SMART CITY ENERGYMANAGEMENT SYSTEM

Dr.M.Murugesan[1], J.Sherrin Banu[2], M.Kokilavani[3], S.Nirmal Kumar[4]
Librarian[1], Assistant Professor, Department of EEE[2,4] Department of ECE[3]
M.I.E.T. ENGINEERING COLLEGE, (Autonomous), TRICHY-07.

Abstract
In the smart city, advanced monitoring systems are implemented to optimize various aspects of urban life. These systems include sensors that detect sunlight levels to adjust street lighting accordingly, ensuring efficient energy usage and safety. Parking alert systems utilize real-time data to guide drivers to available parking spaces, reducing congestion and emissions. Hill station roadways are equipped with vehicle monitoring technology linked to signal lights, facilitating smoother traffic flow and enhancing safety on steeper rain. Information updates are displayed on LCD screens across the city, providing residents with timely updates on traffic conditions and other relevant news. The city leverages solar energy sources to power these systems, demonstrating a commitment to sustainability and environmental stewardship.

Keywords: *Street Lights, Parking Space, LCD Screen, Smooth Traffic, Solar Energy.*

I. INTRODUCTION

The idea of smart cities is becoming more popular as urban areas keep growing rapidly. Experts predict that by 2050, around two-thirds of the world's population will be living in cities. To manage this fast-paced growth, governments and wealthy investors are now exploring new ways to build better cities. In recent years, they have started spending large amounts of money to buy land and create entirely new urban areas. At the same time, they are also investing in modern smart technologies to make cities more efficient, environmentally friendly, and liveable.

A smart city uses advanced technology to improve how the city functions. By sharing and analyzing data, these cities aim to save energy, reduce pollution, and provide a better quality of life for residents. Key tools that make this possible include the Internet of Things (IoT) and Information and Communication Technologies (ICTs). These technologies help cities run more smoothly by improving services such as transportation, energy use, waste management, and communication—while also considering social, environmental, and cultural factors. Urban growth is a natural part of economic development. In India, which has a population of about 1.4 billion people, almost one-fourth live in urban areas. Cities play a big role in the country's economy, acting as hubs for industry, services, and innovation. To support smarter infrastructure, current technology includes tools like PIR (Passive Infrared) sensors, which help manage street lighting more efficiently. These sensors detect motion and adjust the lights accordingly—turning them on when it's dark and someone is nearby, and switching them off when there's no movement or during daylight hours. This helps save electricity and reduces waste.

However, relying too much on PIR sensors can also be a drawback. In bad weather or if the sensor malfunctions, it might not detect movement correctly. This could lead to lighting issues or energy wastage. Regular checks and maintenance are important to keep the system working properly. Also, if the power supply or timing device in the circuit fails, it can affect the entire lighting system. These kinds of challenges highlight the need for reliable design and upkeep when using smart technology in real-world applications.

II. LITERATURE SURVEY

A time-efficient indoor navigation and evacuation (TINE) framework to minimize moving time for mobile users based on Internet of Things (IoT) technologies. In normal time, the proposed TINE framework can estimate the density of mobile users in each area and determine the moving speeds to pass through different areas. Based on the determined moving speed of each area, an indoor navigation path can be planned to provide the shortest moving time for a mobile user. In emergent time, TINE can accurately estimate the escaping time for groups of mobile users by jointly considering the length and moving time of passageways, the capacity of passageways/ doors/exits, the present distribution and parallel moving of mobile users, and the possible congestion caused by other groups. Based on the estimated escaping time, TINE can efficiently alleviate the congestion of all passageways/exits and evenly distribute the evacuation load among exits to minimize the total escaping time[1].

