

The Intelligent Control of Street Light System in Oman through Internet of Things Technology

Asma Ali Hassan AL. Balushi
Department of Computing,
Middle East College
Muscat, Sultanate of Oman.
14f12323@mec.edu.om

Syed Imran Ali Kazmi
Department of Computing,
Middle East College
Muscat, Sultanate of Oman.
skazmi@mec.edu.om

Jitendra Pandey
Department of Computing,
Middle East College
Muscat, Sultanate of Oman.
jitendra@mec.edu.om

Ajay Vikram Singh
AIIT
Amity University Uttar Pradesh
Noida, India
avsingh1@amity.edu

Ajay Rana
AIIT, Amity University Uttar Pradesh
Noida, India
ajay_rana@amity.edu

Abstract—Intelligent Street Lights System based on LED lights is one of the most important concepts in today's life. As now a days world depends on the IoT technologies in different areas. Street lights system will be controlled through IoT technology. In the whole world, enormous energy is consumed by the street lights, which are turned ON automatically all the night. Thus, this will waste a huge energy of the country. The intelligent street light system will work in such a way to turn the LED lights ON when the vehicle is passing through it and when not the LED lights turned OFF. The primary aim of this research paper is to reduce the power energy consumption and cost of the street lights system.

This paper presents the intelligent street lights system that is controlled through IOT technology, which is connecting to sensor device "Ultrasonic" and then to microcontroller device using Wi-Fi connectivity. In addition, it will use the cloud services and mobile application to present the information of the system for the system administrator.

Keywords—Internet of things, intelligent street light system, cloud computing, sensor technology.

I. INTRODUCTION

Internet of things it is defined as a new model which can provides a group of services for the next wave of the technological innovations in this world. Various processes are integrated by IoT technology such as sensing, computation, identifying and networking [1]. IoT is also defined as a network of the physical objects. The internet is a network of computers as well as it can contain into a network of devices such as smart phone, cameras, vehicles, building and industrial systems and etc. Internet of things is a great concept in today's life that is presence in the environment of the different things or objects that are connected to each other through the Wi-Fi connection in order to create new services or applications and then achieve the required goals [2].

Several examples have been seen in the field of street light system which contains vehicle and reduce the power consumption. This research paper shows the intelligent street light system based on IoT technology that is used to reduce the power energy consumption and cost when the vehicle passes through the road the LED lights will be turned ON and when not passing the lights turned OFF at the night. This research paper will present a complete system that consist of sensitive device named Ultrasonic sensor that is used to sense the vehicle when passing through the road. Then the data will

be send from the sensor into the private cloud through the microcontroller device using Wi-Fi connectivity.

II. AIM

The aim of this research paper is to develop the street light system which will be useful for the public and Muscat municipality. The proposed system can be controlled automatically using IoT technology in order to reduce the power energy consumption of the street lights system. Also, the sensing technologies will be used as well to control the lights and make the process of switching the lights ON/OFF based on detected object.

III. THE ISSUES

This research paper focuses on several problems which are listed as the following:

- More energy consumption.
- Increase the cost.
- Light pollution.
- Difficulties that are related to the maintenance of the system.
- Poor quality.

The waste of energy is increased day by day and this will increase the cost as well. Hence, there should be a proper solution that can reduce the power energy consumption of the street lights system. Also, Using the new type of lights (LED) than the traditional one is very useful to save the power energy for Muscat municipality. Controlling the system and store the data in a secured place is very important for each company in the world. This research paper has listed the proper solution to overcome these problems. Also, it has presents how the system administrator can easily manage the system remotely.



Fig. 1. System Design (Private Cloud).

One of the proposed system in smart street lights system research is named as (Internet of Things Based Intelligent Street Lighting System for Smart City) has mentions the smart system that is consisted of IR sensors, LDR, PIC16F877 microcontroller, Relay, UART and ESP8266 node MCU. The system work in such a way to detect the vehicle by using IR sensor when it passes through the street. Then the signals will be transmitted to the PIC16F877 microcontroller and then the system will use ESP8266 node MCU to provide the Wi-Fi connectivity and connect the whole system to the cloud. The LDR is a light dependent device whose resistance decreases whenever the lights fall on them on the other hand it increases in the dark. Relays are in every street system that is used to switch ON/OFF the street lights. The UART (Universal Asynchronous Receiver/Transmitter) it is defined as a microchip that is used to control the computer interface along with it is street lights system. This system saves the energy of the street lights system but it consumes more sources to be implemented to make the system successful [3].

