Smart Street Light Management System Using IOT

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Abstract: -Intelligent and resilient infrastructure is necessary for smart cities for contributing flexible and smart amenities to the citizens. Concerning the United Nations (UN) estimation, the global population residing in urban cities will reach 68% by 2050. Additionally, the Sustainable Energy Action Plans (SEAP) report suggests implementing energy efficiency technologies in smart cities to meet the rising urban population requirement. Internet of Things (IoT) technology empowers to achieve the goal of energy efficiency by integrating sensors, wireless technology, and renewable energy sources in the lighting system. At present, the IoT-based lighting system in urban cities is implemented with streetlamps and lampposts. In this study, we are focusing on lampposts, as it has the flexibility of establishing and implementing a multitude of applications on a single system. Due to technological advancement, the lamppost is embedded with multiple sensors, communication protocols, and energy distribution infrastructure for delivering smart and affordable amenities to the citizens residing in the smart cities. This motivates us to implement a smart lamppost that provides a multitude of applications such as smart light, digital signs, environmental monitoring conditions, electric vehicle (EV) charging port, wireless fidelity (Wi-Fi) hotspot, etc., on a single lamppost. This study proposed the IoT-assisted fog and edge-based smart lamppost for the smart cities to realize the smart infrastructure. Further, this smart lamppost is integrated with low power and long-range communication, i.e., Long Range (LoRa), enabling the smart lamppost to communicate the sensory data to a long-range. Additionally, LoRa is integrated with a Wi-Fi module for establishing the interconnection between the smart lamppost and IoT server. Generally, the proposed architecture is broad perspective; however, we have developed and implemented the hardware models of three components including lighting system, environmental parameters and image sensing in real time. Lighting system and environmental parameter monitoring are integrated on same hardware model for sensing and logging the real-time values of temperature, humidity, CO and light intensity on the IoT server. The developed image sensing prototype based on ESP 32 controller is also evaluated in real-time scenarios, and the performance of the prototype is efficient. The proposed system delivers reliable performance in terms of sensing and communicating environmental parameters and images to the IoT server. Moreover, in future, we will complete the development of other components of the smart lamppost for enhancing the smarter infrastructure in smart cities.

Key Words: — ***Street light management system, Smart lamppost, IoT, ESP 32, LoRa, IoT server .***

I. INTRODUCTION

A smart streetlight is a public lighting fixture that incorporates technology, such as cameras, light-sensing photocells and other sensors, to introduce real-time monitoring functionalities. Also referred to as adaptive lighting or intelligent street lighting, this type of lighting system is recognized as a significant step in the development of smart cities.

In addition to enabling cities to provide the proper amount of street light for local conditions, installing intelligent lighting will help improve citizen satisfaction regarding security and safety, while bringing municipalities significant savings in power consumption and lighting system maintenance. Plus, outdoor lighting infrastructure will serve as a backbone for a number of internet of everything (IoE) applications, such as monitoring weather, pollution and traffic. As municipalities make the transition from traditional lighting to light-emitting diodes (LEDs), about 20% of this technology can be considered smart due to integration with lighting control systems,

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according to ABI Research. However, ABI forecasted that, by 2026, central management systems will connect to more than two-thirds of new LED streetlight installations.

According to the UN estimation, 68% of the global population will be living in urban cities by 2050 [1], and the rise of the population in the urban cities comes with distinct challenges including economic, social, and environmental sustainability [2]. Poor urban infrastructure, health issues, educational challenges, increasing crime rates, aging infrastructure, energy shortages, traffic congestions, high power loss in transmission, and deficiency of real-time sharing are the basic concerns that exist in urban cities [3]. The limitations on crucial infrastructure and lack of resources lead to challenges in providing the basic amenities to the citizens of the urban city [4].