The massive deployment of Internet of Things (IoT) is allowing Smart City projects and initiatives all over the world. The IoT is a modular approach to merge various sensors with all the ICT solutions. With over 50 billion objects will be connected and deployed in smart cities in 2020. The heart of smart cities operations is the IoT communications. IoT is designed to support Smart City concept, which aims at utilizing the most advanced communication technologies to promote services for the administration of the city and the citizens. This paper is presenting a comprehensive review of the concepts of IoT and smart cities and their motivations and applications. Moreover, this paper describes the main challenges and weaknesses of applying the IoT technologies based on smart city paradigm [2].

With the prevalence of sensor-rich smart phones, MCS has become an emerging paradigm to perform urban sensing tasks in recent years. In MCS systems, it is important to minimize the energy consumption on devices of mobile users, as high energy consumption severely reduces their participation willingness. In this article, we provide a comprehensive review of energy saving techniques in MCS and identify future research opportunities. Specifically, we analyze the main causes of energy consumption in MCS and present a general energy saving framework named ES Crowd that we use to describe the different detailed MCS energy saving techniques. We further present how the various energy saving techniques are utilized and adopted within MCS applications and point out their existing limitations, which inform and guide future research directions [3].

Exploiting radio frequency signals is promising for locating and tracking objects. Prior works focus on per-tag localization, in which each object is attached with one tag. In this paper, we propose a comprehensive localization and tracking scheme by attaching two RFID tags to one object. Instead of using a per-tag localization pattern, adding one more RFID tag to the object exhibits several benefits: providing rich freedom in RFID reader’s antenna spacing and placement; supporting accurate calibration of the reader’s antenna location and spacing; and enabling fine-grained calculation on the orientation of the tags. All of these advantages ultimately improve the localization/tracking accuracy. Our extensive experimental results demonstrate that the average errors of localization and orientation of target tags are 6.415 cm and 1.330°, respectively. Our results also verify that the reader’s antenna geometry does have an impact on tag positioning performance [4].

In the Internet-of-Things (IoT) era, it will be increasingly important to accurately and efficiently locate an object in the real world as well as identify it in the virtual world. However, it is not easy to accurately locate an indoor target using radio technology because the multipath propagation of radio waves in an indoor environment may lead to serious position estimation errors. In addition, when each target has a transceiver or each reader operates in its high-power mode, the overall power consumption of the whole system is considerable. In this work, a dual-channel low-power passive RFID positioning system is proposed to solve this problem. The probability for accurately locating a target within 0.5 m from its real position can reach 96.7% in this system.

The positioning area of this work is bigger than those of the prior arts. The total RF radiation power of one block of the proposed system is 23.14 dBm, which is the lowest among reported RFID positioning systems. Furthermore, this proposed architecture can be easily expanded to a large system [5].

Nowadays, more and more urban residents are aware of the importance of air quality to their health, especially those living in large cities that are seriously threatened by air pollution. Meanwhile, being limited by the sparse sense nodes, the air quality information is very coarse in resolution, which brings urgent demands for high-resolution air quality data acquisition. In this paper, we refer to the real-time and fine-grained air quality data on a city scale by employing crowd sourced automobiles as well as their built-in sensors, which significantly improves the sensing system's feasibility and practicability.

The main idea of this work is motivated by the fact that the air component concentration within a vehicle is very similar to that of its nearby environment when the vehicle's windows are open, given the fact that the air will exchange between the inside and outside of the vehicle through the open window. Therefore, this paper first develops an intelligent algorithm to detect the vehicular air exchange state, and then extracts the concentration of pollutants under the condition that the concentration trend is convergent after opening the windows [6].

In this paper, we propose a smart campus care and guiding framework with deep learning-based face recognition, called Deep Guiding, for students through Internet of Things technologies. The Deep Guiding framework can construct the dedicated video trajectory of a campus student, where the recorded video for each student can be automatically classified to achieve efficient footprint review as necessary.

