

# Face Recognition and Tracking Using MATLAB and Arduino

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**Abstract:** Ever wanted to build a Face Tracking Robot by using MATLAB and Arduino and not any other programming like OpenCV, visual basics C# etc. Then read along, in this project we are going to implement face detection by blending in the power of Arduino and Android. In this project, the mobile camera will move along with your face with the help of servos. The advantage of using the Android Mobile Phone here is that we do not need to invest on a camera module and the whole image detection work can be done in the phone itself, we do not need your Arduino connected to your computer for this to work. Here we have used Bluetooth Module with Arduino to communicate with Mobile wirelessly.

**IndexTerms** – Arduino, Face Recognition, Face detection, Image tracking, MATLAB.

## I. INTRODUCTION

The revolutionized computers open up the chances of using images and video frames as an input signals of the signal processing. Such signal processing is named as image processing. Image processing transforms various sets of characteristics of image parameters into output as control signals. The constant revolution in the field of digital image processing opens up a multitude of application in various areas, in which innovative technologies could have been developed. The best platform on which many image processing algorithms have been developed so far is MATLAB. Major advantage of using MATLAB as an image processing algorithm development environment is its built-in image processing functions and its compatibility with hardware such as cameras, Arduino Raspberry Pie and many more.

The aim of this project is to propose a prototype model which both detects and tracks an object with distinct features and generates and sends a control signal to the hardware according to the position of the object. This proposed prototype system contains both software and hardware tools. Software includes MATLAB and Arduino IDE software whereas hardware includes Camera, Arduino board with AT mega 8 microcontroller and USB to RS232 TTL Converter Adapter Module PL2303HX. The goal of this work is to visually detect and track an object in a region and send the data to the Arduino board to glow LEDs connected with the microcontrollers digital output port. The most challenging issue raised while developing the object detection algorithm is that of selecting the feature to use for segmenting the object. Here, using approach based on object's shape is very difficult and less efficient with the system in real time constraints. So, rather using the segmentation by shape, the colour of an object has been taken into consideration. The colour of an object is a subject of its lightning condition.

