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An Intelligent Faculty Tracking and Attendance Marking System using Machine Learning

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Abstract*: In the current era, machine learning and IoT have grown vastly and is one of the most important technologies used today. It has various applications like automated systems, driverless cars, fire alarming system, etc. In this project we are going to implement an intelligent attendance marking system and how to track a faculty in school/college using face detection, i.e., by using machine learning algorithm for attendance marking and using RFID, IP camera, GPS technology for tracking the location of the faculty in the school/college. This system consists of two modules of operations. The first module is the attendance marking module and the second module is tracking the location. This system checks for the location of the faculty when the user enters the name to be searched in the app. The system first checks for the faculty in closed areas like the classroom, canteen, library, etc. and then open areas like the ground, parking area, etc. If the faculty's location is not identified then the system checks the attendance data and informs whether the faculty is absent or not to the user. This methodology has many future scopes. If the machine contains precise data it becomes less time-consuming, it can improve its accuracy and produce exact results and it can reduce the human effort. It can replace the biometric system for attendance marking.

Keywords *: Human Tracking, Haar Algorithm, Intelligent Attendance Marking System, Radio Frequency Identification (RFID), Global Positioning System (GPS), Internet Protocol (IP) Camera.*

I. INTRODUCTION

Humans can without much stretch recognize and distinguish objects present in an image. The human system is swift and exceptionally precise and can perform difficult tasks like distinguishing objects and recognize obstacles with little idea. With the accessibility of lot of information, quicker Graphical Processor Unit (GPU), and better algorithms, we would now be able to prepare computers to identify and classify multiple objects within an image with a high measure of accuracy.Face detection technology has bought in attention due to its huge application value and market potential, such as face recognition and video surveillance system and can be used for detection purposes. This paper introduces a new approach that can be used to detect the current location of a faculty who is present in the College/School so that the amount of time used to find them using traditional methods can be reduced by a huge amount. In traditional approaches Faculty, Students or any Staff who wants to search for a particular Faculty or Staff, searches them either by walking all around the campus, which will consume a whole lot of time or by calling them on their cell phone, which can cost us some amount of money or data charges of each calling. In order to solve this problem we have introduced a system which can be used to detect and say the current position of the intended faculty by using either object detection or GPS tracking system or by RFID methods in which the current position of each faculty is determined and is updated every minute so that the system works efficiently and save us a good amount of time.

In the traditional approach, there is no single device mechanism to find where a particular faculty is present and finding his/her location and marking the attendance. But many visual tracking, human tracking methods are present for tracking and detecting objects and persons.

Multiple Object Tracking (MOT):Using online tracking as Binary Quadratic Programming, For MOT in crowded places can be done using online tracking. MOT with attention to Appearance, Structure, Motion, and Size. In this approach, according to the motion, appearance, structure, and size of the object, a dissimilarity measure is defined. The dissimilarity measure is then used in the Hungarian Algorithm for tracking the object. MOT across Non-Overlapping Cameras, Segmentation System and local object detection are used in tracking within a single camera. The segmentation result and Single-Camera Tracking (SCT) results are used as an input in Inter (Multiple) Camera Tracking. It is done to associate the tracks belonging to the identity.

Activity Recognition: A 3D CNN based method is used for fall detection. It uses video information to train the feature extractor and a Long Short-Term Memory (LSTM) to train the classifier and obtaining the fall detection (activity recognition) using Deep Learning.

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Global Positioning System (GPS) using RFID: Using GPS, the real-time position of the person in the open area can be identified. Radio Frequency Identification (RFID) is used to detect the position of the person inside the room or building.

Smart Attendance System: In this approach, to recognize various targets, they use a smart attendance system to distinguish the individual characteristics of each person using RFID. It uses fingerprint for recognition and k-means clustering for recognizing targets with similar features. Thus, attendance is marked.

Our proposed system aims to address the following critical issues:

1. To design a model or architecture for tracking and finding the location of the faculty in the campus/school with cost-effectiveness and efficiency.
2. To implement a system that would mark the attendance of the faculty.

