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IoT based Smart Parking and Traffic Management System for Middle East College

Abstract— the concepts of smart cities and technology have become popular these days because of the internet of things. The presence of smart cities has become a verifiable matter which needs to be studied in detail. The problems of smart cities include crowding due to so many vehicles and the difficulty of getting parking easily, which leads to getting late for work. This paper discusses the smart parking system based on IoT Technology, which consists of the distance measuring devices (sensors) connected to the controller device having Wi-Fi. Also, it is a component of a cloud services and a mobile phone application that shows the person the information to find an empty parking. This system can be applied in all college and universities. It can be used in all organization that faced a congestion problem and difficulty in finding car parking that also effected the time and late for work.

Keywords— Internet of things IoT, smart parking system, private cloud computing, wireless network sensors and the connectivity device, mobile application (android studio).

Introduction

The internet of things is a wide-ranging vision in which the Internet embraces everyday things where the physical objects in the virtual world become manageable remotely. This concept of Internet of things opens up great opportunities for the economy and development of the world and among individuals [1]. Internet-based information facilitates the exchange of "things", such as services and goods, and provides an information technology infrastructure in a safe and secure manner. Physical objects such as cars, umbrellas and others have become a part of the daily activity of people in services, in business activities and in their daily lives in cities and streets and they are able to communicate and interact through these devices and systems[2].

There are many examples of parking systems which include cars and reduce traffic jams. This research paper discusses the use of Internet of Things in reducing traffic jams when searching for empty parking spaces for cars through a complete system consisting of sensitive devices called sensors that are used to sense cars when parked and send data through a controller device that can take the information from the sensor through Wi-Fi into the private cloud computing. It will also have a mobile

application which connects with the cloud to show the information from sensors and people can easily know the empty parking from their own phones (figure 1).

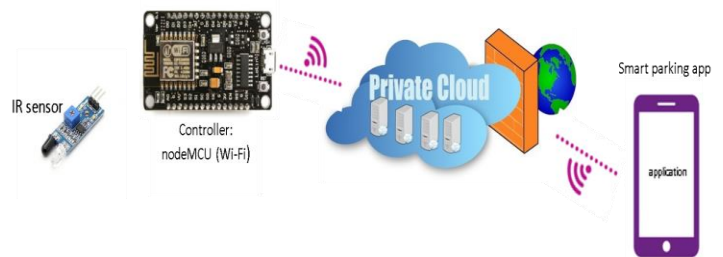


Fig-1 design of Smart parking system

Every years Middle East College has become a growing with the number of students and the problems were mounting complaints from students and staff about traffic and congestion the parking and to finding an empty parking, this has an effects even if the big numbers of parking in MEC was offers but they were late because the parking was away from the classroom and college buildings, this resulting in chaos and waste time searching for an empty position to stop them in places not intended to stop and they may have a traffic violation just because workers need access on time.

So parking traffic problems should manage and find solutions because they affect the efficiency of the employees and they will late to start their job, this are from the Organization's responsibility.

With this system technology solutions in this research that including integrated system being convenient and accessible to all users who are students or teachers staff within the College they can easily find the empty parking via a mobile application.

LITERATURE REVIEW

1- IoT internet of things

In the area of sophistication and modern technology, the Internet has become one of the most indispensable things. IoT is the next generation of using internet as Grant

Notman (2015), Head of Sales and Marketing said "The IoT is removing mundane repetitive tasks or creating things that just weren't possible before, enabling more people to do more rewarding tasks and leaving the machines to do the repetitive jobs."

The (Internet of things) was introduced for the first time by Kevin Ashton in his presentation in 1999 at Procter & Gamble. It refers also to internet of everything, he discusses link among the application and machines as well as people and animals in the network so that data can be shared.

IOT Technology uses real life objects. It connects things through internet like a car, the house, TV, etc. so that you can access and collect information from devices that are connected on the internet. Actually IOT was found before, it developed from communications from machine to machine communications (M2M), this used in Telecommunications where mobile phones and small machine are used. They connect to other mobiles to communicate between each other. The same meaning is used in the IOT, however, instead of machines connecting the people and machine connected on the internet that leads to a new term in communication Man to Machine. With this kind of communication users can gather and manipulate information of this devices that connect to the internet.

