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Emotion Detection Using Facial Expression Recognition to Assist the Visually Impaired

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Abstract - *We are living in the most defining period of Human history and growing at a pace faster than ever before. This growth witnesses the participation of machines in making human life easier and thus there is an increased interaction with machines. As a matter of fact today a human interacts with a machine more than a fellow human being. Hence in the given scenario this project aims at providing machine the ability to understand the human emotion based on the facial expression. The project proposes to use austere machine learning algorithm to establish the result by dividing the project into broadly three stages. The three stages are recognised as face detection, facial data extraction followed by expression recognition.*

Key Words*: *Feature Extraction, Haar-cascade, Real-time video capture, Audio message

1. INTRODUCTION

For humans it is quite easy to understand an emotion but difficult for a computer or a machine to do so. The human emotions are broadly classified into seven categories Neutral, Happy, Fear, Sad, Surprise, Angry and Disgust. This project successfully detects four emotions specifically Neutral, Happy, Sad and Surprise. With the magnitude of development the human race is experiencing the need and the importance of automatic emotion recognition has increased. Facial expression is the most prominent indicator of the emotion possessed by human, other features of expression recognition being voice recognition, eye activity, heart rate monitoring, motion analysis etc. However, the facial expression is the best indicator and indeed a major sign of the emotion the human being is subjected to in the moment. The project is hardware implemented using the Raspberry pi 3b+ with a web-camera to capture the real time video for detection and classification the emotion being detected in the real time.

1.2 Objective and Scope of the Project

The machines are being integrated into the daily life of human beings at pace faster than ever before. In such a circumstance a machine capable of understanding the state of mind of an individual would be a welcome assistance. This information can indeed be extended to a plethora of fields, for example, the healthcare sector to aid the healthcare providers better quality of service to cater the needs of a patient unable to express his state of mind by explicit communication, this mode of machine based emotion detection can be used by retail workers to understand the customer feedback and therefore give a better quality of assistance.

All these instances successfully establish the scope of this project with a sole objective of successfully establishing the underlying human emotion by accurate determination of the facial expression.

1.3 Literature Survey

In conclusion of the literature survey carried out the team has narrowed down to use the machine learning algorithm of cascade classifier for location of the faces and eventually detect the emotion by making use of appropriate . As an addition to the existing system the team also evaluated the need of sending out an audio message of the detected emotion through facial expression which would aid in helping the visually impaired which eventually would cater for specially able people from all walks of life.

The decision to use machine learning based cascade algorithm is a conclusion drawn from the survey as it is an algorithm which identifies faces in an image/ real time video. This algorithm basically uses edge and line detection features proposed by Viola and Jones in their research paper "Rapid Object Detection using a Boosted Cascade of Simple Features" published in 2001. Cascade, the ML based algorithm makes use of a gargantuan amount of consisting of both positive and negative images. The said positive images are known to contain all the that is the subject of interest to the user while the negative are the images of all the entities that are of object the user doesn't wish to detect.

The face detection operation is performed by using a series of classifiers and algorithm which determines if the given image is positive (a human face in our case) or a negative image (not a human face). To achieve the desired precision of detection the classifier needs to be trained with around thousands of images with or without containing any face.

2. SYSTEM DESIGN

2.1 Block Diagram

Automatic facial expression recognition is a procedure performed by machine which can be broadly classified to consists the following steps:

1. Capturing the image via a web-camera

2. Pre-Processing of image: This stage subjects the input image to various processing like Reduction of noise, Conversion of image to Gray scale, Pixel Brightness Transformation

3. Detecting the faces in the real time scene: The system detects multiple faces in the scene and attempts to embark their location. This majorly is the input of the system as the ultimate motive is to detect the emotion

