An IoT Based Smart Campus System

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Abstract— In this digital era, the life of human beings is getting simpler as almost everything is being automatic, replacing the old manual systems. Nowadays internet have become an integral part of human's everyday life without which they are helpless. In this project Internet of Things (IoT) provides a platform where devices can be connected, sensed and controlled remotely across a network infrastructure. The IoT devices controls and monitors the electronic, electrical and the mechanical systems that are to work in a campus. Single admin controls the various devices connected to the cloud server and also facilitates a number of sensors and control nodes. The system designed is economical and scalable as it can be expanded by connecting and controlling of a number of different devices. The interconnected things have physical or virtual representation in the digital world, sensing/actuation capability, a programmability feature and are uniquely identifiable. The representation contains information including the things identity, status, location or any other business, social or privately relevant information.

Index Terms— *Raspberry Pi, Arduino, Sensors, Python, Database, MySQL, Displays, Cameras.*

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1. INTRODUCTION

In digital era, our College campus need a lot of IoT technology for classy environment to utilize secured & modern technology for e-campuses activities in academic course of action. In general context, the college are connected to Internet, and their similar objects that can be converted into smart objects within meaning of the IoT. For E.g.: There are many common objects like computers, printer, projectors, books, poles, tables etc. there are complex objects such as building, labs, parking etc. All these objects can be converted into smart objects by adopting sensors. QR tags like (geographic, text, URL) RFID and giving a significant level of intelligence to allow operation of actuators. And even decision making. All these components of development areas. Most we focused on human comfort in college and security and electricity saving in labs, street light and tracking and smart inventory. All these can also be applied in a campus. Primary focus of Smart e-campus is in the education area, but they also drive the change in other aspects such as management, safety, & environmental protection. The availability of newer and newer technology reflects on how the relevant processes should be performed in the current fast changing digital era. This leads to the adoption of a variety of smart solutions in campus environments to enhance the quality of life and to improve the performances of both teachers and primary focus of smart campus is in the education area, but they also drive the change in other aspects such as management, safety, & environmental protection.

2. ARCHITECTURE OF SMART CAMPUS

2.1 Literatures Survey

1.The main contribution of this paper is an original proposal of an application, platform and data independent model for building the integrated information system that will support educational and other processes at University level. Increased number of students causes a necessity for more precise and efficient approaches of students' authentication and monitoring. based on the affordability and efficiency, the proposed method for students' identification is by using smart cards. The chip on a smart card can store multiple identification factors of a specific user: institution/faculty ID, user ID, password, grades etc. CMS is also used for providing environment, general information about the institution (university/faculties), public news and announcements (on the university/faculty level) etc. However, every user needs to provide a valid authentication data in order to access elearning. We need to protect content, services and personal data from outside intruders and also these systems carry a risk of privacy violation from inside staff (administers and educational staff). One of the solutions can be applying researches from Hippocratic Database (HDB) areas [1].

2.In this paper author divides the whole system into three layers. The IoT is import part of new information and it connects everything through RFID, sensors QR code and realtime positioning technology and realizes the intelligent identification of location and management for goods, IoT of education fully perceives the workers, resources and equipment's of school in a perceptual layer. Then the network layer is responsible for reliable transmission of information from perceptual layer, then IoT realizes the intelligent analysis, early warnings and intelligent scheduling in application layer. Here the isolated systems such as educational management system, finance management system and office management system are integrated by IoT technology. This paper concentrates on office management more than on education or research [2].

3.The author here focuses on the campuses that are spread over fairly large area and it is difficult to control for manage-

ment to track everything happened. This paper tells us about the need of adopting IoT technology in campus using secured smart system for campus academics. In this system sensors are enabled and network devices work continuously and collaboratively to give humans more comfort. The smart classroom collects information, stores it as digitalized data in a memory of e-campus platform. Here platform is created for fascinating learning by means of smart classroom surroundings and security for e-campus. The paper mainly considers the security aspects leaving behind many other important features [3].

4.The major issue considered here is how different services can be integrated into our smart campus which is heterogeneity of systems and technologies that they use. The service provided here aim at increasing productivity in campus, saving a lot of time and making it easy for all people present in campus. Here author proposes a system where smart cards are implemented for access control and payments and data generated is analyzed for human behavior. Smart garbage system is also established using simpler technologies. The proposed system consists of many aspects like smart micro grids, smart lighting, security and safety but all this are not implemented due cost constraint and other problems [4].