## II. PROPOSED SYSTEM

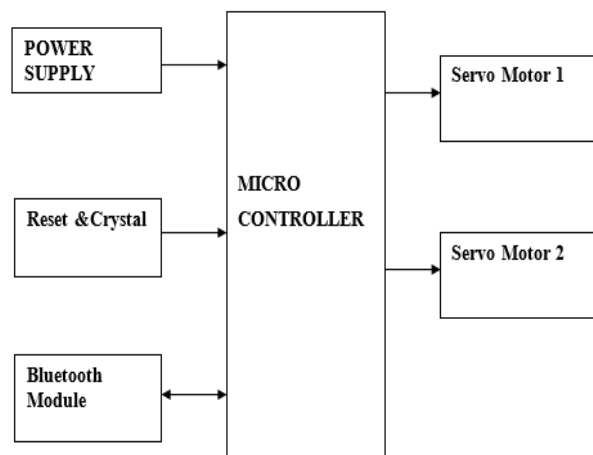


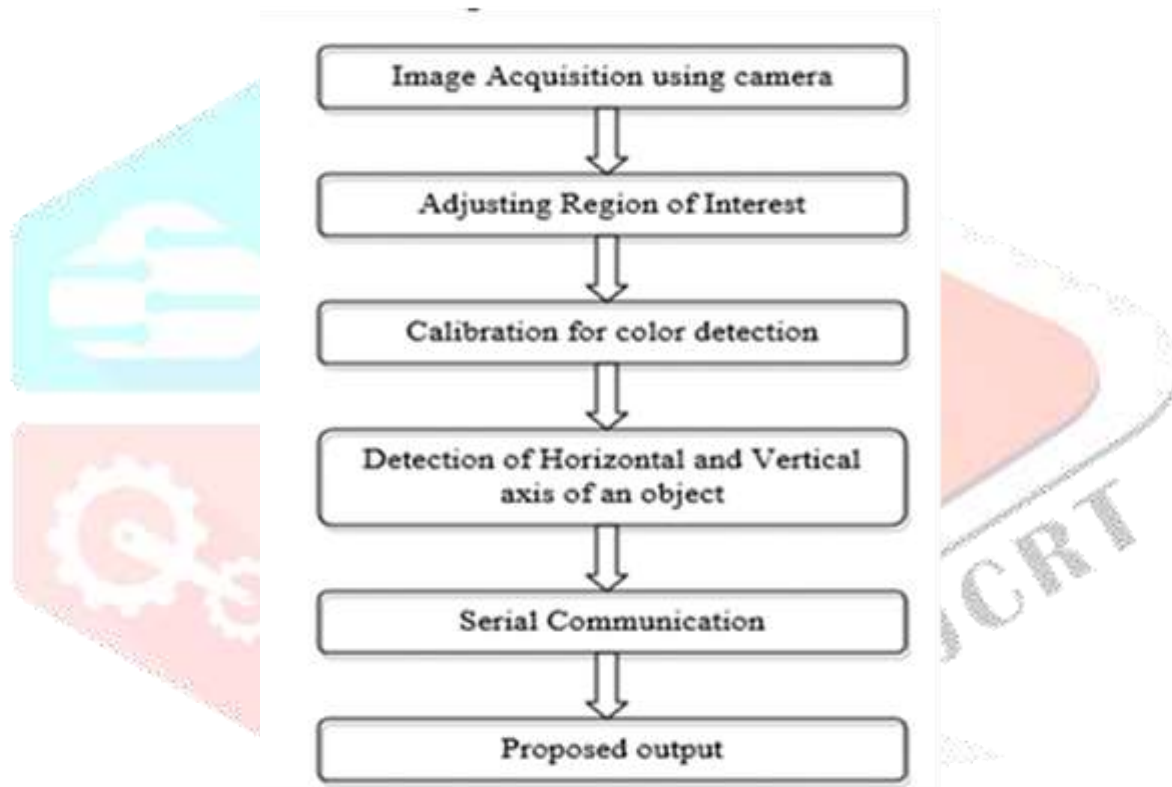
Figure -1: Block Diagram

Monitoring the motion of an object can be done by identifying and tracking distinct feature of the moving object such as color of that object. Here, a hardware set up is required which can be used as an image acquisition hardware such as camera. This camera is connected to a computer. Computer captures the video from the camera. An algorithm for object detection and tracking is written in MATLAB environment. This program detects the object in real time. Position of the object is tracked by referring its axis values which has been defined in the MATLAB program. Accordingly, control signal is generated and sent through serial communication to Arduino board. State of LEDs connected to digital output pin of ATMEGA 8 microcontroller shows the position of that detected object. USB to RS232 TTL Converter Adapter Module PL2303HX is used for the serial communication between Arduino board and computer. Experimental setup of this system is shown in below figure 1.

The proposed system consists of 3 modules. (A)Software Implementation, (B)Hardware Implementation and (C)Open CV Algorithm.

#### A. Software Implementation:

The entire algorithm for object detection and tracking is a base on image processing. The proposed system uses MATLAB as a platform on which image processing algorithm has been developed and tested. As an image acquisition devise, camera is used. A camera can be an in- built camera of laptop or it can be a USB camera as well. To get the detail of the hardware device interfaced with the computer, imaqhwinfocommand of MATLAB is used. Entire MATLAB program for this algorithm can be divided in parts as follows.



**Figure -2:** Flowchart of Proposed System

**Image acquisition:** The first task in image processing algorithm is to get the live video feed from the camera connected. This live video feed has further been converted into sequence of frames and these frames are used in order to apply further image processing algorithm. For that get snapshot command of MATLAB is used, which converts video feed into image array. Conditionally, ROI (Region of Interest) can also be defined for capturing specified area of the frame. Image acquisition toolbox of MATLAB can also be used for image acquisition purpose.