4. Facial Feature Extraction: This is the process of extracting facial features like mouth, nose, eyes, lips

5. Emotion classification : The detected faces are thus classified into the emotion as per training

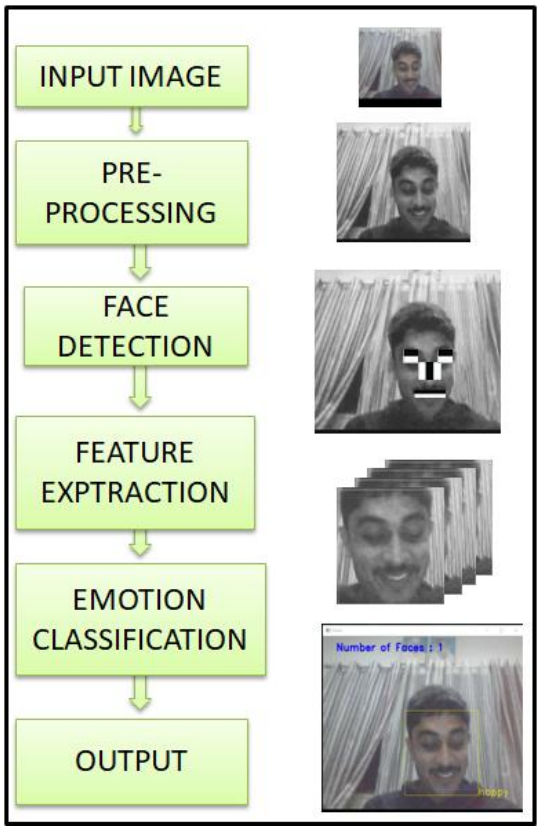

Fig 1: Block Diagram

2.2 Flow Diagram

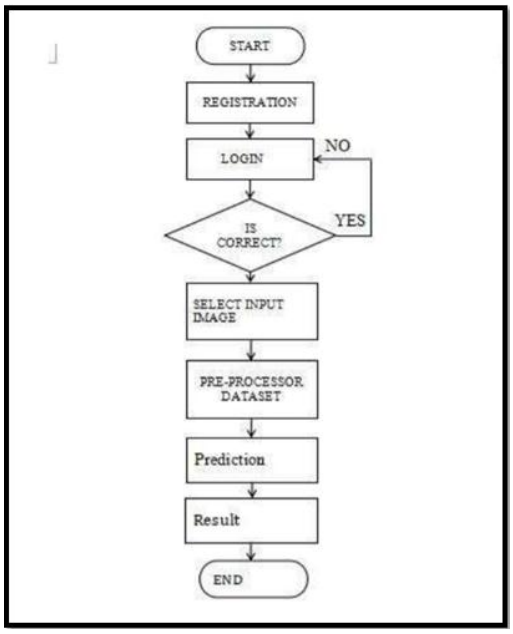

Fig 2: Flow Diagram of Designed System

3. SYSTEM ARCHITECTURE

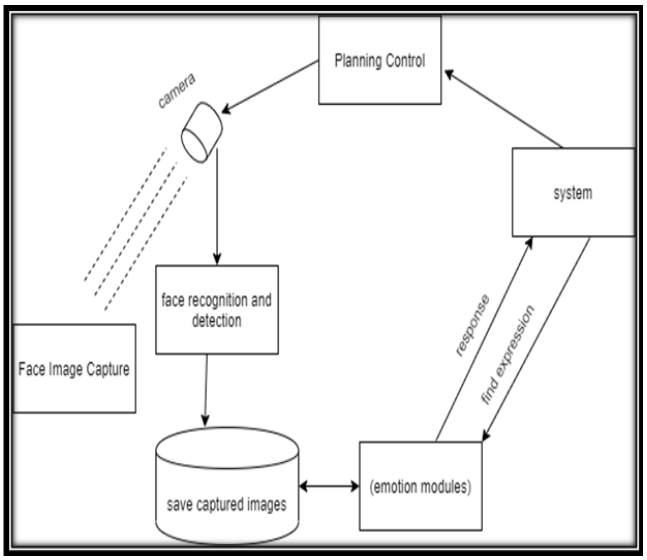

Fig 3: System Architecture

5. EXPERIMENTAL CONCLUSION

Emotion Happy	Table 1: Experiment Outcome For Happy Emotion Validation Dataset									
Database Image										
Truth Value	1	1	1	1	1	1	1	1	0	1
False Value	0	0	0	0	0	0	0	0	1	0
Detected Emotion	Happy	Happy	Happy	Happy	Happy	Happy	Happy	Happy	Neutral	Happy

A similar experiment is conducted for other four emotion detected by the system and the observed results are used to plot the confusion matrix for the multiclass data.

