Face Tracking using MATLAB and Arduino

PoguVignan

B. Tech Scholar, Electronics and Communication Department, CMR Engineering College, Kandlakoya Village, Medchal Road, Hyderabad, Telangana 501401.

Abstract- This paper presents a real time facial feature tracking system employing an inexpensive imaging device and two servo motors, to control the pan and tilt of the camera, for face tracking to capture vital facial features. It has a potential for wide range of applications by integrating MATLAB and Arduino. The main objective of the project is to detect a human face in a web camera and the captured image is processed using MATLAB and to detect the faces and send signals to the Arduino board to control the movement of the camera using two servo motors. One servo for horizontal rotation and another for vertical rotation, face shall be tracked actively and maintained in the frame. The MATLAB code may also include some of the built in functions for the effective face detection and seamless tracking in real time environment. The system was tested on various indoor and outdoor environments and the method shows good robustness and accuracy with a success rate of 95.7%. The proposed method has the ability to track from a selection of facial parts in comparison to being confined to track only the face.

I.   INTRODUCTION

Object detection and tracking are important in many computer vision applications including activity detection, automotive safety, and surveillance [1]. A simple face tracking system is developed by dividing the tracking problem into three separate problems: Face detection in the frame, Initial facial features used for tracking, Face Tracking. Face detection in MATLAB can be done using many different existing algorithms [2]. These algorithms use different mechanisms to identify the facial features. Some use edge detection methods while some use contrast separation. Generally, it is used in object detection applications but, due to its capability of detecting facial features. The reason behind using MATLAB for image processing is due to its features with inbuilt tools and support for good range of hardware like Arduino and Raspberry Pi. In this project, Arduino Uno was used due to its simplicity and compatibility with the MATLAB [3]. Arduino hardware support package can be added to MATLAB via Add-Ons. The aim of this paper is to emphasize the use of object detection framework on human faces in real-time.

Automated face recognition is an interesting computer vision problem with many commercial and law enforcement applications. Mugshot matching, user verification and user access control, crowd surveillance, enhanced human computer interaction all become possible if an effective face recognition system can be implemented [4]. While research into this area dates back to the 1960's, it is only very recently that acceptable results have been obtained. However, face recognition is still an area of active research since a completely successful approach or model has not been proposed to solve the face recognition problem. The inadequacy of automated face recognition systems is especially apparent when compared to our own innate face recognition ability. We perform face recognition, an extremely complex visual task, almost instantaneously and our own recognition ability is far more robust than any computer's can hope to be. We can recognise a familiar individual under very adverse lighting conditions, from varying angles or viewpoints. Scaling differences (a face being near or far away), different backgrounds do not affect our ability to recognise faces and we can even recognise individuals with just a fraction of their face visible or even after several years have past.

II.   LITERATURE SURVEY

When the applications of image processing were emerging and the development was on the peak, the concept of object detection came out as a revolutionary idea. This was the first time when a visual concept was taken into consideration for the purpose of recognition. In object detection, well-defined objects such as cars, buildings can be detected in a still digital image[5].There are certain features in the image of the object that are invariant to the illumination, rotation and other parameters. If these features are identified using certain algorithm, and then filtered, give to us some stable points in an image which helps in recognition at later stages. Now these points become the basis for recognition because no matter how the objects are placed in what environment, they will be unaltered and always set of such points together gives an idea of the presence of objects and further matching process. The idea of edge matching was taken for the purpose of detection in the paper [5].In further research,[6]serial-communication embedded with Arduino gave efficient results. However, it failed to deliver efficient results in the case of objects without proper edges and standard shapes.

This idea was further carried with the detection of frontal of the human face. This surely had immense applications ahead of it. Main application was the recognition of face for security purposes, in crime branch and keeping the database. This was so far one of the best inventions of the era and many scholars wrote about various methods for better and efficient recognition, infact even now it is one of the very important topic in image processing.[7].The MATLAB graphical user interface developed atmosphere was the platform for the implementation where color plane conversion and multiple face detection technique based on Viola-Jones was implemented. Apart from that, there are various efficient methods in this regard. Finding faces in control background, by color, by motion, by the combination, by finding faces in unconstrained scenes are few of them. The process of using image processing for effective feature selection is discussed in [8] and [9].However in paper [7], the proposed technique does

not give the efficient result in matching. Also it does not detect more than one face, and most importantly the computational cost of the technique is too high for the implementation. It was difficult to implement it in real life at common places and there was a need of system which is common, affordable and efficient.