In the internet of things the things can be car, light, sensor, watch, etc. Which are connected to the user through internet it maybe home system control by user to monitor home lights or fans and different devices in home by internet. So IoT it's just a platform for the person to enable him to communicates with machine and control it remotely.

IOT APPLICATION

The possibilities offered by Internet of Things make it possible to develop a large number of applications in our community. Many of them are environments and domains where new applications are likely to improve our quality of life for example at work or home, when traveling, when you are sick, when doing sport and in the gym. These environments have been equipped with objects with rudimentary fittings only, most of which are without any contact. This objective will give the possibility to communicate in between and deployed in the application wide range and can be grouped to different domains are: Healthcare, logistics,

transportation, Smart environment such office or home and the social or personally domain.

IoT has different applications in different fields that solve a lot of problems faced in our life by using this technology for example:

- **Smart Environment:**

This is an important application for environmental conservation, for example, knowing the gas emissions and harmful chemical substances from factories or at sea and rivers to stop water and air contamination. The level of water can also be monitored, for example to monitor floods happen in dams and rivers. And also can warn you of earthquakes and tsunamis and many others of environmental problems through the internet.

- **Smart cities:**

IOT can be used to monitor congestion, traffic management, parking management, accidents or weather conditions in the city, also control street lights and alert municipality if garbage is filled. It can also monitor the vibration of bridges and large buildings as well as hospitals and schools problems. Several things can be done to make the city technology smart and facilitate easy living.

- **Monitoring the healthy:**

IOT can also be used to know and identify health problems such as knowledge of heart rate, blood pressure and disease. It can also communicate with the doctor or send results to him through mobile phone people can easily call the hospital in case of emergency situation from this application. It is very useful for the elderly, children or disabled.

- **Smart House:**

All devices at home can be easily controlled by your mobile phone or by laptop, and also in the case of robberies and strangers entering to the house it can be detected and the police can be warned. IOT also can be used in remote manufacturing processes to make a good production. It can control export processes and also repair, maintain and in diagnostic machines.

1. Study of the existing system

A. Cloud computing

a fundamental tool for the online world in the future. Within a few more years it would be necessary to continue the Internet cloud computing because of the need for high energy use over the Internet. So the utmost importance of cloud computing includes high quality demand, flexibility that allows to increase or decrease server resources in seconds compared to dedicated servers and also constitutes a less expensive option because of better utilization of server resources. It can work together with all services and this allows full use of disk space, memory and processing. Also, the cloud features include high speed and immediate reaction to changes in the time. That is why the cloud option is a good one to use in the smart parking system to connect the sensors and application and all servers in one area of cloud [4].

1. Types of cloud:

i. Public Cloud

Examples of this are: Microsoft, Google and Amazon. The computing infrastructure is fully located in the cloud computing company's headquarters. It is provisioned for open use for the public by the particular organization who is also hosting the services. The Public cloud is operated and owned by the provider service [5] [6].

ii. Private Cloud

This contains more specific security controls than the public cloud. It is used in many banking institutions and data control organizations. The use of private cloud storage allows them to control highly sensitive data through regulations and standards, whether they are records, trade secrets, or confidential information. Private cloud is used for single organizations and it can be internal or external hosting. Private cloud is operated and owned by a single organization so they can define their own data management policies (self-services). Private cloud has the highest security and control level that make it better than the public cloud for organization such as in the Middle East College. Having this type of

cloud in MEC is very good because of the features that a private cloud has. Figure 2 below shows the difference between Public and Private Cloud [5] [6].

