A Survey on RFID based Indoor Student Positioning System using Face Recognition System

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Abstract—In today's world regularity of student's attendance is concerned in the administration of Educational Institutions. Overall academic performance is affected due to poor attendance which further results in detention list. Currently student's attendances are marked by using attendance sheet provided by the faculty members in the classroom, which consumes lot of time and a completely manual process. The proposed system for student's attendance system integrates RFID reader along with Face recognition system. RFID readers would be installed at various locations in campus and also in classes along with cameras for face recognition. When student comes in the vicinity of reader then location can be found which will send that location to the server. Server checks the timetable of that student if he/ she will not attend lecture according to timetable then notification will be send to the admin. This system ensures that attendance record of the students would be maintained properly and efficiently. The system may also generate detention list of the students. It is small scale automated application, which is easy to control as well as time saving and reliable.

Key words: Drift Removal (DR), Indoor Positioning, Radio Frequency Identification (RFID), Face Recognition, Kalman Filtering DR

I. INTRODUCTION

Attendances of each and every student are being maintained by every school, colleges and university. Faculty has to maintain appropriate and proper record for the attendance. The manual attendance record system is not efficient as it takes a lot of time to arrange record and to calculate the average attendance of each student. Hence there is a need of a system which will solve the issue of student record arrangement and student average attendance calculation. The proposed system should store the student's attendance record in digital format so that managing attendance becomes easy task.

Old traditional methods for student attendance are still used by most of the universities and institutes. As these methods are used, many students help their friends by marking their attendance in case of their absence in the institute. So while these methods are used, attendance records are evaluated and maintained manually by the faculty to know the student attendance list. The faculty has to take attendance once again in case if the attendance sheet is lost and therefore absent students gets a chance to mark their presence in new sheet.

This procedure, besides being tedious for lecturer, it even affects student as time is consumed on signing, verifying and then submitting the attendance sheet. Therefore, an automated computerized system can be developed that would manage and help the staff members to maintain and mark the attendance easily. The faculty can easily access this system as it is simple. Handling and management of student attendance data needs to be taken care by the system so that the manual work of student attendance can be avoided. The system would automatically analyze all the data once it gets updated.

A. Why RFID?

In 1940s RFID was invented by Charles Walton. For the decades following this invention scientist and scholars pondered the possibilities of using this technology. RFID is a combination of radar and radio broadcast technology. However, global positioning system (GPS), the most popular outdoor positioning system, nowadays, is poor and unsuitable for indoor positioning applications because of its line-of-sight nature. In the past decade, numerous research activities and commercial solutions to radio indoor positioning systems for complementation of GPS have been emerging. Among manifold radio indoor positioning systems, active radio frequency identification (RFID) is more promising than infrared, ultrasonic, and Wi-Fi. Because infrared indoor positioning system has limitations of line-of-sight inherence and short detection range, but RFID indoor positioning system does not. Ultrasonic indoor positioning system takes more expensive infrastructure and deployment cost than RFID indoor positioning system. Wi-Fi indoor positioning system also consumes more power dissipation and deployment cost in brand new buildings or factories than RFID indoor positioning system. Because the aforementioned radio indoor positioning systems are essentially originated from wireless sensor networking (WSN) technology, their localization granularity and accuracy are alike so that performance comparison on them is unnecessarily addressed. However, all of the following proposed techniques for RFID indoor positioning system in this paper can also be applied to the other types of radio indoor positioning systems. In addition, NFC and passive RFID technologies cannot be taken into consideration, because the very short detection range of NFC and passive RFID, mostly within 10 cm, prevents themselves from performing trilateration or multilateration for location estimation (LE) of the radio indoor positioning system.

B. Why Face Recognition?

Now a day's person identification is one of the most important building blocks for the attendance system. If we implement only RFID based attendance system, then the possibilities of false entries means proxies may increase. In conventional attendance system one can easily make his friends attendance by giving his sign in his absence. Rather in RFID based attendance system on can easily enter others attendance in his absence by using his tag.

