

Biometric Based Gate Access and Informative System through Web Services and SMS Using IOT

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Abstract- In this paper, a touchscreen and biometric based gate access system for colleges is presented which includes the IOT technology for data flow and comparison. The tradition of using touchscreen systems is increasing promptly day by day. With help of touchscreen, algorithms and APIs involved in data processing, the system is majorly works on a principle Software as a Service (SaaS). The main agenda of proposed design is to maintain security in a block of college by allowing only authorised persons (faculty, students, administrative staff etc). The additional feature of proposed design is student can leave the college only with IOT based HOD Permission or only after official timings. Further, an hour wise login lists will be displayed on touchscreen. Also, it gives the information about events held in college on present day. Such that only authorised persons can know the events held. Raspberry Pi is used as controller and C++ based GUI Development tool, Qt is used to make GUI (Graphical user Interface) for accessing biometric module since a two-step authentication is employed in system. System has been tested successfully with a database of 7 candidates and achieved the expected results.

1. INTRODUCTION

In every educational institution, it is a great problem to maintain discipline and controlling the students. It is impossible to keep a track on the students by the mentor or incharges regularly, whether the student is in class room or not. Also there exists a problem with security staff whenever a student wants to leave the college in working hours. Also security is a major aspect to overcome the problems such as thefts by outsiders, such that the system also provides the security by allowing only authorised persons. Also there are situations like where students will leave the college without proper reasons and without informing the class mentors, HOD. To overcome all the problems from previous project designs, we designed a system with new technologies involved.

In earlier systems, there is only portable attendance system which is based on fingerprint identification. This system helped to reduce many issues such as, denying the possibilities of cheating in recording the attendance, helps to ease the lecturers to keep track of students'

attendance, the encryption technique adds more security so there will be no anonymous fingerprint which is able to tamper with the recorded data, and the portability saves time in taking attendance instead of queuing in a line. But there is no security by allowing only authorised persons and a gate access system [1]. Also the system has no idea about who are leaving the college in working hours. [2]

The developments of IoT as an intelligent system can be proceeding with interoperability, energy sustainability, privacy, and security. The development of the IoT exposed many new challenges including the lack of fundamental theory supporting, unclear architecture, and immature standards. To meet these challenges, this paper gives a three-layer architecture including three platforms. Apart from educational institutions, the fingerprint recognition technology can be also used in homes where it provides much needed security. It could be used for door locks, safe locks or as a security measure for digital devices. This paper should prove to be helpful in developing such diverse applications in future. [3]

The application of Raspberry Pi and cloud computing has given a new direction of research into the field of Internet-of-Things (IoT). Biometrics is used for authentication. This paper also describes how biometrics can leverage cloud's boundless computational resources and striking properties of flexibility, scalability, and cost reduction in order to reduce the cost of the biometrics system requirements of different computational resources (i.e. processing power or data storage) and to enhance the performance of biometrics systems' processes (i.e. biometric matching). [7-12]

Short Message Service (SMS) is one of the cheapest and best way for sending a message from mobile. Basic idea of service is to notify updates to the people in a working environment from authorized persons at anywhere just by SMS. This task is accomplished by conjunction of GSM module with Raspberry Pi. Working procedure of this system is only the authorized person can send SMS from anywhere to the SIM in GSM module. [5] With reference to this paper, we introduced SMS service to users but in an optimised way.

We studied a paper which proposes a method in which large screens like computer monitors or televisions can be used for displaying notices sent as text messages from a mobile phone. The proposed method uses HyperText Markup Language (HTML) to present the output since it offers many customisation options. This paper focuses on using HyperText Markup Language (HTML) for displaying messages since using HTML, display features such as font size and background colour can be easily set as per user requirement. For

communication between end node to host system, we have taken this paper as reference and also for making an rich GUI for displaying the status of the system. [6]

In our research, enhancements have been made in terms of security and performance. We discuss and compare on the improvements that have been made as compared to the previous projects. The aims of the proposed system are to categorise the students based on the time they entered into college and to display them and to utilise the Web Services, Cloud storage to reduce the overall complexity of the system. The main feature is that students are allowed to leave the college with permission of HOD through web services. Here fingerprints which are reliable and unique biometrics of a person are used to authenticate for entry and exit.