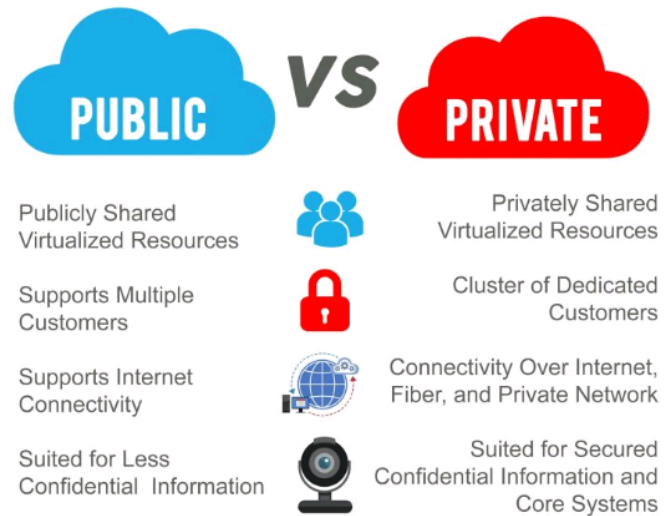


Fig- 2 different between public & private cloud

iii. Hybrid Cloud

Hybrid Cloud is a combination of public and private clouds depending on their purpose. It is a more complex cloud where the enterprise must manage and determine multiple platforms and where the data is stored [5] [6].

B. Sensors

Sensor is a device that responds and detects some kind of input from the physical environment. The Specific inputs can be light, heat, motion, humidity, pressure, or any one of the many other environmental phenomena. The output is generally a signal that is converted into a human readable display at the sensor's location or transmitted electronically via a read or other processing network.



Fig_3 sensors

Sensors are sophisticated devices that are often used to respond and detect the electrical or optical signals. The sensor converts the physical parameter such as temperature, blood pressure, velocity, humidity, etc to an electrically measurable signal.

The sensors are classified into Measure and the primary Input quantity and the application, property, material, technology and the physical and chemical effects.

There are some criteria that you should consider when choosing a sensor. They are as follows:

- Range: gauge sensor reduction.
- Precision.
- Cost.
- Condition environmental: the temperature/humidity.
- Repetition: A reading that varies frequently is measured on the same environment.
- Calibration: necessary for most measuring devices as the readings change over time.

C. Mobile Application

With the advancement of technology in our society, the use of mobile phones around the world is increased, the phone has become a big part of peoples' life now and especially smart phones because it connects to the internet and performs several tasks at the same time within your mobile phone through applications and programs inside the smart phone. You can easily control things or Connect, message, video, send pictures and finish different tasks, so these applications help to make people's lives convenient and easy.

Mobile devices are additional mobile software, such as smart phone and PDA. For example the most popular are games, social networking, and maps, news, business, weather and travel information and also the technical devices such the communication interfaces (Wi-Fi, GSM/EDGE and Bluetooth), processors of audio and video, the Camera, sensor and the GPS.

Characteristics of selected mobile platforms :

Vendor	Operating system (OS)	Programming Language	Application store (launch date)
Apple	iPhone OS	Objective-C	iPhone App Store (07/08)
LiMo Foundation	LiMo Platform (Linux)	Java, native (C/C++)	not yet available
Microsoft	Windows Mobile	Visual C#/C++	Windows Mobile Marketplace (09/09)
Open Handset Alliance	Android (Linux)	Java	Android Market (10/08)
Palm	Palm OS	C/C++	Palm App Catalog (06/09)
	webOS (Linux)	JavaScript, HTML5	
Qualcomm	BREW	C/C++	Plaza Retail (05/08)
RIM	BlackBerry OS	Java	BlackBerry App World (04/09)
Symbian Foundation	Symbian	C++	Nokia Ovi Store (05/09)

Table 1 characteristics of selected mobile platform

D. Existing Smart Parking System

In one of the proposed systems that mentions A 'smart parking system' [9] it was said that the system also consisted of infrared sensors using NodeMCU as a wireless connection and Pi3 raspberry computing tool and LCD was also deployed. The IR sensor is in every parking. These sensors will sense the parking place and the data will be sent to esp8266 nodeMCU. The data will be transferred to Pi3 raspberry, which is connected to the Internet with hard wire. The actual data will be displayed on the LCD whenever parking is vacant. It will be marked as green and if the parking is occupied it marks as red. This will reduce time and traffic but the system has some disadvantages due to the high cost of the many sensors used and the implementation of the system is quite a difficult task. Doing so in a large country or organization is very costly and difficult to implement [9].