**Determining axis of an image:** In this section of an algorithm, an image is divided into sections using its parameters such as length and width. These parameters can be determined using size command of MATLAB. Following is the logic behind this algorithm.

$$x1=x/2-120; x2=x/2+120;$$

$$y1=y/2-30; y2=y/2+30;$$

Here, x is defined as X- axis and y is defined as Y- axis. The fundamental diagram of determination of these axis is shown below. The resolution of this image is 640x480.

## B. Hardware Implementation:

The Proposed system consists of Arduino Uno microcontroller, Camera, Bluetooth Module HC05, Servo motors.

**Arduino UNO:** The Arduino microcontroller is an easy to use yet powerful single board computer that has gained considerable traction in the hobby and professional market. The Arduino is open-source, which means hardware is reasonably priced and development software is free. This guide is for students in ME 2011, or students anywhere who are confronting the Arduino for the first time. For advanced Arduino users, prowl the web; there are lots of resources. The Arduino project was started in Italy to develop low cost hardware for interaction design. An overview is on the Arduino. The Arduino hardware comes in several flavors. In the United States, Sparkfun is a good source for Arduino hardware.



**Figure -3:** Arduino UNO

This guide covers the Arduino Uno board (Sparkfun DEV-09950, \$29.95), a good choice for students and educators. With the Arduino board, you can write programs and create interface circuits to read switches and other sensors, and to control motors and lights with very little effort. Many of the pictures and drawings in this guide were taken from the documentation on the Arduino site, the place to turn if you need more information. The Arduino section on the ME 2011 web site, covers more on interfacing the Arduino to the real world.

The boards feature serial communications interfaces, including USB on some modules, for loading programs from personal computers. For programming the micro controllers, the Arduino project provides an integrated development environment based on the processing project which includes support for the programming languages. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats and motion detectors.

An important feature of the Arduino is that you can create a control program on the host PC, download it to the Arduino and it will run automatically. Remove the USB cable connection to the PC, and the program will still run from the top each time you push the reset button. Remove the battery and put the Arduino board in a closet for six months. When you reconnect the battery, the last program you stored will run. This means that you connect the board to the host PC to develop and debug your program, but once that is done, you no longer need the PC to run the program.

**Bluetooth Module:** HC - 05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. The HC-05 Bluetooth Module can be used in a Master or Slave configuration, making it a great solution for wireless communication. This serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Blue core 04 - External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature).

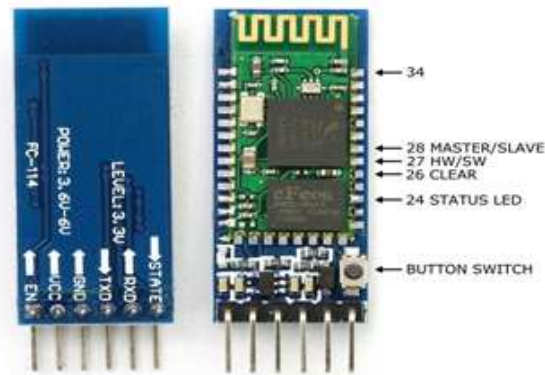


Figure -4: HC-05 Bluetooth Module

The Bluetooth module HC-05 is a MASTER/SLAVE module. By default, the factory setting is SLAVE. The Role of the module (Master or Slave) can be configured only by AT COMMANDS. The slave modules cannot initiate a connection to another Bluetooth device, but can accept connections. Master module can initiate a connection to other devices. The HC-05 Bluetooth module is show in above figure 4.

**Camera:** Here we use a smart phone as camera by connecting Bluetooth. HC-05 is used to interface the mobile to Arduino.