In addition, Deep Guiding can provide time-efficient indoor and outdoor guiding in a campus to quickly reach places, meet friends, and find students. To the best of our knowledge, Deep Guiding is the first campus care and guiding system which provides the following features: it achieves the seamless outdoor and indoor navigation between buildings in a campus; it keeps additional construction costs low by utilizing existing surveillance cameras in a campus; and it reduces the total searching time for finding a specific event or target in a campus by alleviating time-consuming labor overhead to review a huge amount of video data [7].

III. SYSTEM ARCHITECTURE

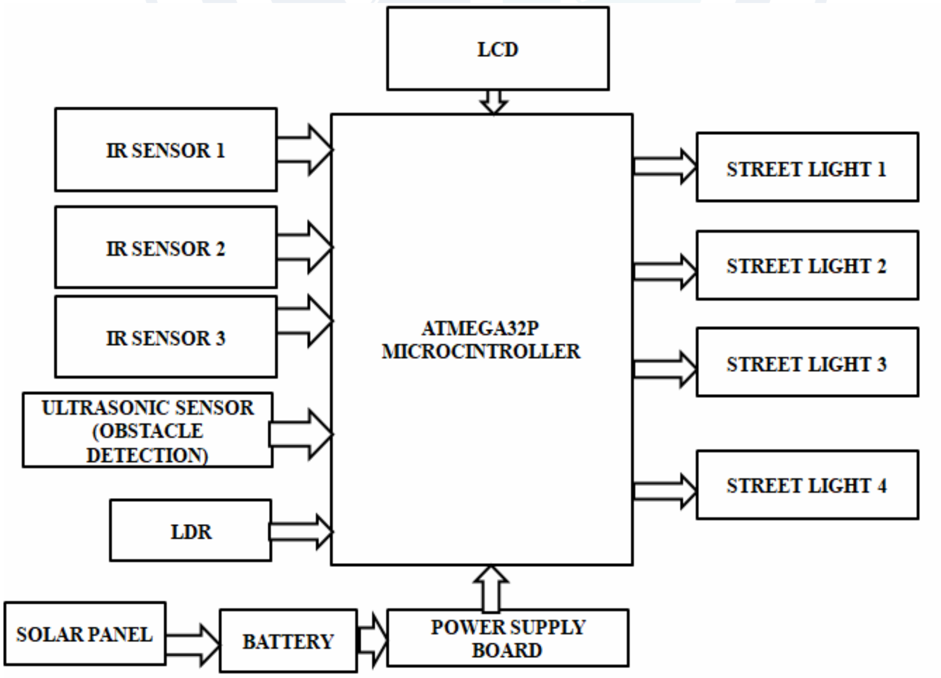

Fig.1 Block Diagram of the Overall System

IV. COMPONENTS DESCRIPTION

Solar Panels: Solar panels are photovoltaic devices that convert sunlight into electrical energy. In the proposed system, solar panels serve as a renewable energy source to power various components, reducing reliance on traditional grid electricity and promoting sustainability.

Battery: The battery stores energy generated by the solar panels for later use, ensuring continuous operation of the system even during periods of low sunlight or at night. It provides a reliable power source for the components, offering energy storage and backup capabilities.

Power Supply Unit: The power supply unit regulates and distributes electrical power to different components of the system, ensuring stable voltage and current levels. It interfaces with both the solar panels and the battery to manage energy flow efficiently.

Arduino Uno: Arduino Uno is a microcontroller board based on the ATmega328P chip, commonly used in electronic projects for its versatility and ease of programming. In this system, Arduino Uno serves as the central control unit, coordinating the operation of sensors and actuators based on programmed logic and input signals.

IR Sensor: Infrared (IR) sensors are used for detecting the presence of vehicles in parking spaces. They emit and detect infrared radiation to identify whether a parking spot is occupied or vacant, enabling real-time monitoring and notification of parking availability.

LDR Sensor: Light Dependent Resistors (LDRs) are used to measure ambient light levels for controlling the intensity of street lights. They change resistance based on the amount of light falling on them, allowing the system to adjust street light brightness according to environmental conditions.