The main objectives of the proposed system are:

- To mark the attendance of the faculty.
- To identify the location of the faculty inside the campus.
- To track the faculty using object detection.
- To design a web application to show the status of the faculty.

So we are proposing an efficient and cost effective model to implement the above mentioned objectives.

II. LITERATURE REVIEW

We have analyzed about 15 related works about attendance management system and face detection methods and the summary of all is provided below. The analytical and detailed study shows that there exists a lot of gap between the theoretical models and real-time models.

Abdel pakey et al. [1] have discussed two blocks: 1) tracking block and 2) trajectory analysis and recovery block. In the first block, a tracker manager is used to control, manage, and compile the result from different built-in and plug-in trackers. The second block consists of three main steps 1) trajectory analysis of forwarding/backward tracklet, 2) a robustness score calculation, 3) and a reporter mechanism. The training block processes video frames which consist of two trackers forward and backward trajectory. The output is then sent to the second block that is trajectory analysis and recovery block. The reporter mechanism consists of particle filter and template matching and works when the threshold value is less than 0.65 which is used to activate particles.

K..Hui Lee et al. [2] have indicated the Intelligent Transportation System (ITS) use in mobile vision. They mainly use video analysis for autonomous platforms. Human tracking is the most important task in a versatile vision for making an intelligent independent system. To track humans efficiently a 3-D based tracking scheme needs to be applied. So, this paper discussed the ground-moving platform based human tracking system. The V-SLAM framework followed a standard adjustment formulation, where they take only the points between the consecutive frames, which processed by the RANSAC algorithm. So, based on this 3-D information they used Constrained Multiple Kernel (CMK), which will be used to resolve occlusion of human tracking.

W.S.Yuwono et al. [3] have discussed the human detection feature on surveillance on an IP camera, generally, an IP camera is used to record data that is saved by the surveillance camera to any other activities. A traditional camera system is a non-notification object when anything wrong happens, and also when the room is dark the capturing of the image is highly difficult and inefficient. This system was proposed to solve these problems by implementing an IP embedded surveillance camera. In this system, the night vision mode is attached in the camera so that the night vision is made possible and capturing of image is efficient. The IP protocol technology made it easier for them to record data without any difficulty. The embedded camera contains an embedded computer for human detection processing and then sends a notification to the owner.

Xiang Wang et al. [4] introduced a framework which preserves object boundaries and the multi-scale context called RegionNet, which generates saliency score for each region. features and is extracted by RoI pooling layers. Edge saliency is preserved by using a mask-based RoI pooling. First, the image is portioned into regions using superpixels and edges. Produce a region mask with the similar size of the image to record the locale index, and downsample it by multiple times and put it into the RoI pooling layer. During the RoI pooling stage features inside the RoI are pooled into fixed scale H×W, the systems generate the saliency score of regions to frame the saliency map of the image.

Jianan Li et al. [5] introduces an object recognition design comprises of a cascade of various CNN networks, which centers on weakly-supervised semantic segmentation, proposal generation, and recursive detection refinement. To produce convolutional feature maps the input image is passed through convolutional and max-pooling layers. From the convolutional feature maps, the semantic segmentation network learns semantic features for the entire image. To generate candidate object proposals the highlights are then bolstered into the proposal generation network.

Yunhyang Shen et al. [6], discussed an object localization called OPG (Object-Specific Pixel Gradient Map). It is trained by using image-level annotations. Initially extract an OPG map to find the individual contributions of individual pixels to an object category. To improve localization accuracy a novel average and max-pooling layer are introduced. OPG improves detection speed.

Guanbin Li et al. [7], discussed the Cross-Modal Attention (CMAC) framework, which consists of an attention-based model for adaptive contextual information and the information is incorporated into a region-based CNN.CMAC contains a fine-grained object part attention module to harness multiple discriminative object parts. By improving the accuracy of RGB-D object detection it provides an interpretable visualization scheme.

Mubarak Shah et al. [8], proposed Binary Quadratic Programming for the online Tracking of hundreds of people in crowded scenes. In this method, they use a tracker to detect people in crowded scenes efficiently and formulate the individual information of the target in the form of appearance, motion, neighborhood motion, pairwise spatial relationship, and pairwise group information.