This research paper will solve the problem of consuming more power energy and cost by using less number of sensors and resources because the intelligent street lights system will use the ultrasonic sensor that is placed on the LED pole and then connected with the Arduino UNO device that is used to controller the process of switching the lights ON/OFF based on the detecting objects. Then the node MCU ESP8266 will be used to connect the system to Wi-Fi connectivity then into the private cloud. Moreover, the information of the system will be presented in the mobile app for the system administrator who can easily manage and maintain the system from anywhere and in any time.

This research paper presents the proper solution to reduce the power energy consumption as well as the cost of the street light system. The IoT technology is looking to several things that can choose the best solution for the street lights system which has more efficiency, speed, less costly.

Another research paper titled (Automatic Street Light Control System Using Microcontroller) concludes that the waste of the power energy consumption and the cost can be reduced by having a smart system that can control the process of the lights to be switched ON/OFF based of the detected objects using photoelectric sensor. Then control the system using PIC16F877A Microcontroller that is used to code the system and presents this codes as electrical signals which is presented as switch the lights ON/OFF [4].

Comparing this system with the search sheet in this research, it is clearly seen that this system uses less number of sensors as well as an advanced types of sensor. Thus, will reduce the cost of the system and reduce the power energy consumption. This research paper presents that the intelligent street lights system in connected to the private cloud computing technology. This technology is more secure and useful for the system administrator to know about how the system is performing in anytime and anywhere.

Also, the system administrator can easily find and know if there is any problem occur in the system and then solve it easily without consuming more time.

IV. CLOUD TECHNOLOGY

Cloud computing is the collection of networks and it is defined as the most powerful architecture of the computing.

This technology can provide the users with the services that are needs along with the payment per month. Users need to have the web browser while using this technology. Cloud computing technology consist of three main services that are provided to the users which are Software as a Service (SaaS), Infrastrucure as a Service (IaaS) and Platform as a Service (PaaS) [5].

In today's life cloud computing services are used by the largest companies around the world such as Oracle, Google and Microsoft. Now a day, these services are also used by everyone. The components of cloud computing are Client Computers, Distributed Servers and Data Centre. client computers are defined as the user interface which can be used in order to interact with the cloud computing. Distributed Servers are the different servers that had been distributed in different places but these servers will work in such a way as there working with each other. Data center is the compilation of the servers [5]. Hence, the cloud technology is the best options to be used in the intelligent street lights system that will connect the sensors and application and the whole servers in one specific area (cloud).

A. Types of cloud technology

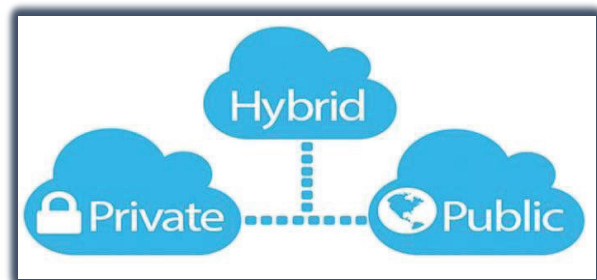


Fig. 2. : Types of cloud technology.

1) Public cloud

The cloud service provider is the owner of the cloud infrastructure. It is defined as the computing service that is supplied by the third party providers. The services are available for all the users and they have to pay for the services that they have consumed only. The advantages of the public cloud technology are cost-effectiveness, high scalability, flexibility and reliability. On the other hand, the disadvantages of this type of cloud that it is less secure and less customizable [5].

2) Private cloud

Private cloud it is defined as a form of the cloud computing technology where the user is limited to the services. The infrastructure policies of this type of cloud computing are decided by a single company where the data can be moved from internal and external data centers. This cloud can provide several advantages for the company such as manageability, compliance, security and privacy. Having private cloud technology in the intelligent street system for Muscat municipality is very great and useful because all the data will be secured and accessed only by the authorized users as well as the other advantages of this cloud [6].

3) Hybrid cloud

It is a combination of public and private clouds. The cloud can also be considered as intermediate stage like the enterprises prepare to move their workloads into the public cloud technology. The company that uses hybrid cloud can

maintain its own private cloud and it can also scale out to it is public cloud if it is required. The benefits of using this cloud are ensuring high availability in the data center and optimal utilizations [7]. Hence, the best type of cloud to be used for the intelligent street lights system is private cloud because of its advantages which are presented in the below figure along with other types of the cloud technology.