Biometric-based techniques proves to be more promising techniques for recognizing individual, instead of

authenticating people and granting them access to physical and virtual domains based on passwords, PINs, smart cards, tokens, keys and so forth. These methods examine an individual's behavioral and physical characteristics in order to determine his or her identity. But the passwords and PINs are hard to remember and can be guessed or stolen.

So here person identification plays vital role. Amongst the person recognition methods, face recognition is recognized to be the most ordinary ones, as the face modality is a method that uses to identify people in day to day lives. Although other methods, such as fingerprint identification, can provide improved performance, still those are not appropriate for natural smart interactions due to their protruding nature. In comparison, face recognition provides passive description that is the person to be identified does not need to cooperate or take any specific action. Means it does not need to interact with the reader directly, it will done automatically.

II. RELATED WORK

A. Conventional Attendance System

In most of the universities or schools the attendance is maintained using the attendance sheets. The students sign on their respective roll numbers and the attendance is marked. This attendance is further marked into registers by the respective faculties. The main problem in this method is that this process consumes much more time and makes disturbance in the ongoing lecture. Also the possibilities of the false entries mean the proxies increase. Students may mark their friend sign while marking their own attendance. So it decrease the efficiency. It also maximizes the efforts of faculties to mark that attendance again in registers from attendance sheets.

B. RFID Based Attendance System

The other mostly used attendance system is RFID based attendance system. This system is mostly used in companies to maintain the employee's attendance. Mostly in this system the passive type RFID is used. When one wants to mark his attendance, he holds his tag near to the reader. When it comes in reader's vicinity then the tag gets activated by the transmitted waves from reader and retransmits the information stored in it. But the problem with this system is that the passive RFID has very short range. So you have to take care that your tag punched successfully. It will be inefficient for some times. Due to very short range (10-15 cm) the passive RFID tags cannot be used for location estimation.

C. Biometric Attendance System

1) Fingerprints:

Fingerprints are the science of identifying individuals by their physical characteristics. It is the most widely used economical user authentication technique which deals with human finger impressions. It is generally seen in areas such as government sectors, educational institutions, industrial fields, etc. The finger impressions are captured by the friction ridges of human fingers when human interacts with finger print recognition system.

a) Advantages:
- It has very high accuracy.
- It is globally used biometric user authentication application.
- It is very easy to use.
- To store the finger templates within the system, a less amount of storage space is required.

b) Disadvantages:
- It is intrusive.
- It can make mistakes with the dryness or irregularity of the finger's skin due to varying age (especially in children).
- This system sometimes requires not just the fingerprint of user but also a valid pin, which proves to be more difficult to use than traditional systems.

D. Face Recognition:

Face recognition is the science of identifying individuals by their behavioral characteristics. The most famous example of a face recognition demonstrated by 'Kohonen' is that a simple neural net could perform face recognition for aligned and normalized face images. The type of network he occupied computed a face description by approximating the eigenvectors of the face image's autocorrelation matrix; these eigenvectors are now known as `eigenfaces.' There are many existing systems to identify faces and recognize them. But the systems are not so efficient to have automated face detection, identification and recognition. As image is a complex high dimension (3D) matrix and processing matrix operation is not so fast and up to mark. Hence, this directs us to handle with enormous image database and focus on the new algorithms which are more real-time and more active with maximum interest of accuracy which are further discussed in our proposed systems. In our existing systems, face recognition is done on the basis of still image i.e. Frontal face capturing. Generally, face recognition for such still images can be categorized into three main groups as follows:
- Holistic Approach: In this, the entire face portion is taken as an input in face detection system to perform face recognition.
- Feature-based Approach: In this, local features on face like nose, eyes and lip corners are segmented and then given to face detection system to easier the task of face recognition.
- Hybrid Approach: In this approach both local features and the whole face is used as an input to face detection system.

The basic overall face recognition model looks like the one below:

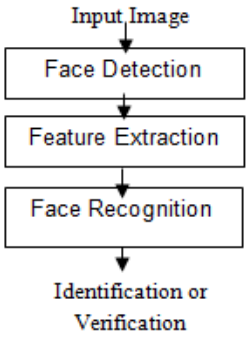

Fig. 1: Basic Block Flow Diagram of Face Recognition.