They formulate online tracking as Binary Quadratic Programming. It uses Frank-Wolfe optimization. It reduces computational complexity so that it can easily handle a large number of people. Handuo Zhang et al. [9], proposed Multiple Object Tracking with attention to appearance, structure, motion, and size. It is used to track uniquely each target in a video.

It uses the concept of Tracking by Detection. They defined a dissimilarity measure based on the object's appearance, structure, movement, and size. The dissimilarity measure is calculated and uniqueness esteems are used in the Hungarian Algorithm. It addresses false detection. It runs in real-time following an online approach.

Jenq-Neng Hwang et al. [10], proposed Online Learning-based Human Tracking across Non-overlapping cameras. It presents a novel approach to track each individual target using a single camera and multiple cameras. It uses a Segmentation system, 2 phase feature extractor, and an online learning-based camera. It improves the robustness of the algorithm by using local object detection with multiple kernel feedback. This methodology is scalable by a fully unsupervised online learning framework.

Jinbo Song et al. [11], proposed Deep learning for fall detection using the 3D convolutional neural network (CNN) with LSTM. It is important in the case of public healthcare. Timely detection is very helpful to instantly delivering the medical service. A 3-Dimensional CNN is used for fall detection. It uses video information to train the feature extractor. To locate the region LSTM is used to train the classifier with the dataset. It has high accuracy as 100%.

Q Miao et al. [12] have discussed a smart attendance system that uses RFID (Radio Frequency Identification) technology to mark the attendance of the faculties in school/college. This model also uses a frequency distribution histogram and a K-means algorithm.

Daniel Patricko Hutabarat et al. [13]have discussed a system using RFID technology and IP cameras for tracking humans in a closed area by providing rooms or building information that is entered. The system is designed using an RFID reader, RFID tags, IP Camera, the database server and Android smartphones. GPS tracking system can be used in open areas but it can't be used in closed areas, so RFID and IP cameras are used.

Hendry Hendry et al. [14] have discussed a system that combines the features of the RFID and GPS technology for tracking humans in open and closed areas. For indoor area, an RFID reader was introduced in each room and the user should tap his/her RFID tag so as to be recognized. Nonetheless, GPS would automatically recognize the position of the user whatever point he/she left the room. Both GPS and RFID would work all the while to track the position of the user. The system was developed as a real-time system.

Mashhood sajid et al. [15] , have discussed replacing biometric by using facial recognition since it will have minimum flaws because all the features of a human being are distinct from each other. Since the normal attendance marking system is time-consuming that is by using paper and pen and attendance systems using biometrics is costly. In this method, they have said that this method can reduce the human effort and save some amount of cost. This method consists of two databases in which one is used to storing the datasets and the other one to mark the attendance. Consist of a camera that captures the image and filters it, which is then compared with the images in the storage database.

By studying and analyzing the above works, we have found out the following gaps for further research. There is no single model available that uses the combination of RFID, GPS, IP Cameras and machine learning algorithms for facial detection. Our aim is to address this gap by implementing an efficient and effective system.

III. PROPOSED SYSTEM METHODOLOGY

The proposed system uses machine learning techniques to track the faculty location in the campus. The system functional requirements are listed below. When the user (in this case Student/Staff/Faculty) wants to know where a particular person is, then they will be provided by an option in the application to find out the location of that particular person using RFID, GPS, Object detection and Face recognition methods.

Functional Requirements for user class are:

Provides User ID: Before searching, the user has to enter his unique ID in the application provided for validation. The system proceeds to the next step after the validation step. If the user passes the validation process, then the user is able to find the location of the Faculty.

Provides the name to be searched: User needs to enter the name of the faculty in the search box in web application being provided to find the location of the faculty. The system will give the result as the location of the faculty after the identification of the faculty.

Functional requirements for Administrator user are:

When the user provides ID for validation, the administrator checks the user's ID. Administrator stores the registered user's information in the database. The administrator performs the calculation according to that information in the database.