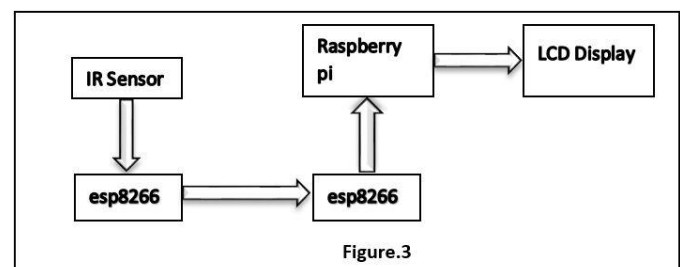


Fig-4 Smart parking system 1

There are a lot of models that can be used to solve the problem of car parking and traffic that is increasing with time. Internet of things is looking for a number of

solutions but actually we are looking at several things to choose the best system which has speed, efficiency, and is less costly plus has other benefits. The system can be selected, modified and used by organizations and companies as required.

Another research paper titled ‘Smart Parking System’ [10] concludes that the previous problem of high cost and excessive waste of time can also be solved, as the user can search for the parking spaces through a web site. When the driver arrives in the parking lot, he/she is checked by the person who controls the parking site. After the person in charge opens the gate, despite automotive devices, the driver moves to a certain slot position. Once the car overlaps a parking space, an infrared sensor (IR sensor) slot detects the presence of a car and sends infrared signals to the Arduino which reduces the number of parking slots available. The system provides real-time update on the status parking slots are all over the city or organization using the Internet [10].

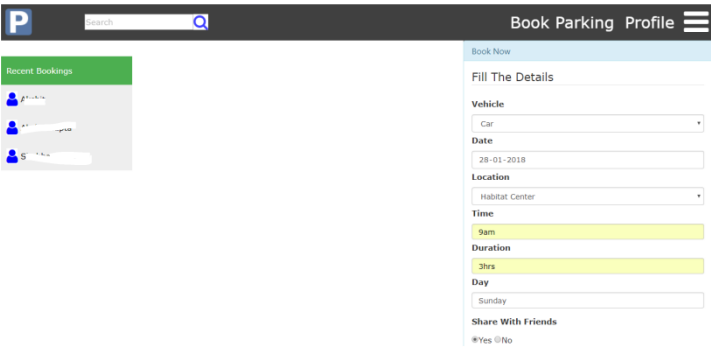


Fig -5: Dashboard (Booking Page)

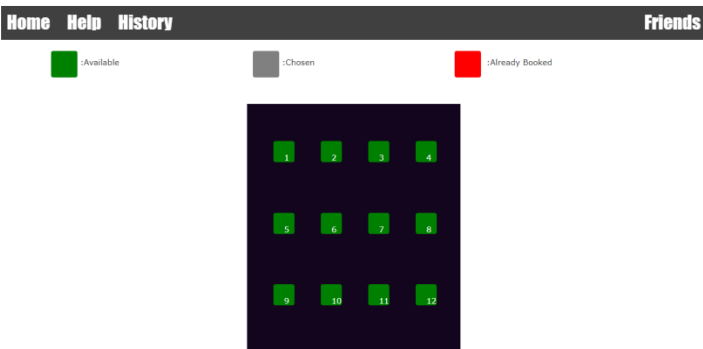


Fig -6: Slot Availability Page

E. Methodology

DSDM model is a new model for developing system or project. I select this type of methodology because of different reasons, first, the result developments are straightforward, and the project system is delivered on the budget required and on time, also the users are involved in the development of the system and the work organized properly on time to finish the basic functions in a short time with good quality. The communication barrier between each partners are removed, the users give the feedback for the system so the developed product is likely to be as per requirements. Last reason, you can know early if the project works or while developing the project [11].

This will help to manage my project as well as need to deliver at time with the requirements that included to finishing.