5.The author here mainly describes IoT enabled classrooms in which data collection can be made possible by using devices for e-learning application. The data is fetched in real time activity. The smart classroom data are stored in digital data elearning platform. Student outside the classroom can access subject data notes using information sharing display board and it can be controlled by administrators for adding updates. Using IoT learning application provides simple and costeffective notes to any corner of the world. The author here says the efficient way of designing smart learning through IoT. It thus probable's teamwork to rapidly increasing timely delivery of subject notes, easy way of learning and data reaches speedily. This paper focuses only on enhancing effective way of classroom teaching technique not towards smart campus [5].

6.The authors objectives are to develop an application that provides a smart and easy way for execution of several academic operations to provide students with information regarding complaints any placement activities or any other event happening in the college. It addresses the problem of students not obtaining correct notifications at correct time, here the gap between college students and administrators are tried to be filled using android application. The main idea here is to design and develop an android based college management system. It reduces the physical human effort. The proposed system focuses only on education system neglecting

other aspects that needs to be addressed to create a smart campus [6].

7.This paper presents the up-to-date outcomes of research project that is aimed on analysis of students with disabilities & how they might benefit from smart software & hardware systems & smart technology. Smart system integrates voice recognition, computer-vision & other technology. The objectives for this particular research project include but are not limited to: Identification of smartness levels in a smart education system. Identification of characteristics of students with various type of disability. Identification of software and hardware systems and technology to aid students with disabilities in highly technological SMCS. It indicates the difference between digital campus & smart campus and it connects everything through RFID, sensor, QR code & RT positioning technology & realize the intelligent identification, location & for goods. The system does not describe many of the aspects that make a complete smart campus [7].

8.Several classrooms, staff offices and laboratories etc. have been equipped with super sensors featuring temperature and light monitors. The factors like temperature and light can have significant effects on the productivity of office workers as well as students. Also, this helps in reducing power consumption by monitoring the environment condition and controlling the appliances. An IR sensor in each room allows building users to find a meeting room that is currently free. Generally, public meeting rooms should be booked via a shared calendar system. These kinds of Systems are required in the university campus as the area is very large and number of rooms are also large. And human can make mistakes and forget to switch off the appliances when in no use and in this case, these systems are useful in order to increase the power efficiency. The system can be viewed as a future of artificial intelligence. This is a powerful and dependable system. It fulfills the goal of energy saving and helps in achieving the efficient use of energy resources. The paper mainly focuses on the conservation of energy in the campus and not the actual smart campus system [8].

2.2 PROPOSED METHODOLOGY

This project uses multiple sensors, some sensors like soil moisture sensor, ultrasonic sensor and cameras are connected to a main processor which is Raspberry Pi and remaining application sensors like IR sensors mic and others are connected to the Arduino processor, the sensors will send a message to main processor for its proper working at the power up stage and processor will acknowledge its present. Each sensor sends the information to main module which either saves the information into a database or it simply proceeds with the required action, information to be saved is sent to Cloud/Local server

and appropriate action or function that is carried out is also saved depending on the type of the data. For the functions like Smart canteen and Smart library which can be accessed by students will be operated using smart phone application. The device that connects the android application and cloud will Raspberry Pi's function known as FLASK. Each time students request will be processed and updated in database.
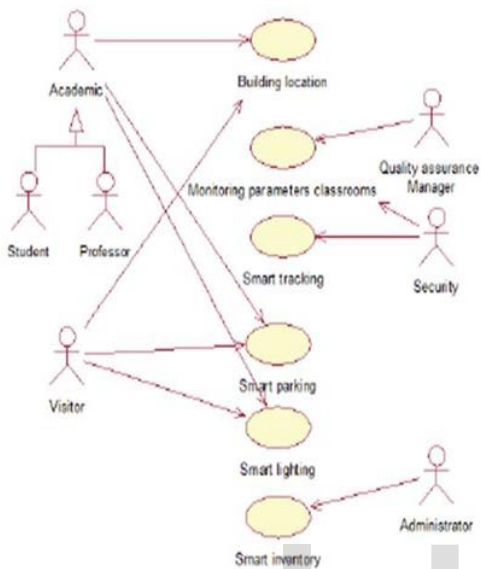

Fig 1. Systems involved in Smart campus.

a) Smart Street Light system:

Here the system is realized using the IR sensor(Infrared). IR sensors have range of 2-30cm these IR sensors are connected on street lights depending on the presence or the movement.