III. PROPOSED SYSTEM

The basic idea of proposed system as shown in Fig.2 is a generic application design to automate and enhance the manual work of recording and reporting in real-time, the Time and Attendance System in universities. A Log is maintained in the Database. Log contains RFID Tag Id and Captured Image by Camera. If both Student Id fetched from RFID Tag and Captured Image is matched, presence is marked as "Present" else it is marked as "Absent".

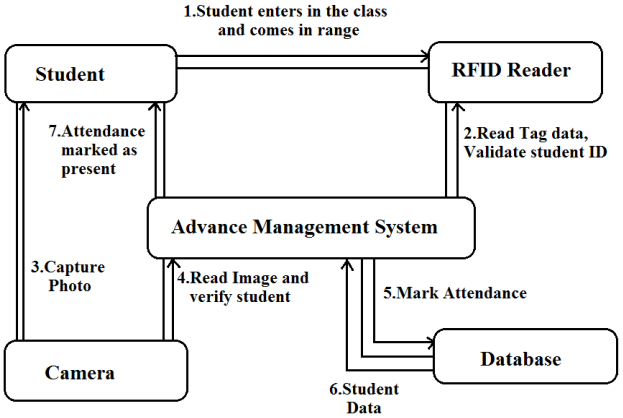

Fig. 2: Notion of Proposed system

A. RFID

RFID is the technology used to transfer data with the use of electromagnetic fields and for the purpose of detecting and tracking the tags attached to the objects. Electronic information is stored in the tags. Some of the tags are mechanized by electromagnetic induction from the magnetic field composed near the reader. Some types gather energy from the examined radio waves and act as a passive transponder.

1) Kalman-Filter Drift Removal

In 1960, Rudolf E. Kalman developed a recursive solution to the discrete-data linear filtering problem known as discrete Kalman filter. Kalman filtering has many diverse applications as in aerospace, marine navigation, nuclear power plant, instrumentation, demographic modelling, manufacturing and so on. A Kalman filter is an optimal estimator i.e. it infers results from indirect, inaccurate and uncertain observations. It is recursive so that new measurements can be processed as they arrive. The Kalman filter is a set of mathematical equations that provides an efficient recursive means, if the noise is Gaussian, to estimate the state of process by minimizing the mean of squared errors. It is an effective and versatile process which combines noisy sensor outputs to estimate the state of a system with uncertain dynamics. If the noise is not Gaussian i.e. given only the mean and standard deviation of noise, the Kalman filter is the best linear estimator. This paper studies the basic linear Kalman filter which is enough to solve the RSSI Drift issue at stage of DR and improve the subsequent RSSI-to-distance transformation issue at the stage of DM. The main mathematical equations of the basic linear Kalman filter can be expressed as (1)-(5) after some simplifications. Based on these five recursive mathematical equations of the basic linear Kalman filter, this paper proposes Kalman-filter DR method.

$$X(k|k-1) = X(k-1|k-1) \quad (1)$$

$$P(k|k-1) = P(k-1|k-1)+Q(k) \quad (2)$$

$$X(k|k) = X(k|k-1)+K(k)(Z(k)-X(k|k-1)) \quad (3)$$

$$K(k) = P(k|k-1)/(P(k|kj-1)+R(k)) \quad (4)$$

$$P(k|k) = (1-K(k))P(k|k-1) \quad (5)$$

Where $X(k|k-1)$ represents a posteriori state estimate at time k given measurements until time $k-1$, and $X(k-1|k-1)$ represents a posteriori state estimate at time $k-1$ given measurements until time $k-1$. $P(k|k-1)$ means a posteriori error covariance matrix at time k given measurements until time $k-1$. $Z(k)$ is the measurement result at time k. $Q(k)$ and $R(k)$ are the covariance of process noise and measurement noise, respectively. $K(k)$ implies the optimal Kalman gain.