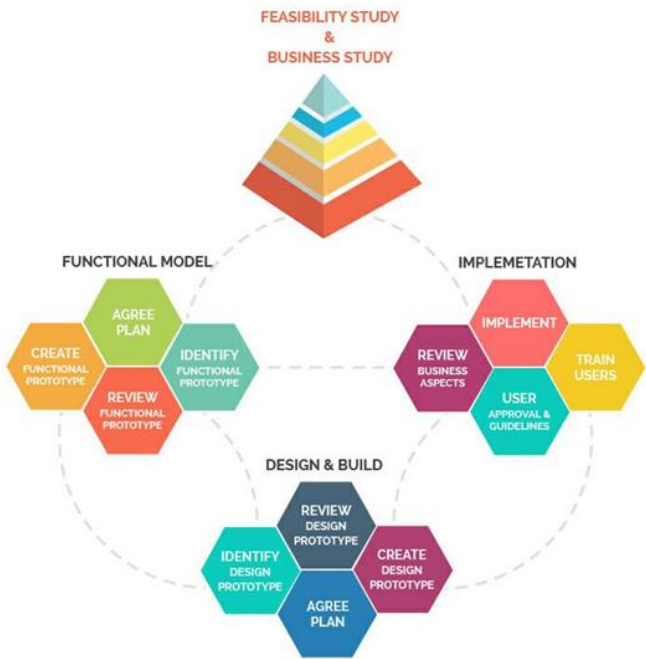


Fig-7 DSDM model methodology [11]

F. Proposed system

1. Framework (System Design1)

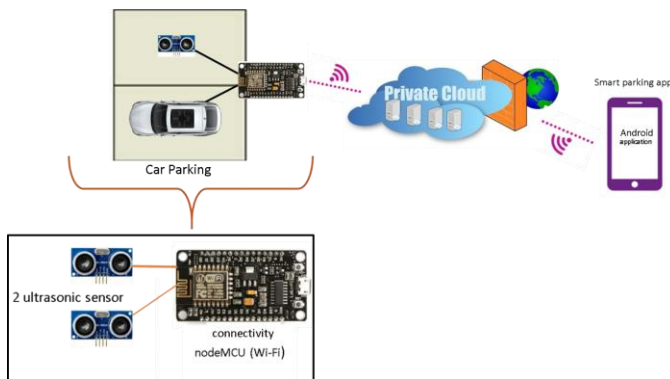
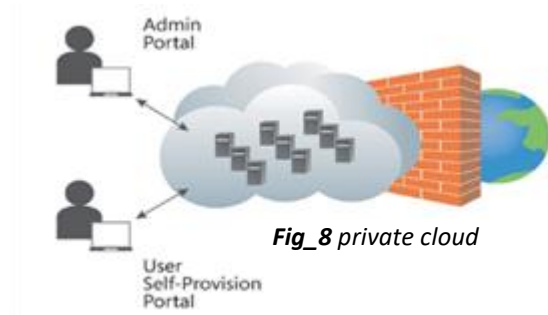


Fig-7 Smart parking system For MEC (Private Cloud)

In the above system design (fig-7) shows the design of IoT smart parking system that used three of main things all IoT should consider which are: the sensitive devices, connectivity or Wi-Fi models devices and the interfaces (the application or web site). This intelligent system for car parking need to have first the sensitive devices which is called (ultrasonic sensor) to measure the distance between the car and parking, each parking have one of ultrasonic sensor. This sensors connected to connectivity devices called (nodeMCU) that response for connectivity and to send the signals from these sensors to the network.



Fig_8 private cloud

The private network consist of different area of servers all these hardwires in one secure network called (Private cloud) the private cloud for Middle East College enterprise it runs all servers own data center of any enterprise is mean the private cloud is deploying cloud computing internally. All servers, cables, software, operating instances, etc., are owned and managed by an organization behind the firewall of the enterprise, as shown in this figure. Cloud offers many services such the ability to efficiently deploy and manage servers to provide maximum flexibility for application development and testing.

Last part show smart parking mobile application, all data that sensor send to cloud through connectivity devices will saved in database server, mobile phone application interfaces will read the data from cloud and

show it in the app which is Android using coding in Android studio program. So the users can easily found the empty parking through their mobile phone.