Moving on, the concept was stretched to face tracking in which the movement of the face can be detected by live video acquisition, taking the database as the reference [10].The research was based on a system that captures and detects faces at distances up to 30 centimeters with lighting conditions. However more efficient way was mentioned in [11] where Fusion technique gave increase in detection rate and reduction in the computation cost, all implemented on a low cost embedded systems. The average detection rate was 98.3 percent.

This was the time when the world accepted and appreciated it and the idea of closed-circuit television (CCTV) cameras, came into picture. They were installed everywhere including roads, public places, even houses and a team of security personnel constantly monitors it. It also records the tracking video for future references.[10] The method used in the paper[10] is the iterative Development model. It can be in two forms, the camera CCTV analog and the camera CCTV network where group of cameras are connected to the DVR or system directly. There are two ways in which the concept of CCTV can be implemented, first when the video is recorded and secondly when there is live video acquisition. In Live Video Acquisition, the camera captures the video having human face and detects the presence of human with the help of algorithm.

This system is used widely in surveillance process and security purposes.

However, apart from just tracking there are various other applications, one of them being the driver drowsiness system [12].The concept of Signal processing is implemented very well in this system. The webcam records the actions of the driver focusing on eyes and whenever the driver is sleepy or drowsy, it detects the changes in the segmented area which focused only eyes and afterwards a signal is generated which

might be in the form of alarm or anything vibration to alert the driver and wake him up. This is a very effective way of avoiding accidents as the cameras and the system work with equal efficiency even in nights. This ensures the constant monitoring of the driver's actions and preventing sleep. The whole process is based on the fragmentation of regions and analysing the situation based on the sum of results the system gets from the entire system.

For example, drowsiness is the collection of the driver yawning with eyes closed and many common and predictable facial movements and expressions. Hence by concatenating the results obtained by seeing the mouth region, eye region and other expressions, the system generates an alarm which finally wakens up the driver. To address the problems caused by illumination and postural changes a robust eye detection algorithm was introduced. It has many techniques and algorithm, one among them being the constant monitoring by a camera surmounted to capture the video of the driver driving constantly, focusing on eyes. If the eyes blink constantly [13],it generates a warning signal to notify the driver. Cascade object identifier from Vision toolbox of MATLAB is used in [13] giving good efficiency by proper programming. Also in [14] when implemented on embedded systems it gives more efficient results. This concept can reduce the risk of accidents by 20 percent and it is under implementation. However it needs lot more elaboration as it is not fully efficient and practically implementable.

III.   PROPOSED ALGORITHM

First the camera position is configured by the Arduino to the initial position. Then the camera provides the video input to the MATLAB. The MATLAB detects the face and sends the co-ordinates of the face to the Arduino. Basing on the principle of centroid the Arduino tracks the face. During tracking the face of the person that is detected is captured as an image by the MATLAB and the MATLAB uses face recognition algorithm for recognising the face detected. If there is a match then it shows the output as matched else it shows as not matched.
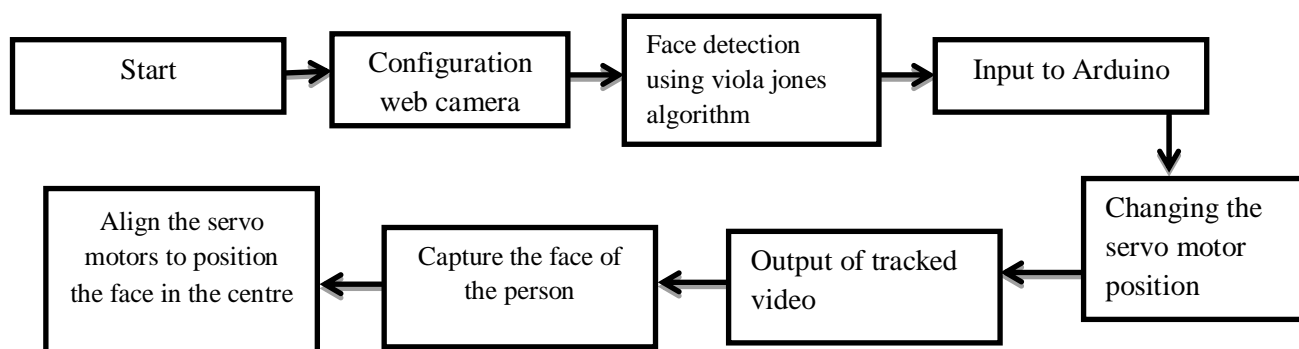
Fig.1: block diagram for face tracking using MATLAB and Arduino