RSSI represents the relationship between transmitted and received powers. It is useful to figure out the distance of separation between a transmitter and receiver when a good portion of electromagnetic wave propagates in a line-of-sight (LOS) link.

Fig. 3 shows the flowchart of proposed Kalman-filter DR and proposed linear-like RSSI-to-distance transformation for the stages of DR and DM, respectively. In Fig. 8, the variable, RSSI_DR, represents drift-free RSSI input raw data through Kalman-filter DR. RSSI_DR must be reset to 0 after the stage of DM is finished or RSSI input raw data are omitted frequently because of poor LQI. In addition, note that two RSSI-to-distance transformation functions to construct the linear-like RSSI-to-distance transformation are applied when drift-free RSSI input raw data is higher than 124 and that is lower than 124, respectively.

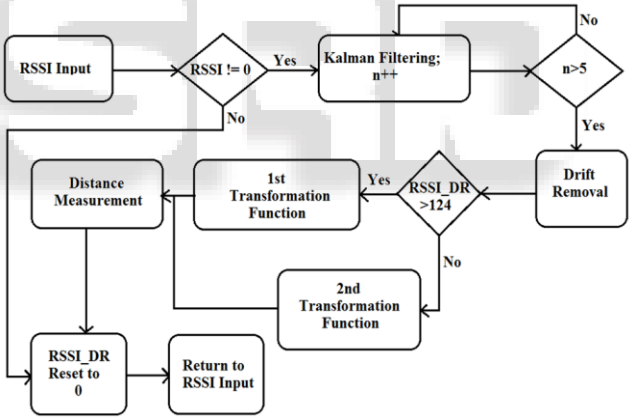

Fig. 3: Flowchart of Kalman-filter DR and linear-like RSSI-to-distance transformation.

B. Face Recognition

Face detection is one of the most challenging problems in the image processing because of variations in scale of the image, location, orientation, pose (frontal, side-view), facial expression, occlusion and lighting condition present which may change the overall appearance of faces in the image. In our proposed system we are using three techniques together to efficiently recognize the face. These techniques are as follows:

- Blob Analysis
- Haar Classifiers
- Edge Detection Algorithm

1) Blob Analysis

A first step of any face processing system is to identify the locations in images where faces are present. Blob analysis to detect presence of face from an still color image after segmentation with chromatic rules using YCbCr color

space, as HSV color components gives lower reliability in complex background and RGB components suffers with changes in the lightning conditions. During blob analysis, the width to height ratio of human face as well as the eccentricity of the blob is taken under consideration. This technique provides good results in single upright frontal face based still color image.

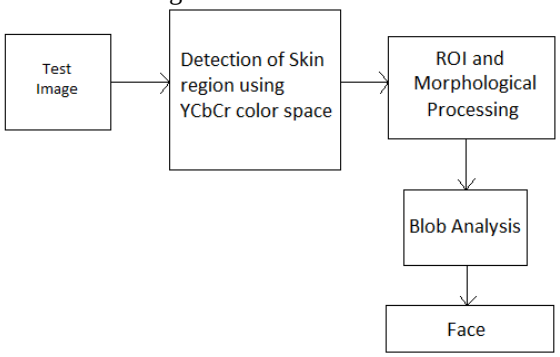

Fig. 4: Working of Blob Analysis

2) Haar Classifiers

A method was invented by Paul Viola to precisely and rapidly identify the faces within an image. By regionalizing the detection area false positive images are eradicated and the speed for identification is increased due to degradation of the area examined. This feature is a machine learning approach and rather than using intensity values of pixels, it uses change in contrast values between adjacent rectangular groups of pixels. It is then used for detecting the objects in other images Haar classifiers can be easily scaled by increasing or decreasing size of pixel group that is being examined. Basically, the algorithm needs a lot of positive images (face images) and negative images (without face images) to train the classifier. Then we need to extract features from it.

For this, we apply each and every aspect on all the training images. For each feature, it finds the perfect threshold which will analyze the faces to positive and negative. But certainly, there will be some defects or misclassifications. We select the best features with minimum error rate, which means features that best classifies the face and non-face images.