2. Framework (system Design 2)

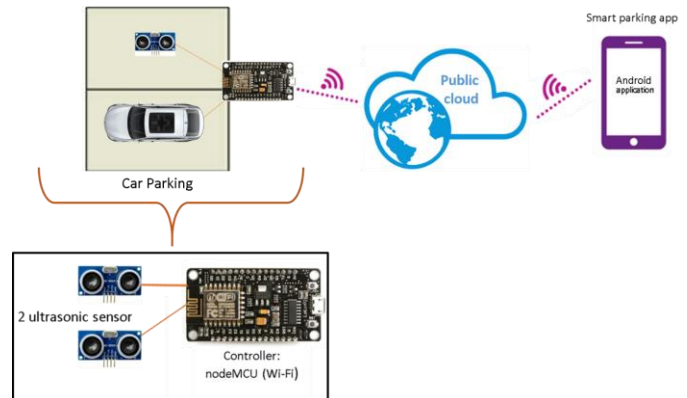


Fig-9 Smart parking system For MEC (public cloud)

This above system design is for public cloud as showing (fig-8) the sensor (ultrasonic) connect with nodeMCU to have a connectivity with cloud, the different is that public cloud is not complex than private cloud, we can have our on public cloud using different public cloud services one of them are ThingsSpeak, depends to IoT ThingsSpeak will send sensor data privately to the cloud database server through IP address and API (application programming interface), and to mobile application as well (fig-9) show IoT ThingsSpeak.



Fig-10 IoT ThingsSpeak

One of the main components of the IoT concept is how to connect different devices to the network so that they can send data and receive commands. There are already different technologies for processing the last mile connection, such as Bluetooth, Wi-Fi, NFC, etc., but

most are complex to deploy and often need additional hardware such as appliance or local control server.

Thingspeak IoT is an open source application and it's an API (application programming interface) for storing and retrieving data from objects using HTTP over the Internet or over a local area network. By using Thingspeak, you can create application recording sensors, site tracking applications and social network for things with status updates.

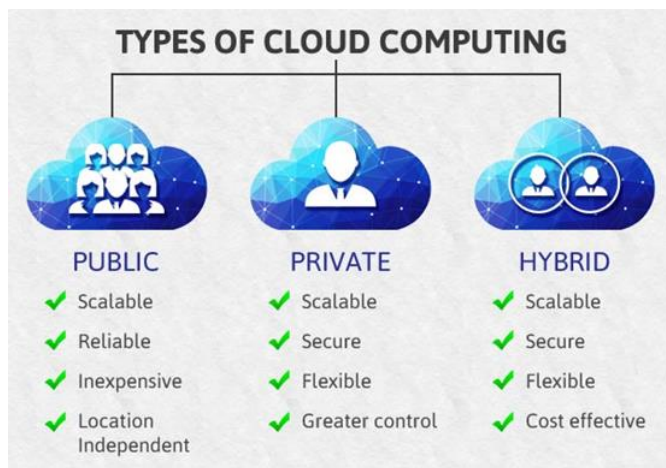


Fig-11 types of cloud computing

(Fig-10) shows the features of each type of cloud computing. The private cloud is the best choice to make for Middle East College Smart Parking System because of the high level of security, scalability, flexibility and greater control.

Therefore, this technique has been used for the following reasons:

- To create new applications and services as well as backup and restore data in order to help when creating the smart parking app for this project.
- Web Hosting and blogging.
- Applying it to Application software services.
- Analysis of data on patterns.
- Make predictions [5].

IR proximity sensor or the infrared proximity sensor is an infrared multi-purpose sensor that can be used to detect obstructions, color and fire detection, line sensing, etc. This sensor outputs the logic +5 V at the digital outlet when an object is placed in front of the sensor and Logic 0V, when there is no body in front of the sensor.

This digital output can be connected directly to nodeMCU, what makes this sensor better to use in the smart parking system because of its different features, which are:

- It can be used in sensor barriers.
- It comes with easy-to-use digital output.
- It can be used for wireless connection and remote sensing infrared signals [7].
- Connecting IR sensors to the NodeMCU is simple and both are not expensive.

NodeMCU is an open source Lua development Kit with esp8266 Wi-Fi onboard module that helps to design models for the IoT projects. It is a low cost Wi-Fi solution which is programmable in Lua scripts and Powered by MicroB USB [8].