Haar features:

Images are classified mainly on feature based systems because in feature based systems the computations required is less. For detection of face mainly two-rectangular features, three rectangular features and four rectangular features are used. These features are called HAAR features and are shown in figure (2).
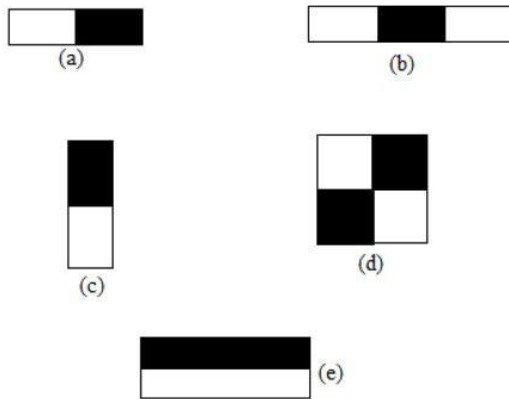

Fig.2: Haar Features

The features are calculated by simple addition and subtraction operation. The features are computed as the difference of sum of pixels in the black portion to the sum of pixels in the white portion. For any rectangular HAAR feature the features are calculated in the above procedure. This procedure is repeated for different types of HAAR rectangular masks and also by varying the size of the mask.

Face Detection

Initially the camera position is set and considered it as origin. Now after running the Viola Jones Algorithm the face is detected inthe real-time video which is taken from the camera and sends the coordinates of the face for tracking. Now initially the video inputis given to the MATLAB for face detection and inserts a bounding box around the face. The algorithm detects the face from thevideo and calculates the coordinates of the centroid of the box. These coordinates from the face are sent as input to the Arduino Unoboard. The camera is connected to two servos for pan and tilt of the camera. These servos are connected to the digital outputs of theArduino board and coordinates are given as input. The camera set position is taken as origin and four quadrants are formed. If thecoordinates are in a quadrant the Arduino board sends signals to the servos such the coordinates are again come back to the originposition. If the coordinates are on positive x-direction then the servo pans to the negative x-direction makes the coordinates to theorigin. Similarly, for tilting also, if the coordinates have varied x and y values then both pan and tilt servos work simultaneously toget the face in range. Thus, the tracking of image takes place by using the coordinates of the face sent by the MATLAB.
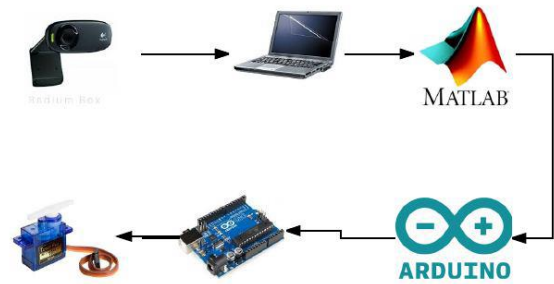

Fig.3: face tracking process

Arduino Uno

Arduino is an open-source electronics prototyping platform which can be used to develop interactive objects, taking input from a variety of switches or sensors, and controlling a variety of lights, motors and other physical outputs. Arduino can be programmed according to the user's requirement and used as a standalone system. The main advantages of using Arduino board are the board is inexpensive, used with cross-platform, programming environment is simple and clear and the software is open source and flexible to modify. The Figure below shows an Arduino Uno which is used in this system.