For communication between end nodes to host system, Internet of Things (IoT) is a technology is used in which cloud storage is used for the data storing received from the end nodes and controlling them remotely [4]. The user's data is stored in the database which includes the biometric impressions and the relevant information such as name, roll number etc.,

We have removed the GSM module and integrated an SMS API in code to send messages to the user. Thus hardware complexity has been reduced.

2. IMPLEMENTATION

In this section, the implementation and architecture of proposed work will be explained. Initially, block diagram of the proposed work will be explained. The block diagram will be in two sections.

Section 1: Student and Gate section, where the system work is to allow the student from outside to college. This section is also responsible for allowing faculty and other employees of the college who are authorized. Figure1 shows the block diagram of Student and Gate Section.

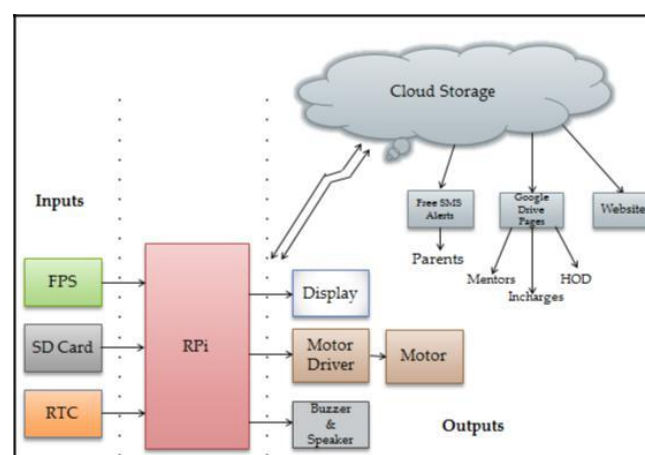


Figure1 Block Diagram of Student and Gate Section

Section 2: HoD and Student section, where the system work is to give permission to student for leaving the college in working hours. Figure2 shows the block diagram of HOD and Student Section.

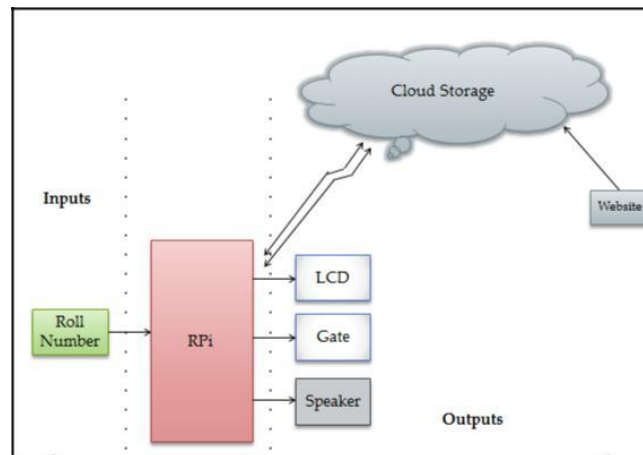


Figure2 Block Diagram of HOD and Student Section

The implementation of proposed work involves in two modules. They are Hardware Module and Software Module.

1. Hardware Module:

This proposed work mainly consists of finger print scanner, microcontroller, a gate control setup which includes a motor along with its driver and few miscellaneous components.

- i. *Raspberry Pi 3*: This is a microcontroller cum microcomputer which is suitable for high-end embedded system applications. We have used Raspberry Pi 3 Model B which has 1GB RAM and 16GB ROM Capacity with a speed of 1.2GHz. The reason behind using RPi 3 is it has inbuilt Wi-Fi which reduces and additional cost of Wi-Fi board or Ethernet cable cost.
- ii. *R305-A Finger Print Scanner*: This component has major role in implementation of the system. It is responsible for enrolling the candidates and searching their details. In simple, it is the key for functioning of this system.
- iii. *Gate Control Setup*: It is an integration of DC Motor and its driver circuit with a wooden/plastic obstacle attached to shaft of the motor to act as gate. A 12V DC Motor is used and L293D H-Bridge based Motor driver is used to drive the motor since Raspberry Pi 3 doesn't provide enough current to drive motor.
- iv. *Misc. Components*: Apart from the above components, the system also includes the components like LEDs for status indication, speaker for voice output and a buzzer for alerts.