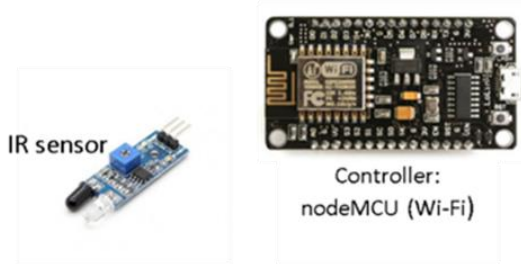


Fig-12 IR sensor & nodeMCU

Mobile application is a part of the Smart Parking System. It is an application program designed to run on a mobile device, such as a smartphone or tablet. Mobile apps often provide users with services similar to those accessed on personal computers. Android Studio is the official integrated development environment for Google's Android operating system and is available for download on Windows, Mac and Linux operating systems. It is software used to design the Android mobile application, and it written with java, Kotlin and the C++.

Using it on a smart phone such as the Samsung, HTC, and LG Models, it can currently reach 76.6% of the world as their operating system is Android OS.

The number is expected to increase as technology progresses. It can also be installed in smart watches, cars and laptops, as Android devices have become a need of the people all over the world. The reason goes back to the open source system in Androids to develop brilliant applications and allow developers to deploy them easily and instantly.



Fig-13 android studio logo

Using the Android Studio program to create a mobile application for the Smart Parking System is good and has been chosen as the best and most excellent environment for applications. The Smart Parking Application can be designed into two pages as can be seen in Figure 5. One page can be used for login because it will be used for Middle East College area and connected to cloud, so all the data will be restored in the database server on the cloud. The second page will show the parking number which will depend on the number of parking spaces available in Middle East College Three parking spaces were selected with each parking space having a sensor. The sensor will send data to the controller device called nodeMCU which is supported by Wi-Fi as shown in (Fig-1). This device will request the data from the sensor through Wi-Fi to the cloud that the Android application is connected with. It will then show the empty parking through some electronic algorithms the device will do and it will compile it to the cloud into the servers and from the servers to the application or smart phone. All the devices should be connected to the internet and at the end this technology is known as internet of things.

This research paper will solve the problem that mentions in the article ‘**smart parking system**’ [9], for the high cost because the number of sensors will decrease so there is no need to use the Raspberry and LCD because this system is only the IR sensor connected to the NodeMCU for Wi-Fi connection and directly via Internet to a private cloud. The information of empty parking will be shown in the mobile phone via an easy application that can be carried on all Android devices easily without extra cost.

The research paper ‘**Smart Parking System**’ [10], that I mention that their system also uses less sensors and less expensive, but is also a wasting of time because the time that person waits to enter the gate and enter the parking lot will effect, but if you might look at the parking in your phone you easily can find it. As we know that the application is easier and more sophisticated than searching for a page and booked the parking, the application is dedicated to this place and can be developed easily.

Having private cloud computing in this system is to build a secure, integrated system with information about where the positions of parking are located, where the owners of the organization, employees or students can easily find the empty parking and they not wait for too much time and delay. They can enter the system by access their name and password, this solves the problem of delay the people in that organization and thus the efficiency of the workers.

(Finding and discussion)

Questionnaire / The questionnaire was distributed to about 50 people at the Middle East College to collect and analyze the required data.

- 1- **Do you agree that the parking system is good for the Middle East College?**