Ultrasonic Sensor: Ultrasonic sensors emit high-frequency sound waves and measure the time taken for the waves to reflect off objects. In the proposed system, ultrasonic sensors are used for obstacle detection.

V. SYSTEM WORKING

The proposed system for smart city management incorporates a range of essential components, including solar panels, batteries, power supply units, Arduino Uno microcontrollers, IR sensors for parking space identification, LDR sensors for controlling street light intensity based on ambient light levels, and ultrasonic sensors for obstacle detection. Additionally, alternate street lights are illuminated during nighttime when no one is passing by. This may consume more energy; therefore, a solar supply with a battery is used to store and provide the required energy. These components are connected as shown in Fig. 1.

By integrating these elements, the system aims to create a robust infrastructure for efficient parking management, optimized street lighting, and enhanced safety through obstacle detection. Through the utilization of solar energy sources and advanced sensor technology, the system not only improves urban mobility but also promotes sustainability and resource efficiency in smart city environments.

VI. HARDWARE IMPLEMENTATION

The overall setup in OFF state and ON state is shown in the figures, Fig. 2 and Fig. 3. It consists of the IR sensors, ultrasonic sensors, LCD display, solar panel, battery, and the Arduino. The smart parking with empty slots and filled slots is shown in the figures, fig 4,5. The street lights are off during the day time and it is shown in the figure, fig 6. Alternate street lights glowing with intensity variation are shown in the figures, Fig. 7.