2. Software Module:

The software module of proposed work includes the designing of the GUI, controlling GPIOs, designing of web portal, sending SMS to the users.

- i. *Qt*: It is GUI development tool for creating the high quality user interfaces for touchscreen display systems. It is based on C++ language and all the packages, modules in Qt SDK are written in C++. A software tool called “*Qt Creator*” is used to build the basic GUI and further modifications are written in code form.
- ii. *Python*: Python is general purpose language extensively used for Raspberry Pi applications. We have python for accessing and controlling the GPIO pins of Raspberry Pi. With the shell scripting calls, python codes are accessed in C++ program for controlling GPIO pins.
- iii. *HTML*: Web portal HOD for giving permissions is designed using the HTML. This HTML code is embedded in the main C++ code.
- iv. *TextLocal SMS API*: For SMS alerts to the candidates, the API called textlocal is used. This API is also embedded in the C++ code. When the login is successful and students left with HOD Permission, SMS is sent to corresponding persons.
- v. Further HTTP, Apache server and php are used for data movement, client-server operation.

Architecture of the proposed work:

Figure 3 describes the architecture of the proposed work. The architecture consists of four layers

- i. Input sensing Layer
- ii. Processing Layer
- iii. Network and Sharing Layer
- iv. Application output Layer.

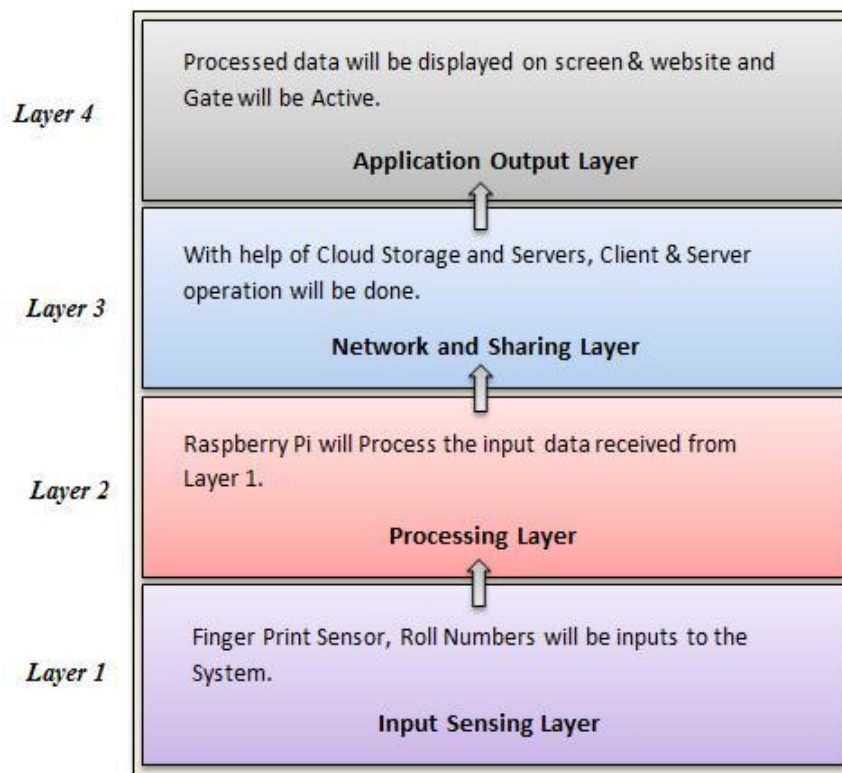


Figure 3 Architecture of the proposed work

Input sensing Layer: This layer includes the input components of the system. The major input component of the system is fingerprint scanner. In this layer, the fingerprint scanner will capture the finger impressions of the candidates.

Processing Layer: This layer is responsible for processing of the data received from the input sensing layer. The microcontroller will search the input data from existed data to decide whether he is authorised or unauthorised. We are using Raspberry Pi 3 model as microcontroller to process the data. Also, the data received will be sent to cloud storage/local server with help of internet through Raspberry Pi.

Network and Sharing Layer: The function of this layer is to transfer the data from web based HOD portal to Raspberry Pi. Granting permission for students to leave college is possible with layer, such that a client-server operation is performed in this layer.

