Indian Journal of Data Communication and Networking (IJDCN)
ISSN: 2582-760X (Online), Volume-2 Issue-5, August 2022

Faceium–Face Tracking

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Abstract*: Human faces are identified and localized via facial detection, which ignores any backdrop objects like curtains, windows, trees, etc. Each frame of the video is run through multiple stages of classifiers in OpenCV's Harr cascade, and if the frame passes through each level, the face is considered to be present; otherwise, the frame is dismissed from the classifier, which means that the face is not detected. When an image is detected, OpenCV also returns the height and breadth of the picture along with its cartesian coordinates. The center coordinates of the image can be determined from these coordinates. When the face is detected, these coordinates are sent via the pyserial library to the Arduino UNO. The camera is attached to one of the servos that are connected to the Arduino to create a pan/tilt mechanism. The servo will align to move the face toward the center of the screen when its coordinates are off-center.

***Keywords*: Open CV, Harr Cascade, IoT, Pyserial Library**

I. INTRODUCTION

IoT or internet of things is an existence that rules out the digital world. An IoT refers to a physical object or a thing, connected wirelessly to the internet. It collects, exchange and organize data with other devices or system over the internet. Every IoT component comprises of a Unique identifier (UID) and transfer data without the intervention and control by an external force. IoT has emerged as one of the most useful subjects in recent times. Its wide variety of applications and abilities to perform a task in a comparatively more cost-efficient manner has attracted wide variety of developers and technology enthusiasts. IoT can be symbolized as an umbrella, everything under it creates a closed environment which enables it to communicate with each other in an easy and efficient manner. The components may include devices, sensors and other equipment's which possess the ability to communicate over a network, preferably in a wireless form.

A smart or digitalized environment enable us to identify people, detail their actions, and respond appropriately. Thus, one of the most important aspect in a digital world is a human identification system. One can identify a person by two means. One is to identify a person directly and corroborate it as a particular person and another is to identify by means of medical resources. Medical method includes DNA testing. It is very necessary to collect blood samples from a person who is in need to be identified and lot other procedures is required for a test. Identifying a person using medical methods is very time consuming and require a lot of man power. These procedures are not only time consuming but also expensive. It requires us to pay for these facilities which may prove to be costly if applied for a huge population. Comparatively identifying a person directly is much easier and cost efficient. In order to effectively work, identification process needed to be digitalized. A smart or digitalized environment enable us to identify people, detail their actions, and responds appropriately. Thus, one of the most important aspect in a digital world is a human identification system. This project FACEIUM is a convenient tool that can incorporate in many devices to detect human faces for tracking their movements.

The ability to detect and recognize human faces has been an important advancement in the field of information technology. Many systems utilize face recognition facility to enhance several features provided by them. Face tracking is done in order to detect a face from the camera in real-time and track the same face if it changes its position. The tracking here does not only refer to tracking the change within the frame, it also positions the camera or turns the camera according to the movement of the person. In other words, the camera itself moves in order to maintain the face in center of the frame so that it never misses the face. In existing systems, the face tracking is limited to objects which are present within the frame and the flexibility of moving camera to track the person is not much implemented.

The reason why this system is necessary is because this system can be integrated with much larger projects and can be used as an additional feature. Most of the face detection and analysis related projects can use this project and it gives them more time and visuals to run through the algorithms and code. Face tracking can also be effectively combined with recognition systems to improve identification of humans. This could change the way in which recognition is done. A frame could keep the face until it is done with all its calculation. This makes it suitable and very much compatible for real-time systems. The project experiences a lot of issues if the camera alone is not functional or fails to deliver a good quality image output. The face detection technique is completely depended on a camera. Thus, malfunctioning of a camera can lead to the failure of the project. The feed or output served by the camera that is in poor quality may also affect the face detection process. The recognition of a face depends upon the image size. The size of an image effects on how organized the face will be. If the image is in smaller size and coupled with larger distance causes less clarity and fails in identification as well.

The components that support the camera needs to be well fixed and functional in order to allow camera to work with most efficiency.

Manuscript received on 18 July 2022 | Revised Manuscript received on 05 August 2022 | Manuscript Accepted on 15 August 2022 | Manuscript published on 30 August 2022.

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The micro-servo on the other hand does the major task of controlling the movement, therefore the micro-servo must function well, its movement should not be restricted. If the movement of the servo is not smooth as expected, there might arise a problem regarding the identification of a face or a person.