The light brightness if there is a no presence it is coded in such a way that the light is dimed this is done so that power can be saved.

Fig 2. Shows smart street lighting system.

b) Smart Parking:

Smart parking consists of IR sensors, cameras etc. When a vehicle arrives at the gate the IR sensors senses the vehicle, the camera captures image and arrival time of vehicle, then the programing is done in such a way a that LCD display shows

using LED which directs the vehicle to its allotted lot. In the parking area, we again use IR sensors, when the sensor gives logical zero as an output then that particular which is used to set the threshold value.
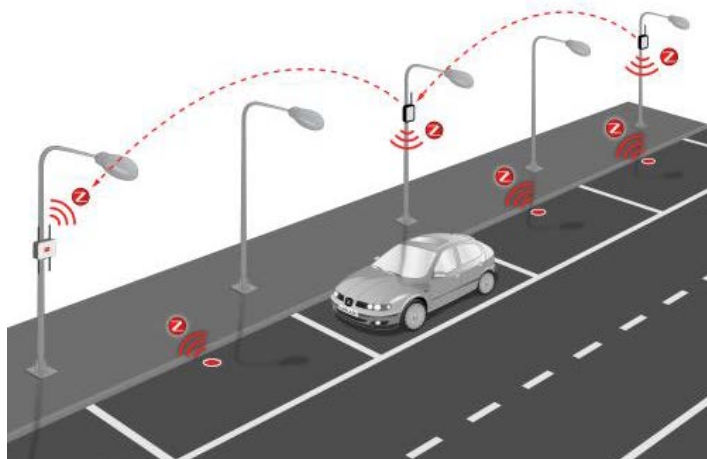

Fig 3. Smart parking system.

Which parking lot is empty there are also arrow marks shown Smart parking consists of IR sensors, cameras etc. When a vehicle arrives at the gate the IR sensors senses the vehicle, the camera captures image and arrival time of vehicle, then the programing is done in such a way a that LCD display shows which parking lot is empty there are also arrow marks shown to direct the vehicle to its respective parking lot.

c) Smart Automation:

Smart Automation consists of controlling, when the light and the fans will turn ON or OFF, her we are using PIR (passive infrared sensors) which is used for motion detection, PIR sensors can detect motion its range of 120 degrees and up to 7 meters. When motion is detected the sensors gives logical high as its output and the fans and lights are turned on, once there is no motion logical zero output is obtained, fans and lights are turned OFF.

d)Smart Gardening:

The soil moisture sensor FC-28 is used for smart gardening system. This FC-28 can be used in two modes, analog and digital modes, we have used this sensor in digital modes. The soil moisture sensor FC-28 contains a potentiometer with it, which is used to set the threshold value.

This threshold value is then compared with the sensor output values using the LM393 comparator which is placed on the sensor module.

The LM393 comparator will compare the sensor output value and the threshold value and gives us the output of logical high and when output is logical high this output is given and turned ON input for the irrigation system which senses there is no moisture and turns ON the water supply. When this sensor again shows logical zero as output the water supply turned OFF.
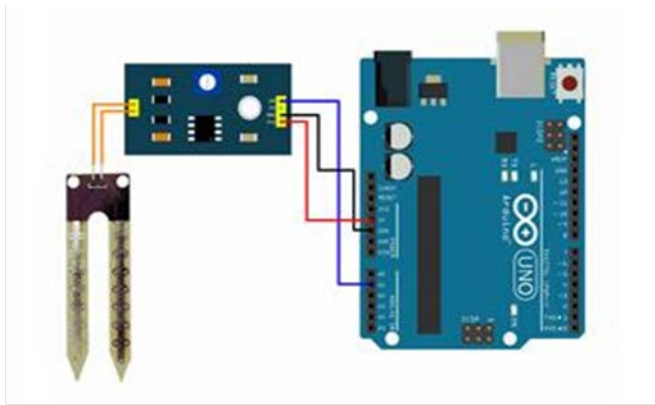
Fig 4. Soil moisture sensor connected to Arduino board

e) Smart Air Quality, Noise Monitoring and Weather Monitoring System:

Here we are using MQ135. This sensor can sense NH3, NOx, Alcohol, Benzene, Smoke, CO2 and some other gases so it is perfect gas sensor for our air quality monitoring system. When Arduino is connected with this sensor it can sense the pollution level in PPM (parts per million). MQ135 gas sensor gives the output in form of voltage levels and that levels are converted into PPM. It is considered that safe level of air quality is 350 PPM and it should not cross 1000 PPM hence whenever the output from MQ135 indicates more than 1000 PPM an alert message is sent to concerned authorities using GSM module.