Non-Functional Requirements of our proposed system are provided below:

Performance Requirements: The performance requirements of the system are that it should be highly accurate, provide the correct results to the user and should work at all conditions.

Safety Requirements: The power supply is a necessary attribute, so we need to be careful while handling the electric power, since the system requires an uninterrupted power supply. The data are stored in the database, so it should be updated at regular intervals. The data is very important for the system's performance. The server should run without any interruption.

Security Requirements: Only permitted users should use the system. In this case, only students/Faculty/Staff are given access to use the system. The system is for registered users alone. The user needs to enter their ID(College) for authentication.

Software Quality Attributes: The Software System is easy to use, it provides fast and accurate results, easy to maintain and store the data.

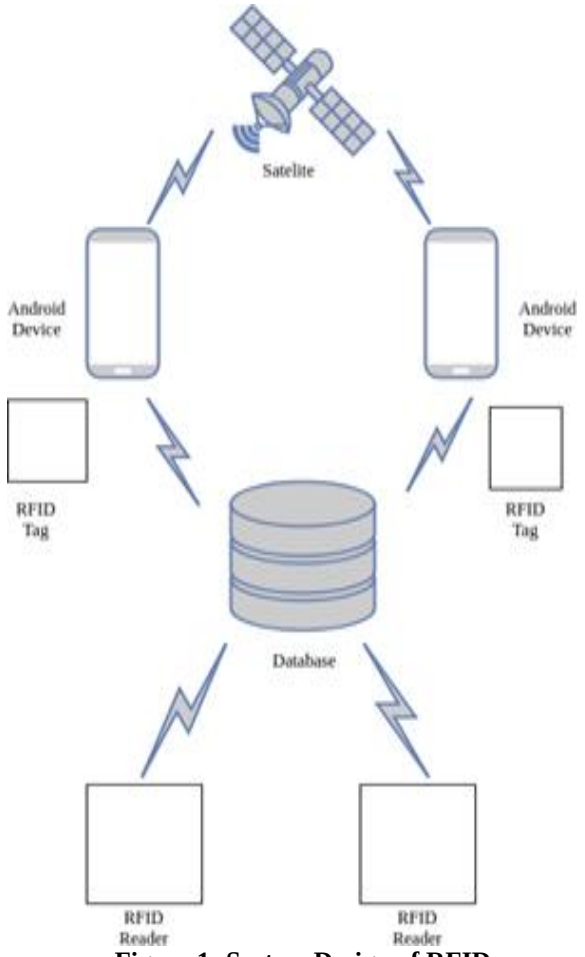

Figure 1: System Design of RFID

Human Tracking using RFID and GPS: The proposed system consists of RFID and GPS, here tracking is used in indoor and outdoor areas. RFID is used for indoor tracking and GPS is for outdoor tracking. For indoor tracking RFID reader is installed in each room, users get identified only if they tap their RFID tag. User ID (UID) is verified through the database server. When it is valid, the position of the user is displayed to the smartphone by RFID. When the user leaves the room or the user is 3m away from the room, the RFID turns off and GPS automatically turns on and thereafter GPS trace the position of the user. The smartphone should support Android Debug Bridge (ADB) integration. During UID verification GPIO (General Purpose Input Output) helps in faster transmission from the RFID reader to the server. If the verification procedure is valid, the RFID reader sends the time and position of the user of *the server. Data is provided by Google through G*oogle maps

Human Tracking using RFID and IP cameras: Here RFID and IP cameras are using to track Faculty in the closed area**,** which means tracking inside the building. The entire building consists of several cameras. Each room should consist of at least one camera. Using an IP camera, it is easy to detect Faculty when they appear on the camera. Here the main parts of the system are:

1. IP camera
2. RFID reader and tag
3. Android phone
4. Network and Server

RFID tags have a particular serial number. Each Faculty will have a RFID tag. And each RFID device is having a serial number. The RFID reader is used to read the serial number of both the tags and the devices and it sends the collected information to the server through the network. The functionality of RFID is like, the faculty needs to tap the RFID reader with their RFID tag during entering and leaving from a room. This process is helpful to determine the location. While tapping the RFID reader, the system gets the information about which RFID reader is used. This information is stored on the server. The RFID devices are communicating through the network.