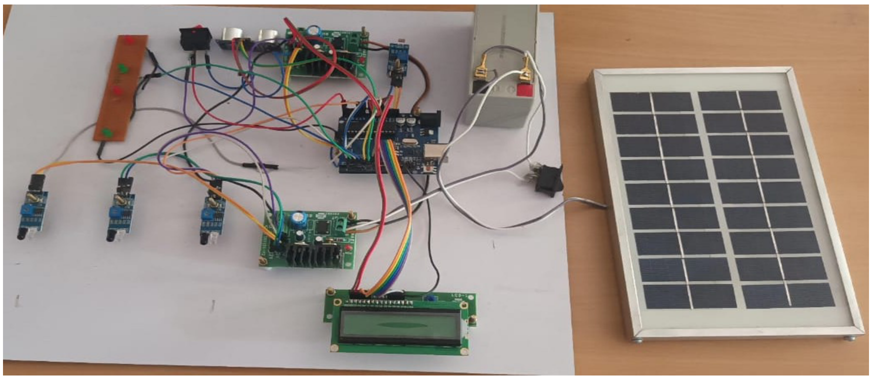

Fig. 2 OVER ALL HARDWARE SETUP OFF STATE

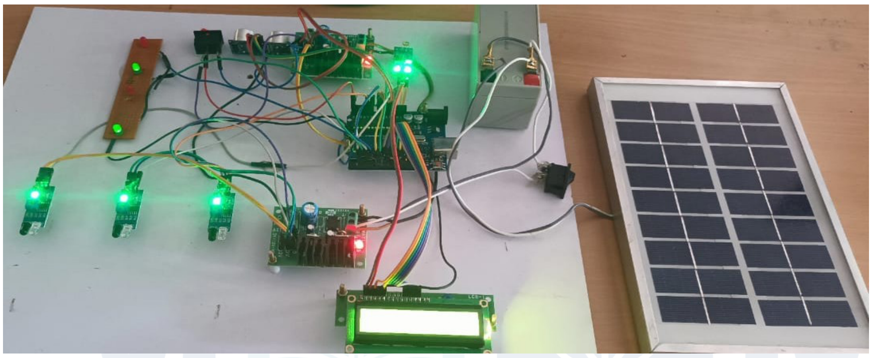

Fig. 3 OVERALL HARDWARE SETUP ON STATE

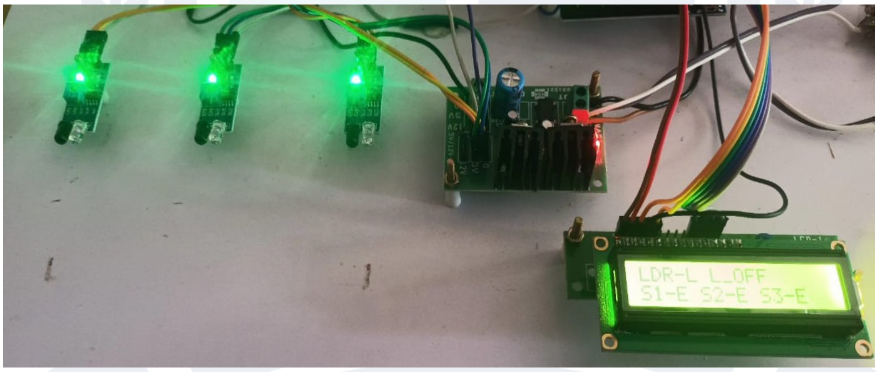

Fig.4 SMART PARKING WITH ALL SLOTS EMPTY

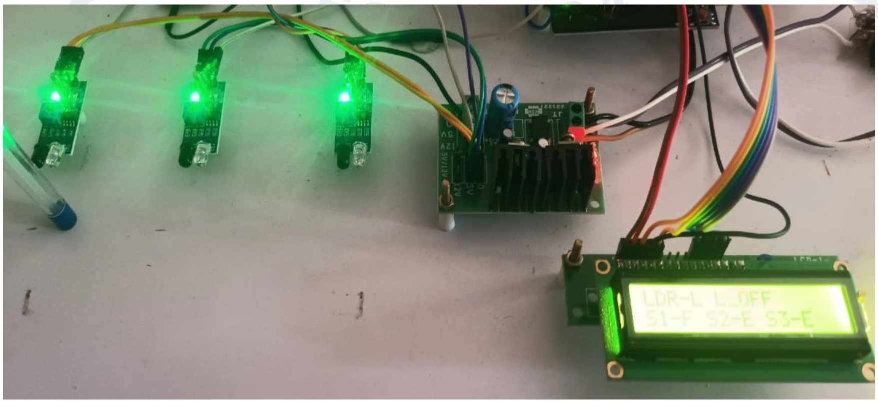

Fig.5 SMART PARKING WITH SLOT 1 FULL

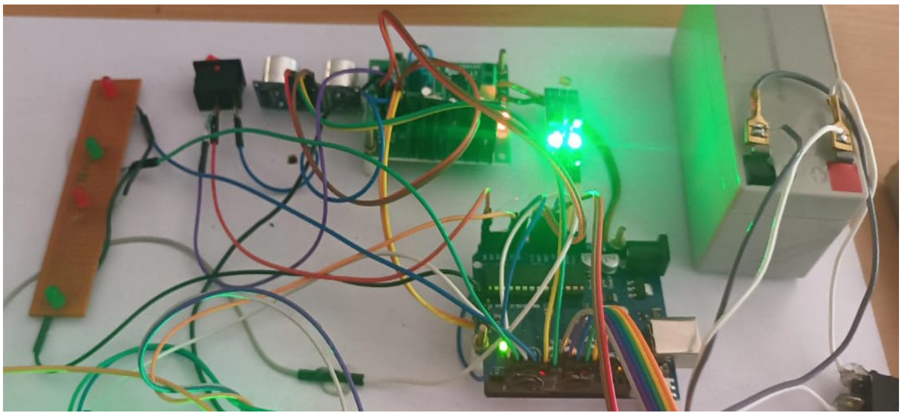

Fig.6 STREET LIGHTS OFF DURING MORNING

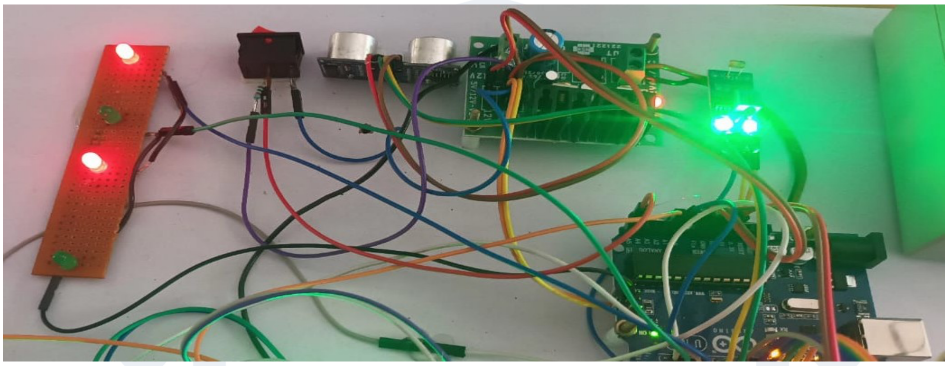

Fig.7 ALTERNATE LIGHTS GLOWING

VII. CONCLUSION

In conclusion, it is observed that the street light can be controlled automatically using Arduino, and a timer delay is used to control the glow of alternate loads. The installation cost and operational cost are very low, and the output efficiency is high. When compared to other topologies, Arduino plays a vital role in automatic control. Further, we have attached a solar supply with a battery to overcome power interruption.

It is observed that the smart parking can be controlled automatically using Arduino, and an LCD display is used to determine the status of the slots. The installation cost and operational cost are very low, and the output efficiency is high. When compared to other topologies, Arduino plays a vital role in automatic control. Further, we have attached a solar supply with a battery to overcome power interruption.

The future scope of the project is that we can use AI technology and IoT technology to enhance smooth and uninterrupted communication between the systems and users. We can also include other concepts like e-waste management, theft detection, surveillance, etc.

VIII. REFERENCES

[1] Hashem, A. T., Chang, V., Anuar, N. B., Adewole, K., Yaqoob, I., Gani, A., … Chiroma, H. (2016). The role of big data in smart city. *International Journal of Information Management*, *36*(5), 748–758.