The cities are facing budget constraints, and this led to the reduction of budgets besides cost reduction measures. Consequently, smarter and resilient infrastructure is essential for supervising the challenges in urban and transforming the urban environment [5]. Here, the integration of smart city technologies can assist to accomplish the goal of smarter and resilient infrastructure [6,7]. However, a huge amount of energy is necessary for maintaining and providing smart infrastructure and amenities to the individuals residing in urban cities. Additionally, the scarcity and continuous rising in fossil fuel prices are demanding effective power management and strategy for enhancing energy efficiency [8].

In order of managing energy efficiency and reducing energy consumption, many local government bodies have replaced high-pressure sodium (HPS) lamps with light-emitting diode (LED) technologies [9]. The LED technology in street lighting enhances the lighting efficiency, consumes low energy, and reduces the impact on the maintenance as its lifetime is ten times more than HPS [10]. Yet, this strategy is unable to meet the energy conservation goals where the streetlights are consuming the 43.9 billion kWh of electricity every year [11]. Streetlights are the foremost contributors of energy consumption in cities as they consume approximately 30% of total energy consumption in any country [11].

Concerning lighting system in urban cities, smart light and lampposts act as a key sources for offering secure and convenient visibility during nighttime on the roads and streets. According to the SEAP report, innovative energy solutions are required for overcoming the global issues in energy [12]. Furthermore, it suggested minimizing CO2 emissions and enhances energy efficiency by employing renewable energy sources [13]. At present LED are embedded on the street lighting for accomplishing the goal of energy efficiency. Besides, upgrading lighting systems with LED leads to saving of 50–70% of energy and maintenance costs [14]. LED can deliver better lighting, reduce CO2 emissions, and minimum energy consumption. However, the amount of electricity consumption of street and highway lights is high because of continuous lighting during nighttime [15]. To minimize the wastage of energy and electricity consumption, the lighting system needs to be interconnected with network infrastructure that provides intelligence to the lighting system [16]. This concept enables street and highway lights for regulating the intensity of light depending upon the traffic conditions and outdoor light intensity [17].

Generally, in smart cities, the significance of smart infrastructure plays a crucial role. When it comes to a lighting system in smart cities, the roads' lights significantly illuminate the light to guide passengers and vehicles. Even though we are advancing sensor and wireless communication technology, we still prefer the manual switch controller. With the manual switch controller, the light glows from sunset to sunrise with high intensity and even in some cases the light also glows in daylight. This leads to high energy consumption irrespective of non-requirement. To overcome this, many studies have proposed distinct solutions for realizing automatic lighting. This automatic lighting system switch the light on and off with respect to light intensity of outdoor environment and movement of the objects. Additionally, the defection in lighting system is also reported to the respective electric authority through wireless communication.

As the population is rising in urban cities, the significance of enhancing the infrastructure with minimum complexity and maximum benefits. To date, the individual systems are being implementing in smart cities for light controlling, environmental (temperature, humidity) parameters monitoring, camera for counting of vehicles on the road and also for security surveillance.

Therefore, when the Sustainability 2021, 13, 6398 3 of 20 lighting system is integrating with multiple applications, it assists city administrative to monitoring things such as temperature, humidity, security, traffic flow, etc., with a single system. The single system is presented as a smart lamppost. For example, if the smart lamppost is integrating with security camera and if the security camera is integrating with

communication and intelligence capability, then it senses the situation and sends visuals to the emergency unit and switches on the light for aiding.

The motivation of the study comes from the above studies, where the hybrid-based framework can be implemented in lampposts for delivering a multitude of applications to the citizens in the urban cities. The multitude of applications including air quality monitoring, automate lighting intensity system, Wi-Fi hotspots, electric vehicle charging ports, etc., and the streetlamps enable the establishment of a novel lighting system termed as a smart lamppost. The future of streetlamps that provides flexible services to the citizens of the urban environment is possible with smart lampposts [18].

The advancement in sensor and communication technology is providing an opportunity to design and implement a smart lamppost that can automatically adjust light intensity, provides a Wi-Fi hotspot, and displays weather data, traffic signage, video surveillance, EV charging, and solar-based energy sources [19].