The main objective of this project FACEIUM is to establish a face tracking device. The implementation of face tracking is done using an Arduino board, camera, micro-servo motor and OpenCV. This project allows us to detect and track all faces present in the video frame. The camera first detects a person and moves along with the person. It moves until it tracks the face in the center of the frame. The camera is placed on a micro-servo motor which ensures the positional feedbacks of the frame. Unlike other camera-based recognition systems, this project has a servo which moves the entire camera module placed upon it to align itself such that the face is at the center of the frame. In previous systems it is seen that the face is detected until it remains within the frame, but in this system the detected face is followed and tracked until all necessary actions are performed.

Kortli et al [5] describes in their paper about various characteristics that make facial recognition system useful. These characteristics include, the capability to work with both images and videos, the ability to process in real-time, the system remains robust in different lighting conditions, independently recognize a person regardless of his/her hair, ethnicity or gender and ability to work with faces captured from various angles.

The most common approach to track a human face is by using an OpenCV and Harr cascade classifiers. OpenCV using Harr cascade classifiers is efficient for an object or a face tracking method. Harr cascade classifier is a machine learning based program used for object detection. This classifier was developed by Paul Viola and Michael Jones. It uses a lot of images to train the classifier. It takes images with and without faces and compares them to build an identifying factor which it applies on the real-time camera feed to detect face. In the Harr cascade classifier, each frame is passed on through set of classifiers, if the face passes successfully from all of them, then it can be concluded that face is present, else face is absent.

Although face recognition is an exceptional advancement and has many applications and has vast and wide variety of areas where it can be implemented, it still has few factors that limit its capability. These include the image quality it receives as an input. The quality can to an extent restrict the operation by providing inaccurate results and leading to ineffectiveness. The images that possess much smaller size make it difficult to apply face recognition algorithms. Use of various face angles may affect the reliability of the face recognition. Another limiting factor is the data processing and storage capability. This can definitely limit usage of facial recognition technology.[7]

II. LITERATURE REVIEW

A. "Face Detection and Tracking"- Nikita Gupta, published in the year 2021 in Delhi, India

This paper [1] shows an approach for detecting face using java and OpenCV. This approach implements a system for face detection in respect of any background or in any lighting condition and to determine whether or not the face exist in the window. In order to do so the classifier itself is trained with face or non-face example-based learning techniques. This system operates in 2 modes- detection and tracking. When the face is detected, it marks the face corner points and switch to the tracking mode. when the number of points lost at a certain level the system fails in tracking and switches back to detection phase. The system mentioned in this project is user-friendly and cost-effective.

B. "Deep Learning based Real-time Face Tracking System in Multi-camera"- Mehmet F. Ozdemira, Davut Hanbaya published in the year 2022 in Malatya, Turkey.

Even though the face detection and tracking has become popular the implementation of face identification system in multiple cameras is very challenging. In this paper [2] a real-time deep learning-based face tracking system in multiple cameras was established. This system uses an SCRFD model which can be used for face detection, and an updated Deep SORT algorithm is used for face tracking as well. ArcFace is used for efficient face recognition. This paper provides us a cost-effective way to design a system that can very much efficiently detect a face and track the movement of the person according to his/her movement. It uses an approach that makes it much more stable.

C. "Real-Time Face Mask Detection Model using Python"- Dr. V. Geetha, Bhavaraju Pavan, Chebolu Sai Kiran, Dr C K Gomathy published in 2022 in Tamil Nadu, India.

This paper [3] describes a real-face mask detection model was implemented for detecting people wearing face mask or not. In this model the system has been trained with datasets that contains 4000 images and another to validate the accuracy of the model. Here Face mask detection machine was build using a Convolution Neutral Network (CNN) which is a deep learning technique and this CNN model is build using a tensor flow system and OpenCV library.

III. METHODOLOGY

The Faceium system functions using an Arduino UNO board, a USB camera and 2 micro-servos. These 3 components contribute the maximum in functioning of the system. The USB camera allows us to fetch the live camera feed, the micro servo acts as a base for the camera and allow camera to position itself sideways according to the movement of the person. This system uses OpenCV library of the python programming language. OpenCV library is an enormous open-source library which supports machine learning, image processing and real-time based tasks. OpenCV is used to process images and videos in order to identify different objects within the image or video.