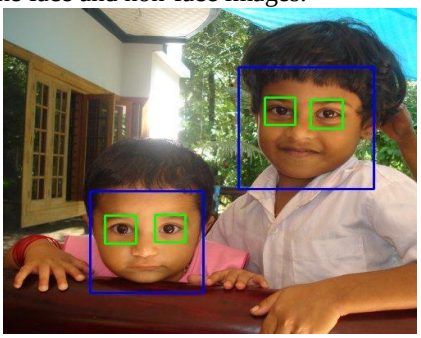

Fig. 5: Face Detection using Haar Classifiers

3) Edge Detection Technique

An edge is a point which aim at identifying points in digital image at which image brightness changes suddenly or sharply. Edges are coordinated into a set of curved line segments. Edge detection is the crucial tool in image processing, machine perception and computer perception, particularly in areas of feature extraction and feature detection. In a function, singularities are referred as cutoff in the intensity values where the gradient approaches infinity. However, image data is distinct, so edges in an image often are defined as the local maxima of the gradient.

Edge detection is an important task in image processing. It is a mathematical tool in pattern recognition, image segmentation, scene analysis and hence in face identification. When an edge detection algorithm is applied to a digital image, it diminish the amount of data to be refined further to the greater extent and therefore filters out information that is less relevant, without the important architectural properties being lost. An edge detector acts as a filter which is used to extract the end points in an image. In this paper canny edge detector is proposed.

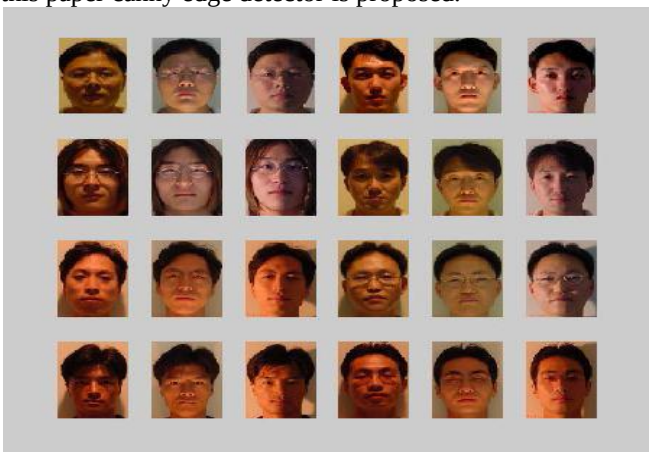

Fig. 6: Various Images of Faces in Sample Database

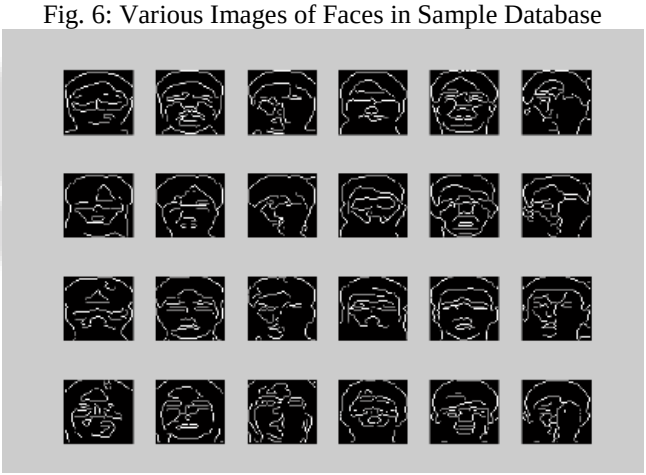

Fig. 7: Edge information of Face Images

IV. Conclusion

This paper presents a survey of student's attendance system via RFID and Face Recognition. Usually students attendance is marked by the professors manually which consumes a lot of time resulting in wastage of lecture. Also number of proxies gets recorded in manual system. This can be replaced with computerized system. RFID will mark the attendance automatically when student's tag is passed through the scanner and student is entered into the class. While face recognition will help in verifying the student and marking the attendance of that individual student resulting in avoidance of proxies.

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