If this system is used in a college, those students and staff who are in the college can use this to find the location of the faculty. Since they are registered previously in the system, the user needs to enter his ID before searching for the location. The system will check whether the entered ID by the user is valid or not. Only after validating the user can proceed to the next step of this procedure. The system is working according to the college map being provided. The result is in the form of the name of the place which is provided on the map.

Facial recognition is currently done by using biometric software which analyses facial patterns of the face. Since it has gained wide gain recognition in all fields, it has now gained importance in the attendance management system. The earlier system uses biometric or RFID or Eigen-value methods.

In this proposed method, we are going to use the histogram method which should have a huge number of positive as well as negative images in order to train the classifier. The system mainly consists of 4 parts:

1. Image Capturing
2. Face Segmentation
3. Face Recognition
4. Update-Database

Image Capturing

Takes the image using a camera, takes a certain number of pictures in a certain interval of time and is uploaded.

Face Segmentation

Here we segment each person's face by using the Haar cascade algorithm in which the segmentation is achieved and coordinate points are marked. Haar cascade algorithm uses features like edge, line, four rectangles.

Face Recognition

We use the histogram algorithm for face identification which similarly in all light situations and considered the most effective feature of this algorithm.

Update-Database

If the captured image of a faculty is presented in the database then the attendance is marked and is updated in the database which is viewed by the concerned authority

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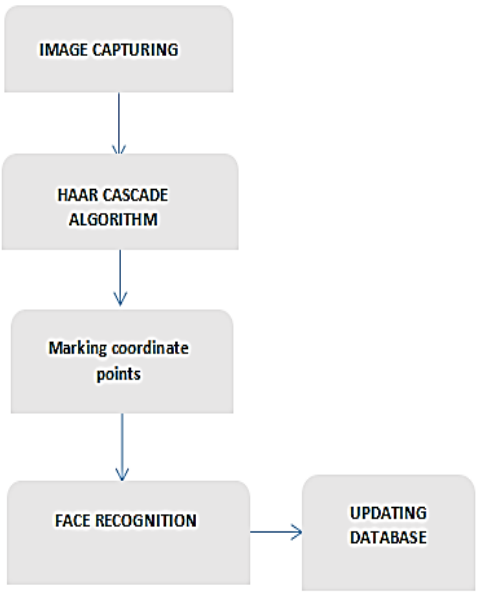

Figure 2: Architecture of face detection

The proposed System Modules are discussed below:

A. Registration Module

The registration process [19] is done by the administrator. Administrator enters the details of the predefined users. Administrator enters the Name, roll no, email id, the designation of the users. The administrator creates the profile vector for each user and stores it in the database. Here roll number acts the unique ID for validating the user.

B. Validation Module

When the user enters their user ID, the system calculates the Euclidean distance between the login vector and the user's profile vector.

C. Attendance Marking Module

Using the Face detection algorithm, the attendance of the faculty gets marked. The time and date also get stored when the Faculty gets detected by the camera.

D. Tracking Module

In this module, the tracking is based on two procedures. Tracking in open area and tracking in a closed area. Tracking in the open area is by using GPS. Tracking in a closed area (inside building/room) is by RFID and IP cameras. When the user enters the name of the faculty to be searched in the application, the system first uses Tracking in closed area procedure. If the faculty did not appear in the closed area cameras and RFID readers [16,17,18] then the system uses racking in open area procedure. When the system tracks the location of the faculty, the result is given to the user. The tracking procedure is based on the map of the area given to the system.

Algorithm

Face Detection algorithm:

Step 1: Capture the image using a camera and upload the image

Step 2: Segment the face from the captured image and detect the face using a haar cascade algorithm.

Step 3: Identify the face using a trained dataset by histogram values.

Step 4: If the faculty details are present in the database then mark the attendance.