[2] Sindhu, A. M., George, J., Roy, S., & Chandra, J. (2016). Smart Streetlight Using IR Sensors. *IOSR Journal of Mobile Computing & Application (IOSR-JMCA)*, *3*(2), 39–44.

[3] Müller, R., & Riener, A. (2011). An energy efficient pedestrian aware Smart Street Lighting system. *International Journal of Pervasive Computing and Communications*, *7*(2), 147–161.

[4] Badgaiyan, C., & Sehgal, P. (2015). Smart Street Lighting System. *International Journal of Science and Research*, *4*(7), 271–274.

[5] Parkash, P. V., & Rajendra, D. (2016). Internet of Things Based Intelligent Street Lighting System for Smart City. *International Journal of Innovative Research in Science, Engineering and Technology*, *5*(5), 7684–7691.

[6] Szum, K. (2021). IoT-based smart cities: A bibliometric analysis and literature review. *Engineering Management in Production and Services*, *13*, 115–136.

[7] Urooj, S., Alrowais, F., Teekaraman, Y., Manoharan, H., & Kuppusamy, R. (2021). IoT Based Electric Vehicle Application Using Boosting Algorithm for Smart Cities. *Energies*, *14*(4).

[8] Gehlot, A. (2021). Internet of Things and Long-Range-Based Smart Lampposts for Illuminating Smart Cities. *Sustainability*, *13*.

[9] Towards secure smart cities: design and implementation of smart home digital communication system. (2021). *Indonesian Journal of Electrical Engineering and Computer Science*, *21*, 271–277.

[10] Srinivas, M., Benedict, S., & Sunny, B. C. (2019). IoT cloud based smart bin for connected smart cities-A product design approach. In *10th International Conference on Computing, Communication and Networking Technologies (ICCCNT)*. IEEE.