Application Output Layer: after successful login and logout, gate will be opened. The data related to login and events, hour wise lists are displayed on touchscreen GUI. The above operations are done in this layer.

Biometric based authentication is used to enter and exit the block of the college. Finger print scanner is placed beside the gate. Since the two-step authentication is employed in the system, candidate need to place the finger on finger print scanner and should tap the

“Login/Logout” button provided on the touchscreen GUI. The GUI of the proposed system is shown in figure4.



Figure 4 GUI designed using Qt.

3. WORKING

In Section1, whenever student wants to enter the college, he will enter the college block by placing his thumb on scanner. After successful verification, a gate will open and records the time of entering. The relevant data will be stored in the database and sends a SMS to the corresponding incharges, mentor and parents. Simultaneously, the same data will be displayed on the screen.

The similar algorithm works for faculty and other employees except that SMS will not sent. If any un-authorised person wants to enter the block, a buzzer will sound as his thumb impression is not stored in the database. The below figure shows the flow chart for section1.

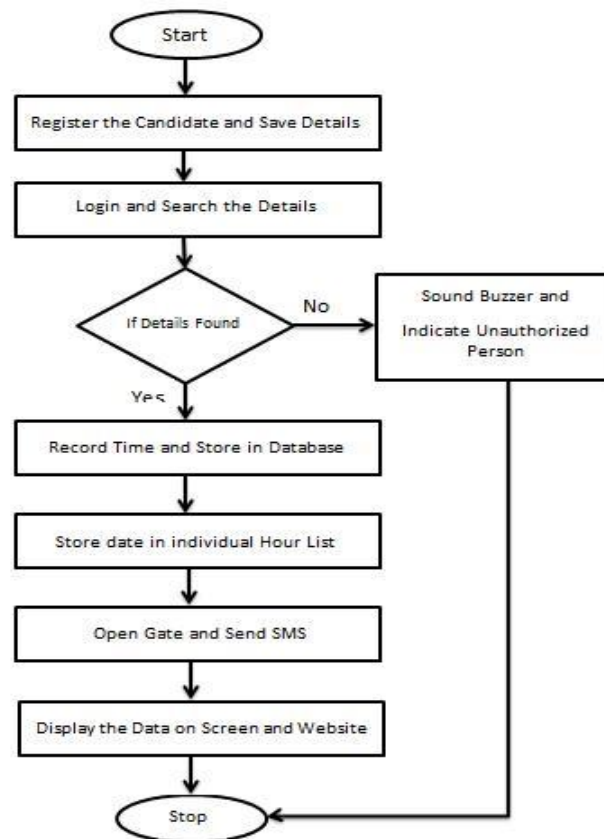


Figure 5 Flow chart for Section1

In section2, if the student wants to leave the college in working hours, he will take the permission from the HOD or any other higher official person. If he permits, he will enter his roll number through the keypad. The system will create a new database of students leaving the college so that only those persons can leave the college by biometric verification. Flowchart for section2 is given in figure 6.

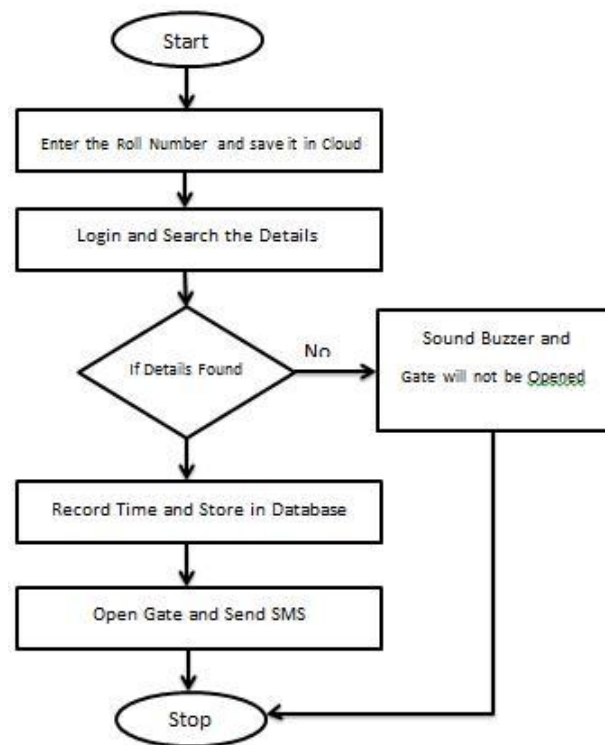


Figure6 Flowchart for Section2

4. TESTING AND RESULTS

As mentioned in the previous columns, proposed work implementation can be done in two stages.