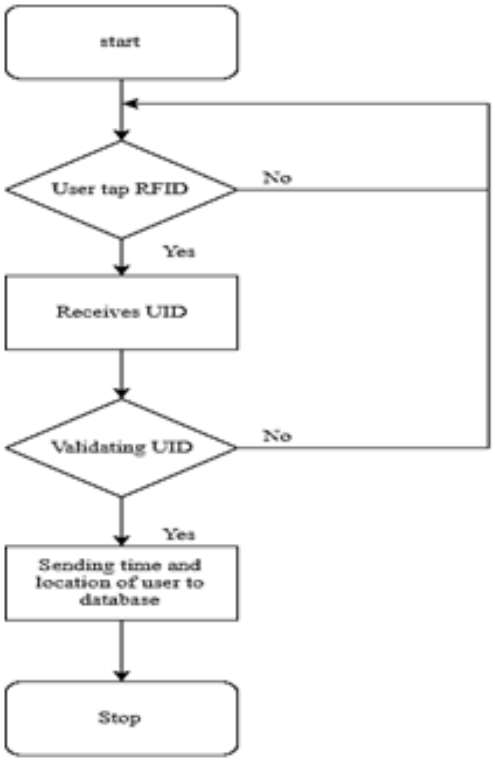

Figure 3: RFID System Flow chart

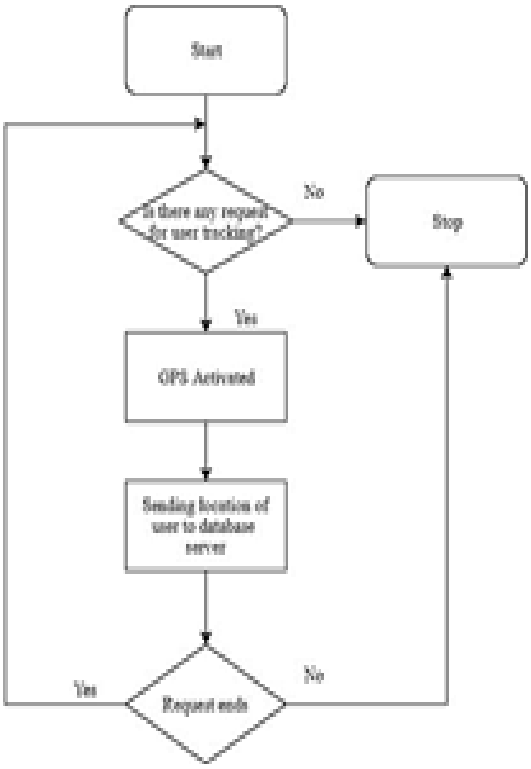

Figure 4: Flow chart of RFID

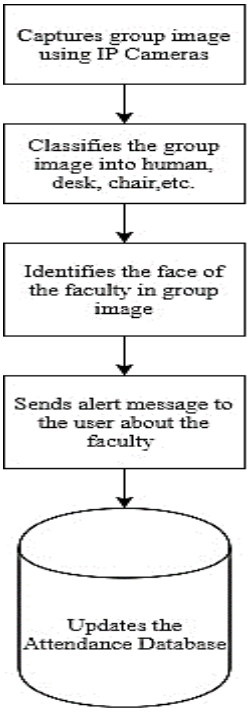

Figure 5: Work flow

IV. SYSTEM IMPLEMENTATION & RESULTS

We have implemented the proposed system for indoor and outdoor areas using RFID, which is provided with the identity card of the user and GPS which will be tracked from the registered mobile number. Indoor areas tracking is achieved using RFID [20,21] and the latter one is used for outdoor tracking. Every user is tracked using the user id (UID) which is verified with the database, when it is valid the position of the user is displayed to the smartphone by RFID.

When the user leaves the room or an indoor area and if he's 3m away, the GPS turns on and traces the position of the user. The GPS [22] data is retrieved from the Google maps which helps in providing the exact location of the user

The IP cameras which are installed in the indoor areas are also to track the location of a user. Here the user who have registered earlier will have their details stored in the server. While the IP camera reads the face using face recognition system, it matches with the details present in the server along the RFID read data [23], if found the details are given to the requested user.

