to process. The system proposed in this paper is easier as compared to existing system and used concept of pressure inside the mask. This selection and leakage detection process is also important for the certification of fit test for the respiratory mask. The fit test certificate provides the recommended size of mask according to face shape.

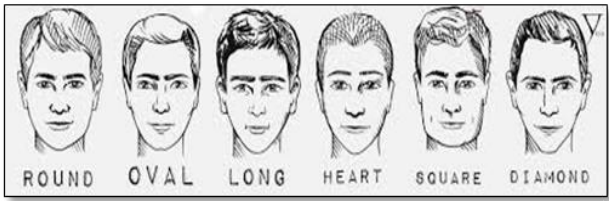


Fig. 1: Common Face Shapes

## II. WORKING METHODOLOGY

Basically two systems are proposed here, first for the selection process and second for the leakage detection. System used for the selection purpose is also known as Test Kit.

### *A. Mask Selection System*

Existing system provides the appropriate face mask on the basis of laboratory test. But this system provides suitable methods for mask selection test which uses the image processing technology. System is built on complete software which provides image processing tools. The selection system will work as per block diagram as shown in fig. 2 below. In this fit test process, the face contour will be examined. Initially image of face is captured through the camera. Edges are detected from the image of face of wearer with the help of canny edge detection operator. Then, dimension of certain area such as length of forehead, jaw line, cheekbones, vertical face are calculated in the software tool. These dimensions are compared with the standard dimension which is stored in data base. After matching process, suitable mask is being proposed by the system. Basically this system works when certain changes occurred on the face area of wearer such as scares, moles around the face mask area, swelling due to any dental work and sometimes wearer loses or gains weight.

#### *1) Canny Edge Detection Operator*

The best selected operator for the edge detection of face image is canny edge detector which is used in this system. Basically, canny edge detection algorithm is used in this system which makes selection system easier. This detector detects wide range of edges in the image of face. Canny edge detection technique is used to detect wide range of edges in the image. It is a best operator used within edge detection algorithm. It was developed by John F. Canny in 1986 explained in [12]. Along with canny operator, some

 

other operators are generally used for edge detection such as Sobel, Deriche, Differential, Prewitt and Roberts cross. Canny edge detector follows certain operations such as:

1) Detection should catch more of the edges shown in the picture with low error rate.
2) The edge point detected from operator should accurately localize on the centre of edges.
3) Detected edges should be marked only once with low false edges.
4) In order to follow the above operation, operator must perform some strict methods which is explained as:
5) Noise is removed by applying Gaussian filter to the image.
6) Find the Intensity Gradients of that smooth image.
7) Apply Non-Maximum Suppression
8) After applying gradient calculation, edges obtained from such gradient method are still quite blurred. To remove this, non-maximum suppression technique is applied to that image. Thus, it suppresses all the gradient value to 0 except local maximal.
9) Apply Double Threshold Method
10) There may be some edges which will be caused by the noise and some color variation. To clarify the different types of edge pixel, double threshold method is applied to filter out edge pixel with weak gradient value and preserves edges with high gradient value.
11) Final method is tracking the edges by hysteresis which removes all other edges that are weak and not connected to strong edges.

Thus by using all the above methods, canny operator provides good and reliable detection of edges in the image.

*2) Database*

In any industry, company the information about wearer is recorded. There are two important types of data are stored in the database, one for the comparison purpose and other for the information about wearer's mask. Dimension of the standard mask are stored in the database which is different for different masks. Each time wearer is under test, type of mask is recorded along with the name of worker, date and other important information. With the help of this data, it is very easy for the industry to get any kind of data at any time.

Here, four dimensions are calculated by using distance tool in software.

$$S = S1+S2+S3+S4+S5 \quad (1.1)$$

Where, S is the total sum, S1 is dimension of Forehead, S2 is dimension of Cheekbones, S3 is dimension of Chin width, S4 is dimension of Jaw line and S5 is dimension of vertical face length. Steps to calculate these dimensions are also shown in the graphic user interface (GUI) of system. Hence new operator can easily calculate all the dimensions.