1. Student and Gate Section.

Student and gate section testing involves in 4 levels of processing. In order to obtain the login and facility, the candidate need to register them self in the database provided. Each candidate is provided with an ID to identify his details. With the registration, level of testing will be completed. The next level of testing is to login/logout of the candidate, where candidate need to place his registered finger on Finger Print Scanner to search his ID and record his time of login and logout. After recording the time, the algorithm in the proposed work will

categorizes the login data and makes a list of candidates attended per hour. The purpose of this data categorizing is to identify the students who came late to college.

The status of system performance will be tracked by LEDs and buzzer provided. Blue LED is named as Runtime LED which is responsible for indicating the status of application i.e while the proposed work is executing, the blue LED will blink continuously. Yellow LED is used to indicate the candidate registration, i.e if candidate is registered successfully, the yellow LED will be ON for 2 Seconds. When the login is successful, the Green LED will be ON for 2 seconds and indicates the successful login and details are valid. If the login has failed due to improper placement of finger on finger print scanner, the Red LED will be ON for 2 seconds and indicates failed login.

Also a buzzer and speaker are provided for alarm and voice output. If login is success, gate will be opened and idle for 3 seconds in which candidate need to enter into college block and then gate will be closed. If the ID of candidate is found in database, the system indicates that intruder/unauthorized person is entering into college. This can be indicated by buzzer alarm and Red LED indication, simultaneously speaker will also give a voice output. With this processing, level 2 of testing will be completed.

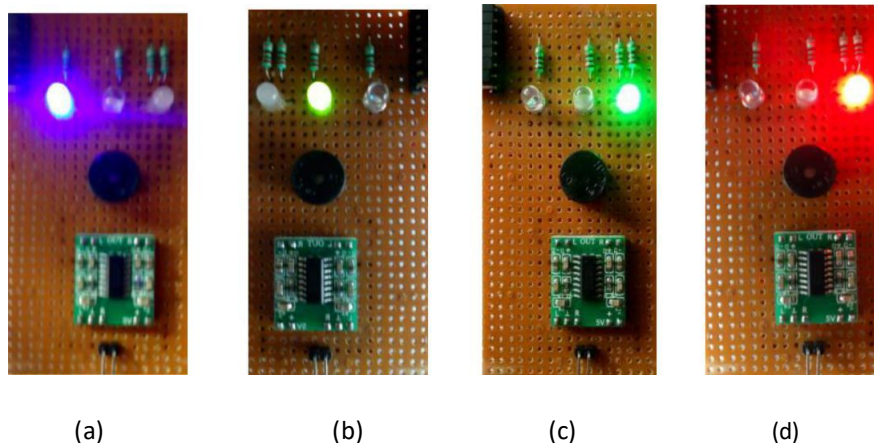


Figure7 Status LEDs [a] RunTime Led, [b] Registration Success LED, [c] Login Success LED, [d] Login Fail LED.

The next level of testing is to identify the number of candidates registered and number of students attended. This can be done with help of program written. A couple of software counters are provided to count the number of candidates registered and entered. For each registration, counter1 will be incremented by one, similarly for each login, counter2 will be

incremented by one. Both the output of counters will be displayed on screen with help of QLCD widgets of Qt.



Figure8 Software Counters in GUI

The final testing of stage 1 will end by checking the hour list of candidates and events list in college. The GUI of proposed work will have 2 buttons namely “Hour wise Student List” and “Events today in College”. The recorded login data will be displayed in categorized hours and whole login data in separate lists. To display the events list, a text file will be provided to co-ordinator to write the events held on day. With help of IOT technology, the file can be transferred remotely and read on host system i.e Raspberry Pi. All the lists mentioned above will be displayed with help of textbrowser widgets of Qt.