Actual / Predicted	Happy	Sad	Fear	Neural
Happy	**0.96**	0.1	0.12	0.06
Sad	0	**0.78**	0.08	0
Fear	0	0.04	**0.62**	0.02
Neutral	0.04	0.06	0.18	**0.92**

Table 2: Confusion Matrix

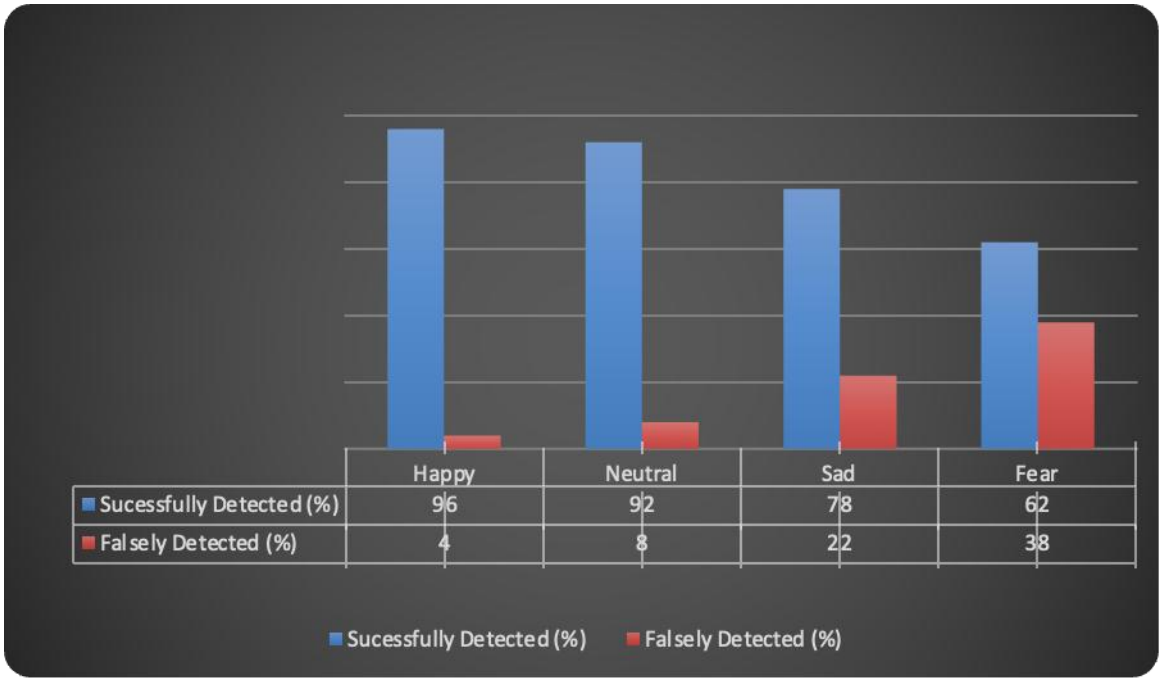

Fig 4: Graphical Representation of Confusion Matrix

Using the data obtained from the experimentation the team performed mathematical calculations as showm below to determine the accuracy, precision and recall value for the system.

Precision: Number of correctly predicted event out of all the considered events

Recall: Number of correctly predicted out of actual events

- $\text{Accuracy} = \frac{TP}{Entire\ Dataset} = \frac{0.96+0.78+0.62+0.92}{0.96+0.1+0.12+0.06+0.78+0.8+0.04+0.62+0.02+0.04+0.06+0.18+0.92} = 82.4\%$

- $P(H) = \frac{TP}{TP+FP} = \frac{0.96}{0.96+0.1+0.12+0.06} = 0.774$

$$\textbf{Av (P)} = \frac{\mathbf{P(H)+P(S)+P(F)+P(N)}}{\mathbf{4}} = \mathbf{83.98\%}$$

- $R(H) = \frac{TP}{TP+FN} = \frac{0.96}{0.96+0.04} = 0.96$

$$\textbf{Av(R)} = \frac{\mathbf{R(H)+R(S)+R(F)+R(N)}}{\mathbf{4}} = \mathbf{82.4\%}$$

6. CONCLUSIONS

The proposed system puts forth an accurate method for detection of emotion using machine learning approach by implementation of cascade classifier. This system differentiates itself from the others by giving an audio message of the detected emotion.

The project also successfully detects multiple images in real time in a single frame a gives out promising results. The designed system implements a simple strategy and thus helps in rapid recognition.

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