Fig.4: Arduino Uno

After developing the whole system, testing of face recognition algorithm and its communication with Arduino board has been tested. Arduino board is programmed such that when a board receives a character from the MATLAB, digital output pin or a board sets HIGH or LOW accordingly. LEDs are connected on this digital output ports and by receiving the signals from the MATLAB, they changes their states from ON to OFF and OFF to ON. Depending on the face recognized, digital output pins on Arduino board sets up HIGH or LOW accordingly.

DC Servo Motor

Servo Motors

Servo motors are generally an assembly of four things: a DC motor, a gearing set, a control circuit and a position-

sensor (usually a potentiometer). The position of servo motors can be controlled more precisely than those of standard DC motors, and they usually have three wires (power, ground & control). Power to servo motors is constantly applied, with the servo control circuit regulating the draw to drive the motor. Servo motors are designed for more specific tasks where position needs to be defined accurately such as controlling the rudder on a boat or moving a robotic arm or robot leg within a certain range. Servo motors do not rotate freely like a standard DC motor. Instead the angle of rotation is limited to 180 Degrees (or so) back and forth. Servo motors receive a control signal that represents an output position and applies power to the DC motor until the shaft turns to the correct position, determined by the position sensor. PWM is used for the control signal of servo motors. However, unlike DC motors it's the duration of the positive pulse that determines the position, rather than speed, of the servo shaft. A neutral pulse value dependent on the servo (usually around 1.5ms) keeps the servo shaft in the center position. Increasing that pulse value will make the servo turn clockwise, and a shorter pulse will turn the shaft anticlockwise. The servo control pulse is usually repeated every 20 milliseconds, essentially telling the servo where to go, even if that means remaining in the same position.

Fig.5: servo motor

Interfacing MATLAB with Arduino
To interface MATLAB with Arduino, certain Arduino libraries are downloaded in MATLAB IDE, this creates a Arduino to run in MATLAB environment. Communication of hand gesture algorithm with Arduino board is done through serial data transfer. To access the serial port of a computer using MATLAB, couple of lines of coding should be done. MATLAB function for serial port access is shown below.

ser =serial('COM18');

Here, COM18 is a serial communication port on which Arduino board is connected. Moreover, aprogram has to be uploaded to ATmega328P using Arduino IDE. This program makes serial communication port as an input port for the Arduino board.
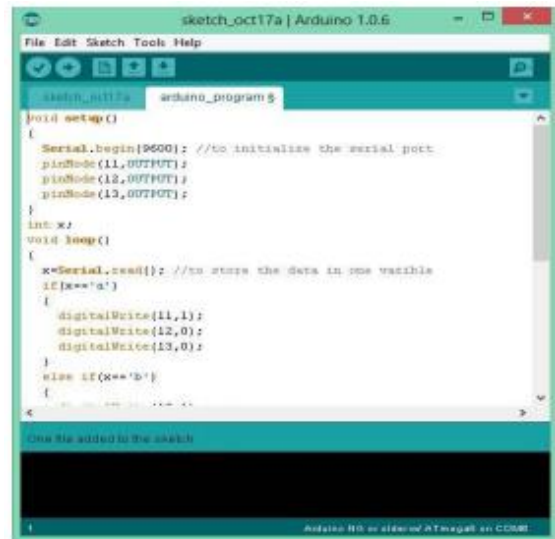

Fig.6: Arduino programming

IV.   RESULTS

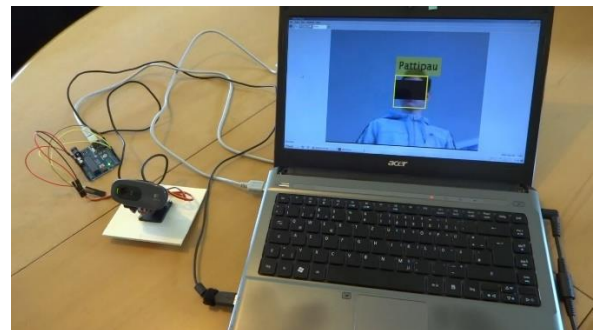Fig.7: hard ware connections servo motor to camera

Fig.8: output for face tracking

V.   CONCLUSIONS
In our work, the face detection and tracking is mainly based on the facial features.Thealgorithm used for face detection andtracking. It is done by usingMATLAB code, where Camera detects the face and tracking is done through the movement of camera using a ARDUINO. Next step is face recognition, where the detected and tracked face is recognized and it is matched it withavailable database-where set of images are already available with different expressions and conditions. If the match appearsbetween recognized image and image available in database then it

will display capture image is matched else it gives capture imageis not matched. We can implement this method in various places where security and video surveillance is highly essential. In thispaper we are restricted with basic laboratory conditions where the application part can be done with high costs.