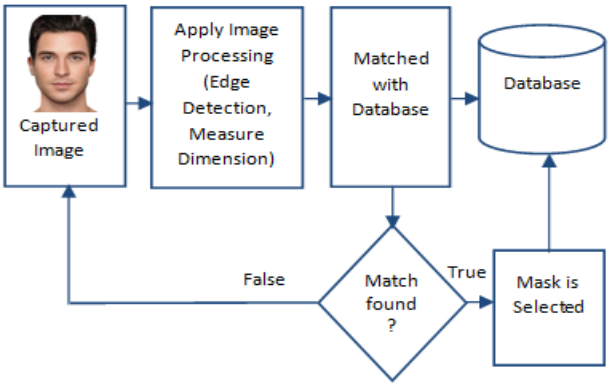


Fig. 2: Block Diagram for Mask Selection System

*B. Leakage Detection System*

Leakage in the respiratory mask may occur due to any physical changes or activity during work in the industry. Inhalation of poisonous gases through the leakage may produce hazardous condition. Hence, finding out leakages within a minimum amount of time is very essential to avoid inhalation of harmful gases, particles. Existing technology proposed equipment which uses either ultrafine aerosol or odour compounds for testing purpose [3]. Such equipment is costly and requires more time to test. But this system is used advance technology for finding leakage. Pressure inside a mask changes immediately, if leakage get occurs in the mask. For the detection of leakage, pressure sensor is used to determine the changes in the pressure inside the mask. Such variations are observed and proper controlling action is taken by the controller as shown in fig. 3. Such controller must be best for controlling the inputs and should be of low cost. Thus, this system becomes smaller in size and it is easily mounted inside a mask. Leakage detection is done step by step by using measured pressure in the mask.

Especially, a fixed pressure range is selected with the help of controller which follows conditional loop as;

```
if    (P<10 && P>04);
      then ("Buzzer is Off");
else
       ("Buzzer is On");
end
```

Here, P is the standard value of pressure required for the smooth respiration. Basically, pressure changes only when the outside air is moving inside the mask or air inside the mask is coming out. That means leakage is occurred.

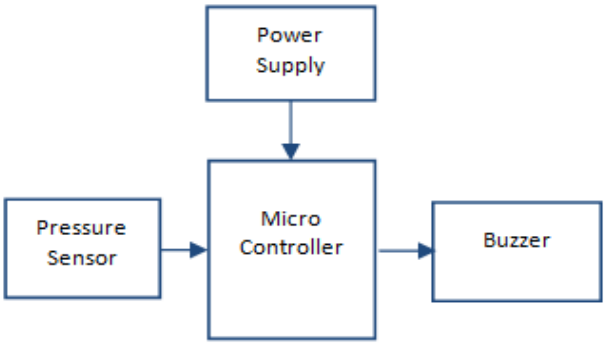


Fig. 3: Block Diagram of Leakage Detection System

## III. RESULT AND DISCUSSION

As study presents two types of task, result is also discussed in two ways. Firstly, mask size is selected as per GUI given

 

in fig. 4 below. There are two ways to get image of face for the analysis such as Load Image button and Capture Image button. Load Image button can browse image from system in which passport size photo is applicable whereas Capture Image button can capture image from webcam attached to the system which is real time image. Here, oval shape is detected as per the image. GUI also includes tips for the measurement of dimension. We can measure dimension from both images (original image and edged image) as shown in GUI.

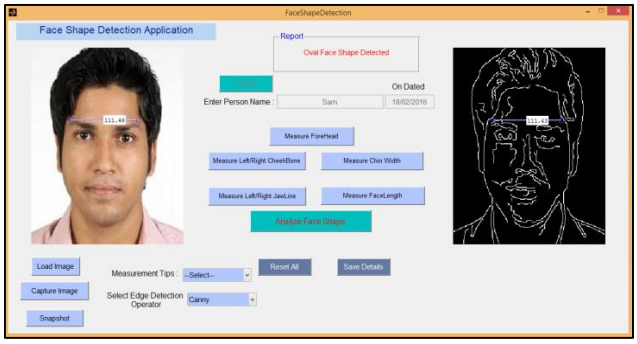


Fig. 4: Mask Selection GUI


Fig. 5: Pressure Sensor Based Leakage Detection System

For leakage detection, only pressure sensor is used with controller which controls buzzer or LED depending on the pressure inside the mask as shown in fig. 5. Pressure sensor used for this purpose is very small in size. Hence, it is easily attached inside the mask. This sensor detects pressure in the range of 3 psi to 16 psi. Here, pressure range is set from 4 psi to 10 psi which is standard range for breathing. When pressure goes out of this range, buzzer will be on. As per study and practical implementation, system performs operation within minimum time before any hazards occur. Thus, system is suitable for easy detection of leakage using very low cost equipments.

## IV. Conclusion and Future Scope

Thus, system selects best fitted respiratory mask which leads to avoid inhalation of harmful gases. This system is very effective because, it is very low cost system and makes use of advance technology which leads to fast operation. Selection system gives accurate result and small portable system is used for leakage detection, both are discussed in this paper. Human can feel safe with this system because, if any leakage is further occurs in the mask, it also gives an indication immediately. So, there is no need of fit test every time which is complex as well as time consuming process.

As technology has been rapidly changing to fulfil today's worlds increasing demands, detection of the exact location of leakage is possible. If light rays will be moved along the boundary of mask, it gives the location of leakage. This will make the system complex but it will detect the leakage area accurately and hence will be used for human safety.

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