2. HOD and Gate Section.

HOD and gate section testing involves in 3 levels of processing. In first level of processing, if student wants to leave the college in emergency cases, he will approach to HOD and takes permission. The HOD will confirm and enters corresponding student's roll number in portal. In second level of processing, the student will place his registered finger on scanner to logout. Through IOT technology, the algorithm in system will compare the roll number and placed finger impression of student. If the roll number assigned to corresponding finger impression and roll number entered by HOD is same, then gate will be opened and Green LED will be turned ON for 2 seconds. Simultaneously, voice output is also can be heard. And final level of processing is update the counter. A software counter is provided to count the number of students left with HOD permission. For each HOD permission leave, counter will be incremented by one and displayed Qt widget QLCD.

Few screenshots of the GUI while testing:

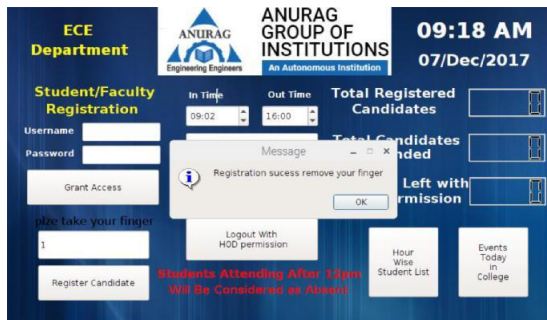


Figure9 Successful Registration Process Popup



Figure10 HOD Online Portal

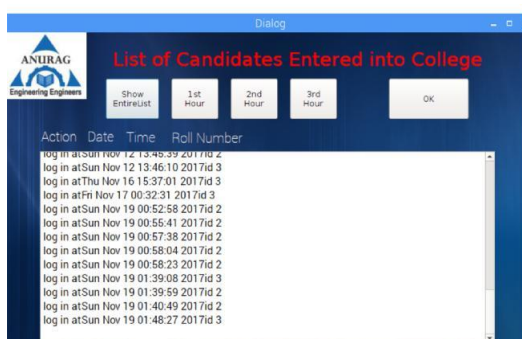


Figure11 Hourwise List

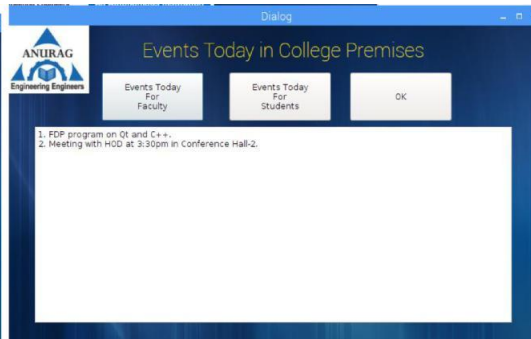
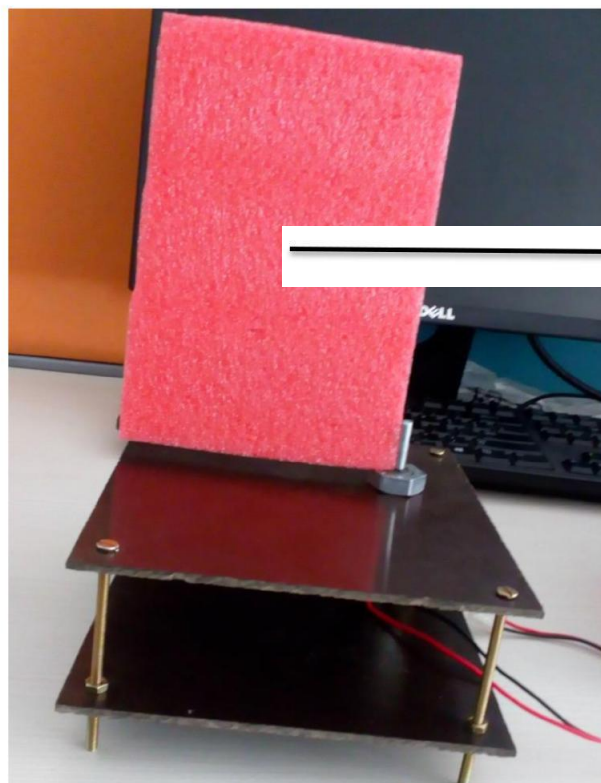


Figure12 Events For Faculty Data



Figure13 SMS sent to corresponding people

Final Appearance of the proposed design:

Gate Setup

Figure14 Final Appearance of the proposed work

V. CONCLUSION

The proposed work has been tested perfectly and successful results are achieved with a database of ten candidates. The maximum usage of Raspberry Pi using python and C++ made an efficient and reliable system with zero delay in operation. Protocols like I2C, UART has been understood and verified its functionality with practical implementation.