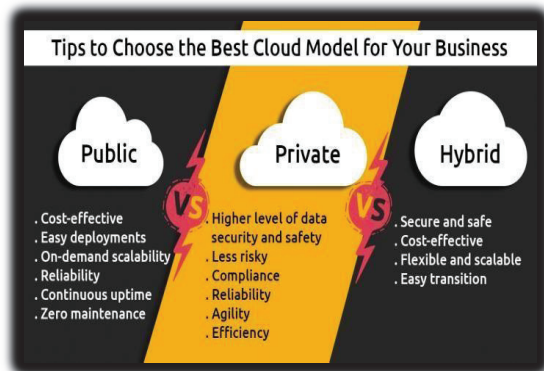


Fig. 3. Types of cloud technology.

Private cloud technology has been used in this system because of several reasons which are listed below:

- To create new app for the street lights system along with its services.
- Save the data of the system securely than the other types of the cloud.
- Analyse the data on patterns of the system.
- Provide flexibility and cost saving.

V. INTELLIGENT STREET LIGHT SYSTEM

The existing system is consisting of a mobile app that is used by the system administrator to manage and control the street lights system remotely and easily. The app is an application program that is designed in such a way to be run in smart devices like mobile devices and tablets. This project uses Blynk application software which is defined as the most popular internet of things platform that is used to connect the devices to the cloud technology. Blynk app can be downloaded in different OS such as Windows, Linux, and Mac. Blynk app is an open source software that is used to design the applications and it is written in C++, Java, and Python language.

This application can be run in different operating systems like Android OS, iOS OS, and Hybrid OS.

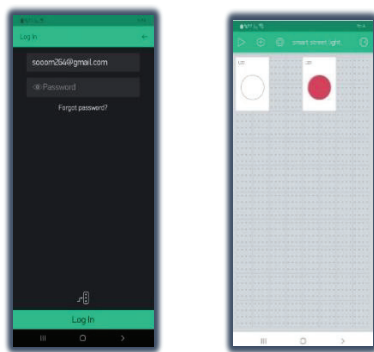


Fig. 4. Blynk application of smart street light system.

The intelligent street lights system has used the Blynk software to create the mobile app for this project. It is a very good choice because it was easy to create the app and it has been considered as the best environment for creating the applications.

The system will work in such a way to reduce the power energy consumption of the street lights system. It consists of several devices like the Ultrasonic sensor that is placed on the LED lights that work to detect the objects and then send the data to the microcontroller device that is named Arduino Uno. After that, the node MCU is used to provide the Wi-Fi connectivity and connect the whole devices to the cloud. Hence, connecting all these devices to the internet is known as the internet of things technology.

Arduino is defined as an open source microcontroller which can be programmed easily at any time. This device is designed in such a way to provide an easy and cheaper way for the academic students as well as the professionals to create devices that have the ability to interact with their environments using the sensors. It is also known as a minicomputer that is used to program the electronic devices [8].

Ultrasonic sensors are non-contact measurement devices which are used to provide the precise distance measurement of the objects. This can be achieved by using the ultrasonic waves; these waves are transmitted by the sensor transmitter. Whenever the sensor hits an object, a part of the energy will be reflected back to the sensor receiver as echo signals [9]. Then these signals will be sent to the microcontroller to perform the process of switching the lights ON.

VI. METHODOLOGY

In this research paper, the chosen methodology is the CADSDR methodology. This methodology is more proper for the proposed system because it consists of six main stages which are required in this system in order to complete the work successfully. These stages are collection of data, analysis of data, develop prototype, survey, design, and result. Here, as each project in the world should be successful and achieve its objectives, there should use a proper methodology. The CADSDR methodology first will start with the collection of data stage that will search about the required data from the different sources. The second stage is analyzing the data of the street lights system as well as determining the different tasks of the system to be completed in a specific time. The third stage is developing the prototype of the system that will use the advanced technologies in order to meet the objectives of this research paper. The fourth stage is survey, a technique used to study some particular idea to collect the required information about a specific topic. Here, the questionnaire is used to complete this research paper. In the fifth stage, that is named design, the street lights system is designed by using Visio program by mentioning both physical and logical design. It is also defined as the stage where the prototype of the project has been tested. The design of the street light system should be more smart and intelligent. Thus, this will help to improve the performance of the street light system. The last stage is the result, which is to highlight the findings of the system and the results that the system finds. Also, it is known as where the proposed system will end with the final product.