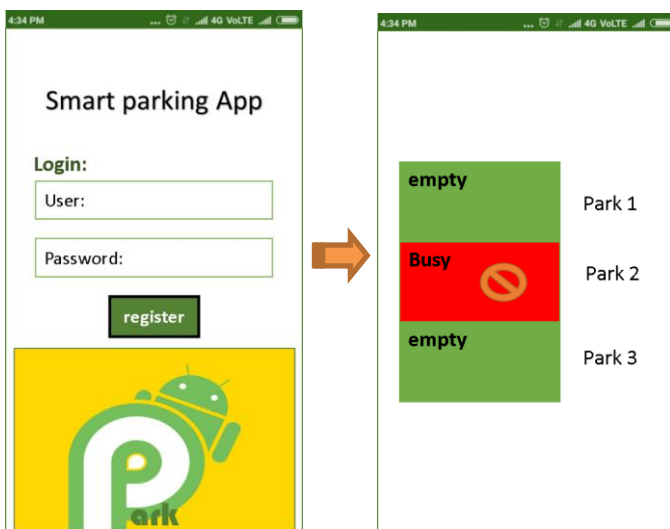


Fig-14 smart parking application pages design in Android Studio

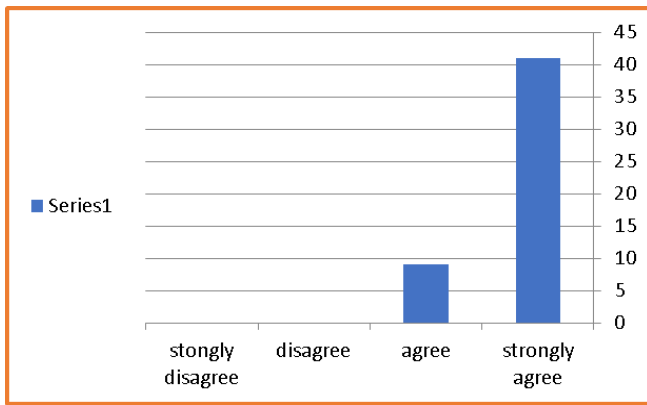


Fig- 15 parking system at MEC

This graph shows the importance of having parking system for Middle East College. It show about 41 strongly agree and 9 agree that parking system is good to have for our college. No one is opposed to this system. This means that students and staff in our college have car parking problems.

2- How long does it take to look for the parking in Middle East Collage Park?

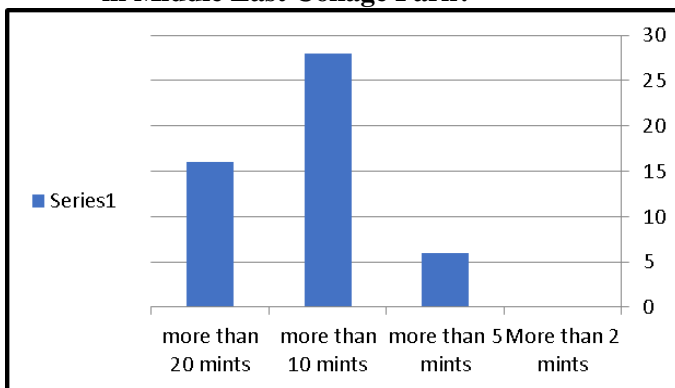


Fig-16 the time spend for found the car parking

This chart shows the time that student or staffs take to search for parking, as it shows they take a lot of time that will affect the time of lectures as students spend in only searching the parking position. They take about 10-20 minutes and more to just search the parking, so having a system of the parking will manage the traffic and not waste time in searching for the parking space.

3- Do you think having an application for car parking in a mobile phone will reduce the time lost in search the empty position?

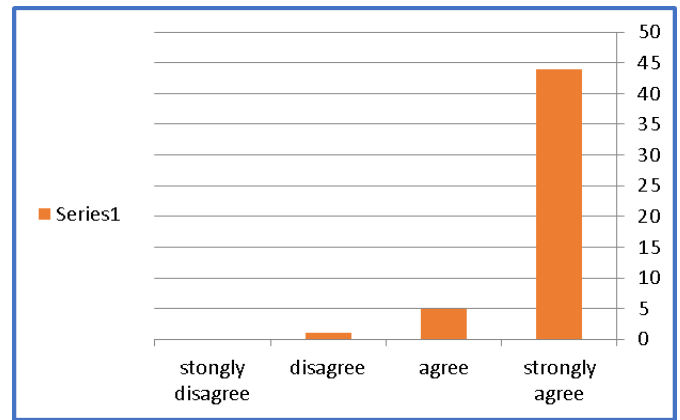


Fig-17 time reduced by using mobile application for the Parking

This graph shows the importance of parking application in mobile phone in reducing the time wasted in search of the parking. 44 of students and staff strongly agree to this idea and 5 agree. This meant that mobile application will manage the time in search of the parking area. This analysis shows that application system for parking of Middle East College is good and important to have.

CONCLOUSTION

We can hereby conclude that this system provides a very efficient and easily way of dealing with parking traffic that people are facing every day in their life and also to saving both time and money.

We can develop the project or application to become more accurate in the future and we can add to the system the possibility of booking car parking over the mobile phone application easily.

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