**Servo Motor:** A servo motor is a rotary actuator or motor that allows for a precise control in terms of angular position, acceleration and velocity, capabilities that a regular motor does not have. It makes use of a regular motor and pairs it with a sensor for position feedback. The controller is the most sophisticated part of the servo motor, as it is specifically designed for the purpose. Here we use servo motor to control the rotation of the mobile camera.



Figure -5: Servo Motor

### C. Using OpenCV with MATLAB

MATLAB and OpenCV are complementary tools for algorithm development, image and video analysis, and vision system design. MATLAB provides integration with OpenCV through the Open CV.

- Use and explore current research algorithms, whether they are implemented in MATLAB or OpenCV.
- Use OpenCV algorithms with the convenience of the data access, image acquisition, and visualization capabilities in MATLAB.
- Use MATLAB to explore, analyze, and debug designs that incorporate OpenCV algorithm.

**OpenCV algorithm:** Open CV (open source computer vision) is a popular computer vision library started by intel in 1999.the cross-platform library sets its focus on real time image processing and includes patent-free implementation of the latest computer vision algorithm.

OpenCV now comes with the very new face recognizer class for face recognition.it also show how to create the visualization we can find in many faces. Face recognition is a task for humans. How it will recognize the faces because of inner features (eyes, mouth, nose) or outer features head shape, hairline used for successful face recognition. Face recognition is all about extracting those meaningful features from an image. Face recognition based on the geometric features of faces probably the most intuitive approach to face recognition.one of the first automated face recognition system was described in kannade73.the recognition was performed by calculating

the Euclidean distance between feature vectors of a probe and reference image. Such a method is robust against changes in elimination by its nature but has huge drawback. The accurate recognition of the marker point is complicated, even with state of the art algorithm.