For realizing noise monitoring we use microphones with amplifier LM386. The amplified signal is given to Arduino and depending on the output range obtained an alert signal is sent to respective place. Human ear can hear from 0 to 140 dB sound and the sound whose limit is more than 120 dB is considered as noise and hence whenever the output of microphone reaches more than 120 dB then that place is alerted for creating noise pollution.

f) Smart Library

Smart Library system is combined with an Android application that is created and is installed in all the student phone. This application will inform all the students about the books available in the library, question papers and other books, magazine information. This android application will also inform as about the status of books that has be borrowed.

In the library when the student enters it is monitored by cameras and the student when enter the aisle in which the required book is present is supposed to swipe the identity card only then that aisle will be open allowing the access to obtain the books. The books each contain NFC tags (Near Field Communication) which will have its reader, when a particular book is removed from the aisle it is accessed from the database which NFC tag and its number belonging to when books, is corresponding data is retrieved. The student is given 30 seconds time to return the book to its place. Before its get added to its account, at the end of retrieving the book the student must swipe the book in front of NFC card reader so that the

book can be added to that student account and be removed from the available book list.

If the book which is removed is not exposed to NFC card reader by the student, then when walking out and alarm is set to alert the authorities of an authorized book retrieval. The data base is created in MySQL software which will allows us to store that database in cloud for easy access. The store information can be retrieve as and when required. The MySQL database for smart library consists of all the information of the book present in library, student information and staff information. The books that are exposed to NFC card reader is removed from available list and student information linked and informed to authorities. When the number of days allotted to keep that book is up, a notification warning is sent to the student to return the book and if book is not returned on time then the amount corresponding is reduced.

g) Smart Canteen:

Smart Canteen is operated using android application. The android application contains the list of food available that particular time. This application can be accessed by both student and other faculty members through these applications they would be also place their order for the food they want.

The amount of the order food will be deducted after 10 minutes of placing order which is the time deduction given to the customer cancel their order.

The list of food items is updated on the database daily which is also accessed from cloud. Cloud used here is AWS cloud (Amazon Web Services) at the preparator end their will be screen showing in the list of orders for food placed. The preparators will prepare the food ordered in the given delay of 10 minutes once the food is prepared there will be a buzzer indication the order number i.e. ready for service. The list of customers is also stores with the amount of food ordered to keep the accounts list of food items are updated every day as the change in menu and same is updated in database.

h) Smart Office

Smart Office is basically a database that consist of all the information regarding students, faculty and others concern to the campus. Students, faculties can access this information through an android application. The database will consist of student information like Name, Semester, USN, Personal details, Marks card details, Fees pending, Attendance etc. This database is updated as and when changes occur.

3.CHALLENGES AND ISSUES

The proposed IoT based smart campus will offer enormous benefits to the society. Several devices and objects are connected with the help of RFID and other sensors. Thus, this proposed smart campus is a multifaceted in nature. Hence, chal-

lenges and issues are many to be addressed.

a) Object Naming

The proposed smart environment will connect several thousands of devices and objects for different services. Every device and object needs to be uniquely identified over the network. So, a dynamic mechanism of object naming and identification is needed to manage large number of devices connected.

b) Data Conversion

The signals and data inferred from the connected devices and objects will vary in their nature and hence, they cannot be transmitted via conventional network using internet. Effective methods of data conversion to be used for making the data compatible for further processing by IoT.

Many applications from various domains will have different identification technologies for the devices and objects. Several clients will be involved accessing and making use of the services by this smart environment. It is essential to take necessary steps to take proper privacy measures and prevent unauthorized access of the devices and objects. There is another possibility where people may not be aware of the sensors fixed, so, it is good to regulate the privacy of human being as well.

c) Interoperability

The devices and objects are heterogeneous in their functioning. Each device and object will use their own technologies and they may not be compatible to use the services of others. Interoperability to all the objects and devices like NFC tags, sensors should be ensured. The manufacturing of devices and objects are not with same standard and the standardization object and device manufacturing is needed.

d) Quality of Service

As several millions of data to be transferred for various services, there may be lack of quality of services. It is necessary to take steps to ensure the quality measure to provide better services to different applications in the smart environment.

e) Security Attacks

Information from the devices and objects connected to this smart environment are prone to security attacks like firsthand attack, gossip attack, observation attack, inference attack, automated invasion attack. A proper security mechanism should be devised to address these mentioned attacks.

f) Data Encryption and Key management: Data encryption is also a major concern in the proposed smart campus.