Along with OpenCV Haar Cascade classifier is required in order to complete the face recognition and tracking task. The Haar classifier is used identify a human face.

Neetu Saini et al [4] in her paper describes face detection as task of localizing faces within the images which are sent or inputted to the system. It is a fundamental part of any face processing system. It allows us to detect human face and also perform various operations which utilize the detected face. The Haar cascade passes each frame of the video through a set of classifiers, if the frame completely passes, then the face is considered to be present. The classifier is itself built by training several images with or without faces. The unique feature is found out by the classifier which is used to further identify face in a given image.

The OpenCV actually returns the coordinates of image once face is detected, which include its height and width. These coordinates are used to calculate the central coordinates using he formula: x+width/2 and y+height/2. The obtained coordinates are sent over to the Arduino UNO using Pyserial library. The micro servo motor provides the movement/tilt which allows to move the camera, as the camera is attached to the micro servo. The face needs to be always at the center of the frame, so whenever the object moves, the servo aligns the camera in such a way that the face is always in the center of the frame.

The camera is attached to the vertically moving servo. There is another servo which allows movement in horizontal manner. This horizontally moving servo is attached to the shaft of vertically moving servo. The servo is connected to the Arduino board. Since it uses 2 servo motors, an additional power supply is also required. This process is repeated in real-time which gives us real-time view and tracking of face. The camera feed is taken out live and face is detected, if the object is moving, the camera moves accordingly such that it continues to get a view of the face. The next part of this project is the face recognition section. Initially, it is important that several sets of faces are trained so that the face recognition feature can be made much more functional and accurate. The pictures of people are placed in separate folders. The name of each folder is set to the name of the person whose photos are present in that folder. Once we obtain all necessary photos, the program is trained using these images and as an output, a file is created. This file consists of the trained data and labels, which is simply the name of people whose images were used for training, this data is encoded to make sure it is kept safe and secure and is further used for the recognition part of the program. Once the face is seen in the camera feed, the file data is utilized to recognize the face and a prediction is performed. Thus, a live face recognition feature is obtained.