Additionally, the integration of digitalized technology such as IoT in smart lampposts empowers us to obtain the sensor information regarding environment data, traffic data, number of vehicles, and passengers crossing across the lamppost on the server [20].

The contributions of this study are as follows:

- IoT server assisted fog and edge-based architecture is proposed for smart lampposts.
- Smart lampposts are integrated with low power and long-range communication, i.e., Long-Range, enabling the smart lamppost to communicate the sensory data to a long-range.
- LoRa is integrated with a Wi-Fi module for establishing the interconnection between the smart lamppost and IoT server.
- The proposed architecture is broad perspective; we have designed and implemented three components, namely, lighting system, environment parameter monitoring and image sensing in real time environment.
- A hybrid system is implemented for monitoring the lighting system, environment parameter monitoring and, moreover, the sensing values of these components are plotted in the graph.
- Master and slave controller-based mechanism is implemented for the intercommunicating the components of smart lampposts.
- A proteus simulation is performed for the smart lighting system.
- The working of developed image sensing prototype based on ESP 32 is also discussed in the study with real-time implementation results. The structure of the article is organized as follows: Section 2 covers the related works and overview of IoT and nearby technologies. The proposed architecture of the smart lamppost is covered in Section 3. Section 4 covers the hardware and software description. Section 5 covers simulation. Results are covered in Section 6 and the article concludes in Section 7.

II. PERSONALITY ASSESSMENT THEORY

Electronic technology and internet led to the inclination of the global Smart tools is apparently supported by and provided with more opportunities by the development of Characteristics Model (CM) which in turn is based on the concept of modern job design. Fortunately, the development in modern information systems, digital technologies, the universal access Human Resource Management development make the system more applicable. Following the trend, the proposed system tries to design a plan to integrate the Job Characteristics Model into the HR system to search for a new model of efficient operation on Human Resource Management in the Internet Age.

Openness (O)	From cautious/consistent to curious/inventive intellectual, polished, creative, independent, open-minded, imaginative, creative, curious, tolerant
Conscientiousness (C)	From careless/easy-going to organized/efficient, reliable, consistent, self-disciplined, organized, hardworking, has long-term goals, planner

Extraversion (E)	From solitary/reserved to outgoing/energetic, express positive emotions, excited, satisfied, friendly, seeks stimulation in the company of others, talkative
Agreeableness (A)	From cold/unkind to friendly/compassionate kind, concerned, truthful, good natured, trustful, cooperative, helpful, nurturing, optimistic
Neuroticism (N)	From secure/calm to unconfident/nervous angry, anxious, neurotic, upset, depressed, sensitive, moody

Today there is a growing interest in the personality traits of a candidate by the organization to better examine and understand the candidate's response to similar circumstances and in this system HR adds some criteria like personality required, roles and responsibilities etc. and system are examining automatically to candidates are feet to all this criterion or not for this, the system conducts a personality prediction test to determine the personality traits of the candidate.

Finally, it presents the results of the candidates to the recruiter who evaluates the top candidates and shortlisted the candidate. In this project, we will register him/her with all resume details, hobbies, strengths, weakness and 15 to 16 questions for personality prediction in that HR analyzed the Candidates Openness(O), Conscientiousness(C), Extraversion(E), Agreeableness (A) means is one of the five personality traits of the Big Five personality theory.

A person with a high level of agreeableness in a personality test is usually warm, friendly, and tactful. They generally have an optimistic view of human nature and get along well with others. Neuroticism (N) Means is one of the Big Five higher-order personality traits in the study of psychology. Individuals who score high on neuroticism are more likely than average to be moody and to experience such feelings as anxiety, worry, fear, anger, frustration, envy, jealousy, guilt, depressed mood, and loneliness, which will be further, used by the system to shortlist their CV or candidates. After completing the top 10 or above shortlisted candidates, auto mail is sent.