The below figure shows the framework of the street light system in Oman.

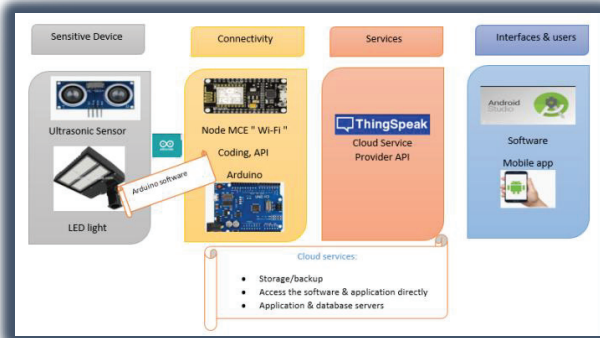


Fig. 5. : framework.

VII. FINDING AND DISCUSSION

It is an approach that is used to obtaining the required data and information from the different sources which are related to this system. The proposed system is controlled by using IoT technology that has helped to complete the work effectively. Moreover, from the information that has been taken from the different resources finally the analysis has been done as it is shown below.

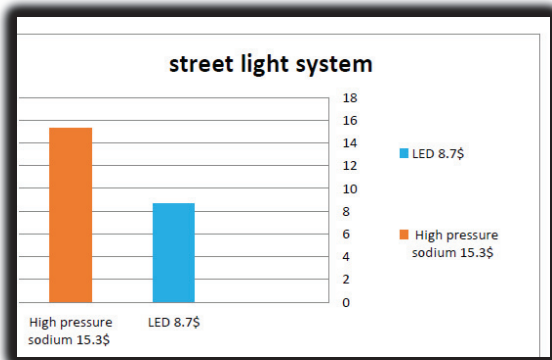


Fig. 6. The cost saving of the street light system.

This figure presents the cost saving in million when it uses the LED lights system and the high pressure sodium light in Los Angles in 2013. It present that the cost saving in LED light is around 8.7\$ million while it is 15.3\$ when using the old lights on the street light system.

VIII. CONCLUSION & RECOMMENDATION

At the end of this research paper it is clearly can be seen that the street lights system can reduce the power energy consumption and cost of the country. Also, using LED lights it is very good solution to be implemented in the street lights system that can save more energy than the traditional one. In addition, with the advanced technologies that are used in this system the street lights system can save the cost of the Municipality as well as the maintenances of the system will be reduced. Finally, having an intelligent street lights system can help the system administrator to solve the problems easily in anytime and in anywhere since the system is connected to the private cloud technology. The recommendations of this system is to invest the saving money of this project in other fields that needs to be improved. Also, to develop the mobile app and give the user the ability to access through the internet to know if there is

any issue or any problem in that road. Moreover, in the near future this system can be implemented in other places like campuses, industries and in other cities in the Sultanate of Oman.

REFERENCES:

- [1] Colakovic, A & Hadzialic, M. (2018) ' Internet of Things (IoT): A Review of Enabling Technologies, Challenges, and Open Research Issues' Article in Computer Networks [online]1(2),17-39. available from< https://www.researchgate.net/publication/326539025_Internet_of_Things_IoT_A_Review_of_Enabling_Technologies_Challenges_and_Open_Research_Issues> [10th December 2019]
- [2] Salazar, C et al. (2016) ' Internet of Things-IOT: Definition, Characteristics, Architecture, Enabling Technologies, Application & Future Challenges' International Journal of Engineering Science and Computing [online] 6(5), 6122-6131. Available from< https://www.researchgate.net/publication/330425585_Internet_of_Things_IOT_Definition_Characteristics_Architecture_Enabling_Technologies_Application_Future_Challenges> [10th December2019]
- [3] Siham Al Hinai; Ajay Vikram Singh, "Internet of Things: Architecture, Security challenges and Solutions", 2017 International Conference on Infocom Technologies and Unmanned Systems (ICTUS'2017) (Trends and Future Directions) at Amity University Dubai, UAE, 18 – 20 December, 2017 Pages: 202 – 205
- [4] Tambare, P et al. (2016) 'Internet of Things Based Intelligent Street Lighting System for Smart City' International Journal of Innovative Research in Science, Engineering and Technology[online] 5(5), 76847691.available from<<https://www.researchgate.net/publication/323280>> [25November2019]
- [5] Danish Showkat, Subhranil Som, Sunil Kumar Khatri, (2018) "Security Implications in IoT using Authentication and access control", 7th International Conference on "Reliability, Infocom Technologies and Optimizations (Trends and Future Directions) ICRITO 2018, Published IEEE Xplore: 01 July 2019, DOI: 10.1109/ICRITO.2018.8748731, 29-31 August 2018, IEEE Conference, Amity University, Noida, India.
- [6] Saad, M et al. (2018) ' Automatic Street Light Control System Using Microcontroller' Mathematical Methods and Optimization Techniques in Engineering[online] 1(3), 92-96. available from< https://www.researchgate.net/publication/321318899_Automatic_Street_Light_Control_System_Using_Microcontroller> [25November20]
- [7] Srivastava, P & Khan, R. (2018) 'A Review Paper on Cloud Computing' International Journals of Advanced Research in Computer Science and Software Engineering [online] 8(6), 17-20. Available from<www.ijarcsse.com> [14th October 2019]
- [8] Kulkarni, G & Patil, N. (2012) ' Private Cloud Secure Computing' International Journal of Soft Computing and Engineering (IJSCE)[online] 2(1), 75-77. Available from< https://www.researchgate.net/publication/234166312_Private_Cloud_Secure_Computing> [2December2019]
- [9] Palwel, R & Kulkarni, G & Dongare, A. (2012) ' A NEW APPROACH TO HYBRID CLOUD' International Journal of Computer Science and Engineering Research and Development (IJCSE) [online] 2(1), 1-6. Available from< https://www.researchgate.net/publication/234166328_A_NEW_APPROACH_TO_HYBRID_CLOUD> [23November2019]
- [10] Louis, L. (2016) 'WORKING PRINCIPLE OF ARDUINO AND USING IT AS A TOOL FOR STUDY AND RESEARCH' International Journal of Control, Automation, Communication and Systems (IJCACS)[online] 1(2), 21-29. Available from <https://www.researchgate.net/publication/326316390_WORKING_PRINCIPLE_OF_ARDUINO_AND_USING> [1November2019]
- [11] Fatma Al Shuhaimi; Manju Jose; Ajay Vikram Singh, "Software Defined Network as Solution to Overcome Security Challenges in IoT", 2016 5th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO) at AUUP, NOIDA, India, September 07-09, Year: 2016 Pages: 491 - 496, DOI: 10.1109/ICRITO.2016.7785005
- [12] Stiawan, R et al. (2019) ' An Ultrasonic Sensor System for Vehicle Detection Application' Journal of Physics[online] 1-6.available from< <https://iopscience.iop.org/article/10.1088/1742-6596/1204/1/012017/pdf>> [2nd December]
- [13] N. Agarwal, A. Rana, J. P. Pandey, "Fine-grained access control and secured data sharing in cloud computing", in Advances in Intelligent Systems and Computing, Vol. 729, pp 201- 214 (2018).

- [14] A. Saroliya, U. Mishra, A. Rana, "Performance Evaluation and Statistical Analysis of AUR-Chord Algorithm with Default Working of Structured P2P Overlay Network", in *Advances in Intelligent Systems and Computing*, Vol. 583, pp 753-760 (2018).
- [15] D. Gupta, A. Rana, S. Tyagi, "Sequence generation of test case using pairwise approach methodology", in *Advances in Intelligent Systems and Computing*, Vol.554, pp 79-85 (2018).
- [16] V. Kunwar, N. Agarwal, A. Rana, J. P. Pandey, " Load balancing in cloud—a systematic review", in *Advances in Intelligent Systems and Computing*, Vol. 654, pp 583-593 (2018).
- [17] B. D. Chauhan, A. Rana, N. Sharma, "Testing sufficiency test (TST) - Evolving a new model for estimating software test cases", in *International Journal of Applied Engineering Research*, pp 12-21 (2017).
- [18] G. Dubey, A. Rana, J. Ranjan, "Fine-grained opinion mining of product review using sentiment and semantic orientation", in *International Journal of Business Information Systems*, Vol. 25, Issue 1, pp 1-17 (2017).
- [19] S. Ghosh, A. Rana, V. Kansal, "Predicting defect of software system" in *Advances in Intelligent Systems and Computing*, Vol 516, pp 55-67 (2017).
- [20] A. Saroliya, U. Mishra U, A. Rana, "Improvement in routing techniques in P2P networks using a cloud service interface with secure multiparty computation", in *Far East Journal of Electronics and Communications*, Vol. 16, Issue 3, pp 673-683 (2016).