Developing a Novel Approach Using RFID and LDR For Efficient Parking System in A smart City: A Review

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A B S T R A C T

Smart city is an important domain which is reaching great heights nowadays. Smart cities are those, that are well developed socially, and economically and offer a quality of life, in the smart cities concept factors like smart Infrastructure, smart waste management, smart Lighting application, smart Environmental monitoring, smart parking systems, smart finance, smart Governance, and smart roads. And the various technologies that make a city smart have been analyzed. In the modern world due to rapid urban Development, the increment in the number of vehicles can be seen, which makes finding a car parking a difficult task. In this paper, we will discuss the various approaches to smart parking systems and the various sensors that can be used. The new approach to Smart parking will be developed using RFID and LDR.

1. Introduction

Smart cities, as the name indicates, are the cities that have smart control of the cities using various electronic methods, sensors, advanced communication techniques, etc. where IoT (Internet of Things) plays a major role in the working of the smart cities. IoT plays an important role in creating smart cities to set up a connection between the sensors, devices, and networks that are used in setting up a smart city. Smart City can be considered the most encouraging Internet of Things (IoT) applications. The role of a smart city in both the academic and the industry can be seen, A Smart City is a platform created using various technology. the smart city is made up of various components like smart grid, smart roads, smart lighting, smart public transport and safety, smart environmental monitoring, smart parking, and smart waste management.

Among all the components smart parking is the key highlight of the paper, in today's fast world and due to rapid urbanization, the parking problem can be faced. So as a part of a smart city, the parking also needs to be smart. The smart parking system uses various proximity sensors, ultrasonic sensors, IOT, etc. smart parking system is an essential element of the smart city according to the survey around 30% of vehicles on the roads of major cities are searching for vacant parking lots. it generally takes about 7.8 min to find a suitable parking lot causing traffic congestion, air pollution fuel wastage, and driver frustration. Various technologies are used for the smart parking system. A lot of time is wasted in searching for vacant slots for parking and many times it creates jams. Conditions worsen when there are multiple parking lanes and each lane with multiple parking slots. The use of a smart parking management system would reduce human efforts and time with additional comfort. In the proposed system, the display unit displays a visual representation of the parking, and it shows the empty and occupied slots which help the user to decide where to park their car. The system will not only save time but will also manage the check-in and check-out of documents under the control of software and hardware required. This systemIn these users are guided to the vacant slot for parking using Displays at the entrance of the parking floor, these displays show a visual representation of the parking lot with empty and occupied slots which are green and red respectively.

Nowadays, in many public places such as malls, multiplex systems, hospitals, offices, and market areas there is a crucial problem of car parking. There are many lanes/slots for car parking in the car parking area. So, to park a car, one must look for all the lanes. Moreover, it involves a lot of physical labour and labour.so, there is a need to develop an automated parking system that directly indicates the availability of vacant parking slots in any lane right at the entrance. It involves a system including an infrared transmitter-receiver pair in each lane and a display outside the car parking gate. So, the person desirous to park his vehicle is well informed about the status of availability of parking slots. The Current parking systems do not have any intelligent monitoring system and the parking spaces are monitored by security guards. the traditional parking systems are incapable of providing a smooth parking experience to the drivers and reducing the parking search traffic on the roads. This

highlights the rationale of adopting advanced technologies to make the urban transport system modern and ease the problems faced by drivers.

2. Methodology

In any industry, planning is important to achieve its goals. The plan can be achieved by sequencing the flow of work into a typical methodology fig.1 represents the methodology according to which the project will be executed.