The usage of touchscreen module has been success with new technology Qt using C++ platform. With this touchscreen, perfect touch response is achieved since system is made with proper GUI standards. The entire proposed design is integrated in a box made with acrylic sheet and will be placed at the entrance of the required block of the college. A DC motor with load capacity of 5kg has been used for gate setup.

The main agenda of proposed work is to improve the discipline of students by forwarding regularly their details to corresponding Class incharge, Mentors and Parents. Such that it also reduces work for staff and faculty of the college. Also, to categorise the students based on the time they entered into college and to display corresponding data. With the design proposed in this paper, we are able to provide security by allowing only authorised persons, such that college is intruder free. The proposed work is able to provide the solutions for the problems faced in real time and perfect achievement is succeeded.

The proposed work justifies the terms “Embedded System” and “Internet of Things” as it is integrated the hardware and software serving for dedicated application via internet as a medium for data transmission and storing the information.

REFERENCES

- [1] Nur Izzati Zainal, Khairul Azami Sidek, Teddy Surya Gunawan, Hasmah Mansor, and Mira Kartiwi, “Design and Development of Portable Classroom Attendance System Based on Arduino and Fingerprint Biometric”, IEEE 2014.
- [2] Y ash Mittal, Aishwary V arshney, Prachi Aggarwal, Kapil Matani and V: K: Mittal, “Fingerprint Biometric based Access Control and Classroom Attendance Management System”, IEEE 2015 indicon.
- [3] Shanzhi Chen, *Senior Member, IEEE*, Hui Xu, Dake Liu, *Senior Member, IEEE*, Bo Hu, and Hucheng Wang, “A Vision of IoT: Applications, Challenges, and Opportunities With China Perspective”, IEEE 2014 IOT.

- [4] Dhvani Shaha, Vinayak Bharadi, "IoT based Biometrics Implementation on Raspberry Pi", 7th International Conference on Communication, Computing and Virtualization 2016.
- [5] Patchava Vamsikrishna, Sonti Dinesh Kumal, "Raspberry PI Controlled SMS-Update Notification (Sun) System", IEEE 2015.
- [6] Yash Teckchandani, G. Siva Perumal, "Large Screen Wireless Notice Display System", IEEE 2015.
- [7] Jubairahmed, L., Satheeskumaran, S., Venkatesan, C.: Contourlet transform based adaptive nonlinear diffusion filtering for speckle noise removal in ultrasound images. *Clust. Comput.* 1–10 (2017). <https://doi.org/10.1007/s10586-017-1370-x>
- [8] Satheeskumaran, S., Sabrigiriraj, M.: A new LMS based noise removal and DWT based R-peak detection in ECG signal for biotelemetry applications. *Natl Acad. Sci. Lett.* 37(4), 341–349 (2014).
- [9] Satheeskumaran, S., Sabrigiriraj, M.: VLSI implementation of a new LMS based algorithm for noise removal in ECG signal. *Int. J. Electron.* **103**, 975–984 (2016).
- [10] Venkatesan C, Karthigaikumar P, Varatharajan R (2018) FPGA implementation of modified error normalized LMS adaptive filter for ECG noise removal. *Cluster Comput* 1-9. <https://doi.org/10.1007/s10586-017-1602-0>
- [11] C.Venkatesan, P. Karthigaikumar, A. Paul, S. Satheeskumaran and R. Kumar, "ECG Signal Preprocessing and SVM Classifier-Based Abnormality Detection in Remote Healthcare Applications," in *IEEE Access*, vol. 6, pp. 9767-9773, 2018. doi: 10.1109/ACCESS.2018.2794346
- [12] Venkatesan, C., Karthigaikumar, P. & Varatharajan, R. *Multimed Tools Appl* (2018). A novel LMS algorithm for ECG signal preprocessing and KNN classifier based abnormality detection, 1-10. <https://doi.org/10.1007/s11042-018-5762-6>