Encryption algorithms like AES, RSA, DH use keys of longer in length whereas Elliptic Curve Cryptography algorithm uses shorter length key. ECC is recommended for the data encryption because the devices and objects are very tiny and the heavy weight key exchange will prevent effective functioning.

g) Security for Hardware

The IoT Smart Environment will cover larger geographical area. There is a chance of intruders' interventions towards the objects and sensor devices. Sensor data may be inferred by authorized sources by setting up their own RFID readers and other devices. Thus, it is necessary to protect the devices and objects attached in the smart environment from intruder's access, physical damage and malfunctioning.

h) Network Congestion

As millions of objects and devices connected, certainly there will be network congestion in data transmission. The future research on IoT should also focus to avoid network congestion without data loss. Security measures should be taken to ensure the transmission of data without the external interferences.

4. RESULTS

Though we have suggested a huge system when it came to implementation, we so far finished only a part of it which includes Arduino processor connected with multiple sensors. Here the cloud and database is obtained from Blynk cloud server, which will also let us store the data and manipulate the devices. An app is created and admin can manipulate it from app. We could manipulate the lights and fan using the Blynk app, as well the light intensity can also be controlled. App can also indicate when the garbage is full as well as when the noise crosses its level. The figure 2 shows the android application that has results.
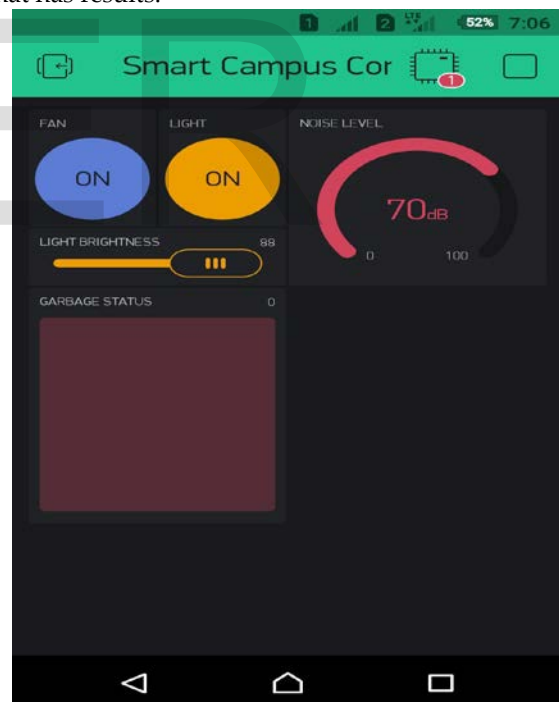

Fig 2 showing android application monitor.

5. CONCLUSIONS

These kinds of Systems are required in the university campus as the area is very large and number of rooms are also large. And human can make mistakes and forget to switch off the appliances when in no use and in this case, these systems are useful in order to increase the power efficiency. The system can be viewed as a future of artificial intelligence. This is a

powerful and dependable system. It fulfills the goal of energy saving and helps in achieving the efficient use of energy resources. Study of various papers gives a better option of WiFi enabled processor instead of Bluetooth and ZigBee for communication and also to process the sensor data. Hence, due to survey it became possible to make power efficient, cost efficient, fully automated system. This system is taking a step forward towards the goal of increasing the technological advancement and Smart City.

5.1. Future Enhancements

The future research in IoT may concentrate on the challenges and issues discussed in the paper.

- Security is a major concern in the proposed environment integrating the different business applications. Security architecture for the proposed work may be designed in future to give integrated solutions solving different security issues like key management, intruder's attacks, unauthorized access and network congestion.
- Future research efforts in IoT should also be focused to resolve interoperability as many devices and objects with heterogeneous functionalities are attached to the smart environment. The possible services with different nature with same data inferred and when required by many may cause poor quality of service.
- Research endeavors in future should also deal with the quality of service
- The proposed system may get slow down later as many applications are connected together. To overcome this issue, high performance microprocessors should be used in the system for better flexibility.

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