In psychology, the theory based on the Big 5 factors is the most widely accepted model to describe the basic structure of human personality. The theory based on these factors is called the five-factor model (or the Big 5 model) and it is the most widely accepted model of personality. It provides a nomenclature and a conceptual framework that unifies much of the research findings in the psychology of individual differences and personality.

It reduces the large number of personal adjectives into five main personality traits that form the acronym OCEAN. It was first studied in the 1990s when five factors or personality traits were established and has been used until the present time.

According to Table, individuals in the Big 5 model vary in terms of the OCEAN, that is openness to experience, conscientiousness, extraversion, agreeableness and neuroticism. It represents a complete set of traits that could capture personality differences.

III. MATHEMATICAL MODEL

Let S is the system;

S = {I, O, F, DD, NDD, Success, Failure}

I = Input to the system

I = {username, password, add candidate, add HR associate, add HR, add title, add details, apply for job(contest), view interview question, candidate cv}

O = Output of the system

O = {successful registration, apply for job(contest), give the questions answer, candidate result, view top 10 candidate, shortlisted candidate, send auto mail to candidate}

F = Functions in system

F={adminreg(),adminlogin(),registration(),login(),
addJobTitle(),addJobDetail(),applyForJob(),enterCandidateDa

il(),solveQuestion(),resultOfCandidate(),viewTop10Candidte( ), candidateShortlist(), sendAutoMail()}

DD = Deterministic data

DD = {Null}

NDD = Non-Deterministic data

NDD = {I, O}

Success:

In this project, we have implemented an organization-oriented recruitment system that would assist the human resource department in short listing the right candidate for a specific job profile and also shortlist the employee of the year. The system would be used in many business sectors that will require expert candidates, thus reducing the workload of the human resource department.

Failure: Network Fail.

IV. Results And Discussion

Our proposed system works as follows; Admin: firstly, admin can add, update, delete HR associate, HR, also add manager and view complaint/feedback/suggestion and also view the top employee of the firm. HR Associate: Main role of HR associate is, he will add job title (vacancy) with required personality, roles and responsibilities. They will view the top 10 employees of their firm. HR: HR will view top 10 shortlisted candidates who will qualify the HR round and eligible for the required job or post and send auto mail to shortlisted candidates. HR will also view the top employees of their firm. Candidate: candidate can view the job title of the firm which is posted by HR associates. Candidate can apply for a job which is suitable for him and enter his hobbies, strengths, and weaknesses and also answer the 15 to16 questions.

The proposed system produces ranking decisions that were relatively highly consistent with those of the human experts. This system will enable a more effective way to short list submitted candidate CVs from a large number of applicants providing a consistent and fair CV ranking policy. The presented system automates the processes of requirements specification and applicant's ranking. This system can be used in many business sectors that may require expert candidates and also reduce workload of the human resource department.

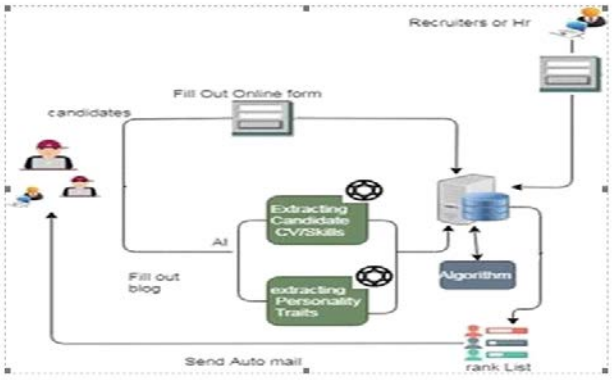

Fig.1. System Architecture of Personality Assessment Tool

V. Conclusion

In the proposed system, we have implemented an organization-oriented system that would assist the human resource department in short listing the right candidate for a specific profile. The system could be used in many business sectors that will require expert candidates, thus reducing the workload of the human resource department.

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