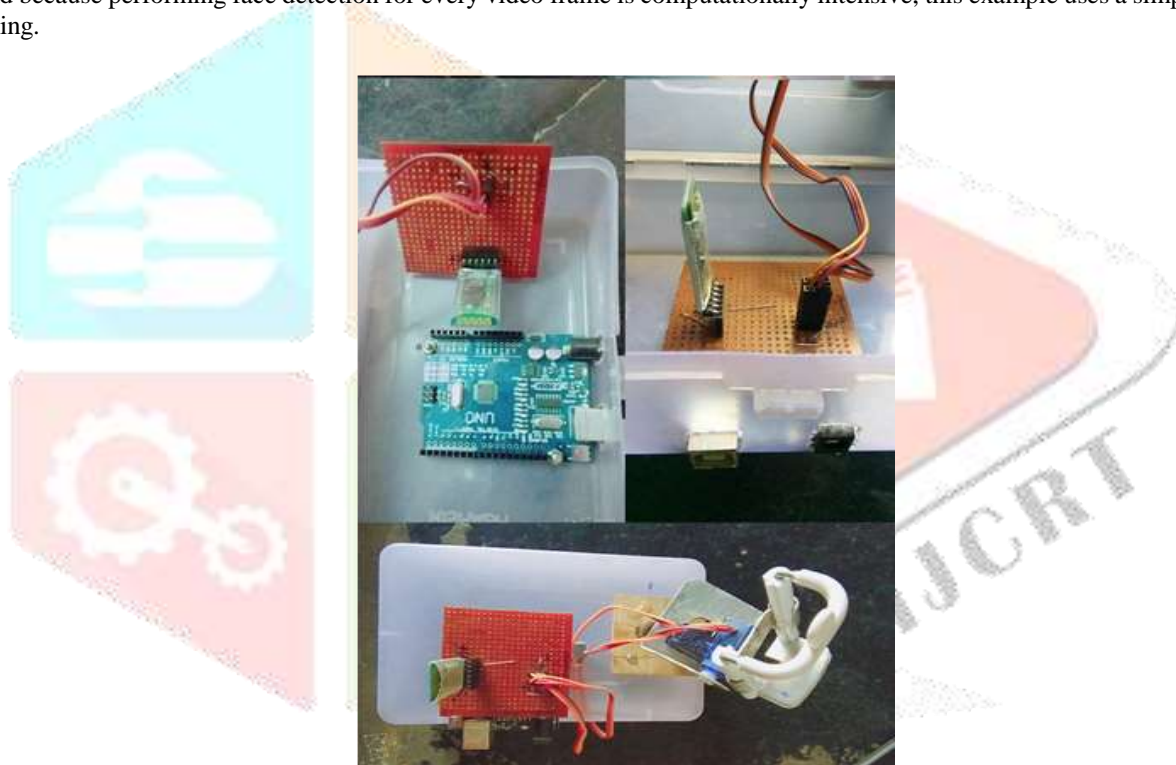
### III. EXPERIMENTAL RESULTS

Object detection and tracking are important in many computer vision applications including activity recognition, automotive safety, and surveillance. In this example, you will develop a simple face tracking system by dividing the tracking problem into three separate problems:

1. Detect a face to track
2. Identify facial features to track
3. Track the face

**Detect a Face to Track:** Before you begin tracking a face, you need to first detect it. Use the vision. Cascade Object Detector to detect the location of a face in a video frame. The cascade object detector uses the Viola-Jones detection algorithm and a trained classification model for detection. By default, the detector is configured to detect faces, but it can be configured for other object types.

You can use the cascade object detector to track a face across successive video frames. However, when the face tilts or the person turns their head, you may lose tracking. This limitation is due to the type of trained classification model used for detection. To avoid this issue, and because performing face detection for every video frame is computationally intensive, this example uses a simple facial feature for tracking.



**Figure -6:** Experimental Setup

**Identify Facial Features to Track:** Once the face is located in the video, the next step is to identify a feature that will help you track the face. For example, you can use the shape, texture, or colour. Choose a feature that is unique to the object and remains invariant even when the object moves. In this example, you use skin tone as the feature to track. The skin tone provides a good deal of contrast between the face and the background and does not change as the face rotates or moves.

**Track the Face:** With the skin tone selected as the feature to track, you can now use the vision. Histogram Based Tracker for tracking. The histogram-based tracker uses the Camshaft algorithm, which provides the capability to track an object using a histogram of pixel values. In this example, the Hue channel pixels are extracted from the nose region of the detected face. These pixels are used to initialize the histogram for the tracker. The example tracks the object over successive video frames using this histogram.

#### IV. CONCLUSION

The facial expression recognition system presented in this research work contributes a resilient face recognition model based on the mapping of behavioral characteristics with the physiological biometric characteristics. The physiological characteristics of the human face with relevance to various expressions such as happiness, sadness, fear, anger, surprise and disgust are associated with geometrical structures which restored as base matching template for the recognition system.

The behavioral aspect of this system relates the attitude behind different expressions as property base. The property bases are alienated as exposed and hidden category in genetic algorithmic genes. The gene training set evaluates the expressional uniqueness of individual faces and provide a resilient expressional recognition model in the field of biometric security.

#### V. FUTURE SCOPE

The use of spherical canonical images allows us to perform matching in the spherical harmonic transform domain, which does not require preliminary alignment of the images. The errors introduced by embedding into an expressional space with some predefined geometry are avoided. In this facial expression recognition setup, end-to-end processing comprises the face surface acquisition and reconstruction, smoothening, sub sampling to approximately 2500 points. Facial surface cropping measurement of large positions of distances between all the points using a parallelized parametric version is utilized.

The general experimental evaluation of the face expressional system guarantees better face recognition rates. Having examined techniques to cope with expression variation, in future it may be investigated in more depth about the face classification problem and optimal fusion of color and depth information. Further study can be laid down in the direction of allele of gene matching to the geometric factors of the facial expressions. The genetic property evolution framework for facial expressional system can be studied to suit the requirement of different security models such as criminal detection, governmental confidential security breaches etc.

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