VI.   REFERENCE

[1]. K. A. Joshi and D.G. Thakore, "A survey on moving object detection and tracking in video surveillance system," International Journal of Soft Computing and Engineering (IJSCE), ISSN: 2231-2307, Vol. 2, Issue 3, July 2012.

[2]. Marciniak T, Chmielewska A, Weychan R, Parzych M, Dabrowski A (2013) Influence of low resolution of images on reliability of face detection and recognition. Multimedia Tools Appl. doi: 10.1007/s11042-013-1568-8

[3]. Zulkifli SA, Hussin MN, Saad AS. MATLAB-Arduino as a low cost microcontroller for 3 phase inverter. 2014 IEEE Student Conference on Research and Development (SCOReD). BatuFerringhi. 2014: 1- 5.

[4]. S. J. Klum, H. Han, B. F. Klare, and A. K. Jain, "The FaceSketchID system: Matching facial composites to mugshots," IEEE Trans. Inf. Forensics Security, vol. 9, no. 12, pp. 2248–2263, Dec. 2014.

[5]. Pietroperona,JitendraMalik,"Scale-Space and edge Detection'',IEEE Transactions on Image processing,Vol 12 No 7,July 2010 .

[6]. Panth Shah, Tithi Vyas , "Interfacing of MATLAB with Arduino for Object Detection Algorithm Implementation using Serial Communication", IJERT, Vol. 3 issue 10, October 2014, ISSN :2278-0181.

[7]. DhanarIntan Surya Saputra, Kamal Miftahul Amin, "Face Detection and Tracking Using Live Video Acquisition in Camera Closed Circuit Television and Webcam", 2016 1st International Conference on Information Technology, Information Systems and Electrical Engineering(ICITISEE),Yogyakarta, Indonesia.

[8]. C. Gururaj, D Jayadevappa, Satish Tunga, "Content Based Image Retrieval System Implementation through Neural Network", IOSR Journal of VLSI and Signal Processing (IOSR-JVSP), Volume 6, Issue 3, Ver. 3 (May - June 2016), e-ISSN: 2319 – 4200, p-ISSN No.: 2319 – 4197, pp 42 – 47, DOI: 10.9790/4200-0603034247.

[9]. C. Gururaj, D Jayadevappa, Satish Tunga, "A Study of Different Content Based Image Retrieval Techniques", International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE), Volume 5, Issue 8, August 2016, e-ISSN: 2278 – 1021,p-ISSN No. : 2319 – 5940, pp 247 – 252, DOI:10.17148/IJARCCE.2016.5846.

[10]. AryuantoSoetedjo, I KomangSomawirata," Implementation of Face Detection and Tracking on A Low Cost Embedded System Using Fusion Technique", The 11th International Conference on Computer Science & Education (ICCSE 2016) August 23-25, 2016.

[11]. RudrakshYagnik, Ashish Jangid, Sachin Jain "A Practical Implementation of Face Detection byusing Viola Jones Algorithm in MATLAB GUIDE", IJERT Vol. 3 Issue 9, September- 2014.

[12]. Mr. Raees Ahmad, Prof. J.N. Borole, "Drowsy Driver Identification Using Eye Blink detection", (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 6 (1) , 2015,270-274.

[13]. Tianyi Hong, Huabiao Qin, "Drivers drowsiness detection in embedded system", Vehicular Electronics and Safety, 2007. ICVES.IEEE International Conference.

[14]. Wei Zhang, Bo Cheng, Yingzi Lin, "Driver Drowsiness Recognition Based on Computer Vision Technology", Tsinghua Science and Technology (Volume: 17, Issue:3,June,2012.

PoguVignan is a B. Tech Final Year student in electronics and communication Engineering from CMR Engineering college. Her subjects of interest are VLSI and Embedded systems.