Code sample used for haar cascade algorithm is provided below.

```
import numpy as np
import cv2face_cascade =
cv2.CascadeClassifier("haarcascade_frontal
face_default.xml")
eye_cascade =
cv2.CascadeClassifier("haarcascade_eye.xml
")img = cv2.imread("image.jpg")
gray = cv2.cvtColor(img,
cv2.COLOR_BGR2GRAY)faces =
face_cascade.detectMultiScale(gray, 1.3, 5)
for (x,y,w,h) in faces:
img =
cv2.rectangle(img,(x,y),(x+w,y+h),(255,0,0
),2)
roi_gray = gray[y:y+h, x:x+w]
roi_color = img[y:y+h, x:x+w]
eyes =
eye_cascade.detectMultiScale(roi_gray)
for (ex,ey,ew,eh) in eyes:
cv2.rectangle(roi_color,(ex,ey),(ex+ew,ey+
eh),(0,255,0),2)cv2.imshow('img',img)
cv2.waitKey(0)
cv2.destroyAllWindows()
```

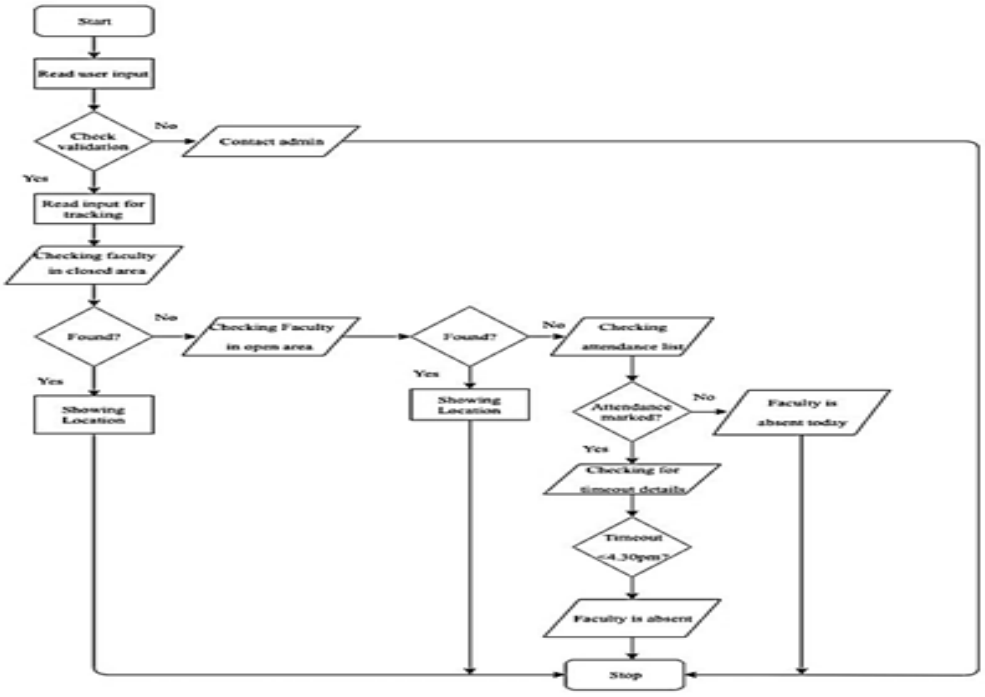

Figure 5: Overall Flow Chart of the Proposed System

The attendance marking system is achieved using the facial data collected from the IP camera, this is done by checking the data which is already present in the biometric system. If the user has not marked attendance, the system will automatically mark the attendance along with the date and time of tracking of the user.

V. CONCLUSION & FUTURE WORK

Human tracking in different aspects where developed in many systems but the main drawback was it won't be able to trace and track in all the possible manners which are in existence. Our proposed intelligent system track using all the possibilities that are necessary for human tracking thereby providing complete access to the particular person wherever he is to required user who may be a student or an employer or by a firm. Our future work is extend this proposed method so that it could be useful anywhere human tracking is needed.

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