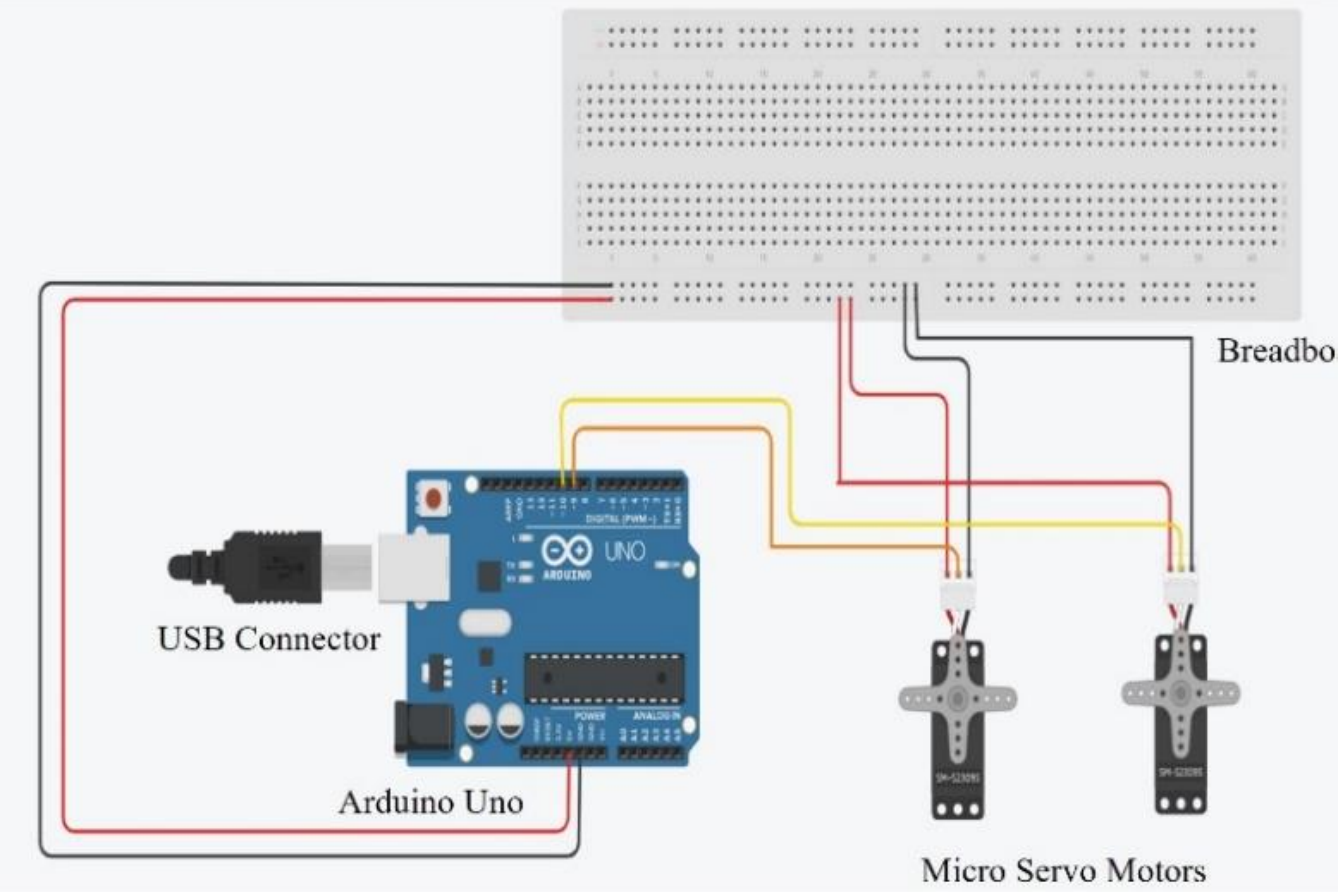

Fig. 1. Schematic Diagram of Facieum [6].

IV. FUTURE ENHANCEMENT

Currently the Faceium is capable of identifying the human face and tracking the face according to the movement of the face. It also has an additional face recognition feature. It uses the trained sets of data to identify and recognize the face shown in the real time camera feed. It uses an yml file to store the trained data. The trained data is nothing but several images of people separated in individual folders with the folder name containing the name of the person. The program accesses each folder and processes each image individually and writes the corresponding training output to an yml file.

Similarly, all folders in this directory are taken and all images within these folders are accessed to train the system with the given faces. The name of each folder is written into a separate file as a dictionary with key as an id and value as the name of the folder which is the name of the face owner. This system can be further expanded by adding an additional module which is the attendance system. The live feed will be able to identify faces using the camera and it will recognize and mark the attendance automatically. This allows us to mark attendance without the need of manually checking and marking attendance for every individual. Though this add on feature is really great, the accuracy of recognizing and identifying faces completely depends upon the trained images. The accuracy directly depends upon the number of images used to train. Greater the number of images, better is the accuracy.

V. CONCLUSION

This project not only describes an effective feature that can be considered useful in more than one domain, it also has the possibility of various extensions which can make this project useful in many environments. Faceium tries to establish an effective face tracking and recognition system that can decrease the number of cameras required for surveillance and other activities. Instead of multiple cameras, such a camera can provide a much wider area to cover as its servo motors allow rotation of the camera based on the movement of faces detected in the camera. Therefore, the chances of developing blind spots is less. Apart from surveillance it can have various extensions and can also be used to institutions for attendance marking.

DECLARATION

Funding/ Grants/ Financial Support	No, I did not receive.
Conflicts of Interest/ Competing Interests	No conflicts of interest to the best of our knowledge.
Ethical Approval and Consent to Participate	No, the article does not require ethical approval and consent to participate with evidence.
Availability of Data and Material/ Data Access Statement	Not relevant.
Authors Contributions	All authors have equal participation in this article.

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Jufin P A is currently pursuing Masters of Science in Computer Science from St. Albert's College (Autonomous), Kochi. Prior to this, she completed her Bachelor of Science degree in Computer Science. She has a wide range of interests ranging from IoT, python and Machine learning.

Amrutha N joined Department of Computer Science, St. Albert's College (Autonomous), Kochi as Assistant Professor in 2021 July. She graduated in B-Tech Information Technology in 2017. She completed her post-graduation in M-Tech Computer Science & Engineering in 2019. She holds a patent in the year 2021 entitled as Intelligent IoT based smart irrigation system using cloud computing. Her major areas of Interests include Security and Cloud Computing.