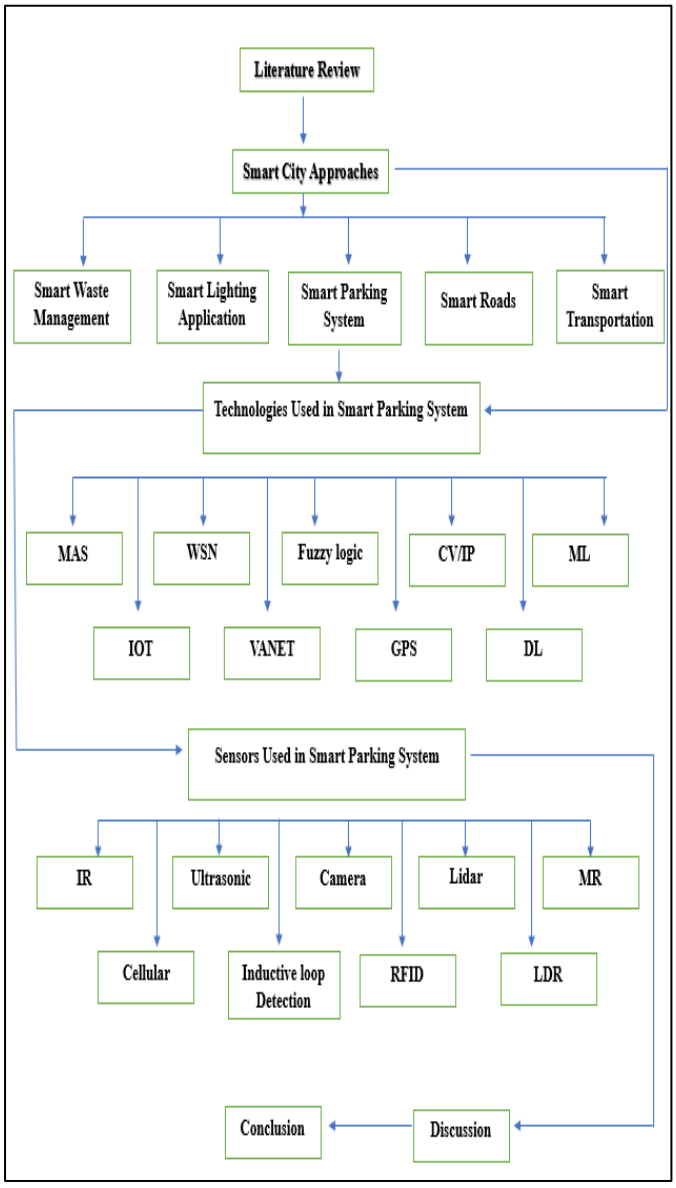

Fig No.1 Flow pattern of the Methodology

3. Smart Parking System: An Overview

3.1 Smart Parking Survey

Many large cities face the major problem of providing parking spaces for their citizens at the peak hours of the day. As a result, citizens spend a huge amount of time searching for parking spaces or waiting in line to get a parking space. This results in traffic congestion. Considering the problems, many researchers have suggested different SPS approaches and technologies to these problems.

In [27], a Multi-Agent System (MAS) based SPS has been designed. The system uses agent networks that coordinate with the driver and the SPS. It utilizes an algorithm that provides a negotiable solution. In addition, the system provides vehicle guidance for the shortest route to the parking location and parking reservation facility.

A Car Parking Framework based on the lot has been proposed in [28]. Automatic car parking management with the help of sensors and actuators along with Radio Frequency Identification (RFID). This system provides vehicle guidance, payment facilities, parking lot retrieval, and security. This system has a low energy consumption rate with low implementation costs.

The authors of [29] developed a WSN-based SPS. The system uses a hybrid self-organization algorithm for WSN technology. The system is designed to be more energy efficient due to its wireless communication. As a result, it enhances the life expectancy of WSN nodes and overall WSN. In this system, both web and smartphone applications are used to provide SPS facilities to the users.

The authors in [30] suggested a scheme of parking lot availability based on sample parking spaces. The scheme works on the Fuzzy logic to predict available parking spaces. The system is dedicated to park-and-ride (PAR) commuters, which infers that the sample parking spaces are located near public transportation facilities.

Research conducted in [31] proposed a visual vehicle parking space occupancy detection method via a deep Convolutional Neural Network (CNN). The system works with a decentralized approach and can detect parking lot occupancy in real time via smart cameras.

The Author [32] Proposed that Vacant parking space detection and tracking system based on sensor fusion The system uses a sensor fusion technique to fuse the data produced by the Around View Monitor (AVM) system's sensors. The data generated by ultrasonic sensors is used to monitor parking space occupancy. The system has three stages: detection of parking lot markings, classification of parking lot occupancy, and tracking of parking lot markings.

The authors in [33] proposed an IoT-based SPS. The SPS can monitor the vacant parking slots and indicate them to the user via loT applications. The system works in 3 modes: On-field Network, Cloud platform, and User side platform.

In [34], the authors proposed a Vehicle Ad Hoc Network (VANET) based cloud framework delivering a secure and privacy-conscious service termed Parking information as a Service (Plaas)which provides SPS details from VANET-oriented cloud infrastructure makes it possible to provide security and privacy to many nodes in a connected manner. ET-enabled vehicles along with the Park Side Units (PSUs) communicate parking information known as Parking Mobility Vectors (PMV) with the Roadside Units (RSUS) via cloud infrastructures. which provides location privacy. This system includes tracking traffic on different routes, providing vehicle theft protection features and tracking down dangerous vehicles.

A cloud-oriented SPS based on loT technologies has been discussed in [35]. The SPS provides a parking reservation service and uses RFID tags. ensuring only the respected user gets to the parking lot.Additionally, the system uses Number Plate Recognition (NPR) for vehicle security.Also, it can detect oversized and overweight vehicles and restrict them from entering the parking area.

4. Approaches to Smart Parking System

4.1 Wireless Sensor Network (WSN) based SPS

The cloud can be defined as a network of wirelessly connected sensor nodes that have spread spatially and are dedicated to monitoring various environmental aspects such as sound, temperature, pressure, etc. The WSN -based sensor node includes various sensors used to monitor various aspects of the environment. In WSN, all the sensor nodes are connected to a sink node via a wireless connection [36]. Nowadays, WSN has received outstanding traction among SPS developers for flexibility, scalability, and low deployment cost. Due to these benefits, many of the research articles analyzed in this paper utilized WSN as the primary approach to building SPS.

4.2 Multi-agent system (MAS) based SPS

It is a self-consistent computer-based system that brings together multiple intelligent agents to solve problems. To facilitate the evolution of species, various researchers have used emesis as a band or indoor and outdoor parking space due to its unique effect in both areas. A significant portion of MAS-based SPS provides computing facilities to the agents, which reduces the data transmission head of the whole system. As a result, the power consumption rate decreases. [37,38,39]

4.3 Computer vision/image processing based SPS

Computer vision/Image processing-based SPS uses different types of camera networks to use image data to extract different information such as parking lot occupancy status, license plate recognition, and face recognition to provide road traffic congestion reports. The systems based on computer vision/image processing technologies usually have a high data transmission rate from the camera network to the processing units because these systems rely on real-time parking lot video data for feature working. These sorts of SPSS are usually suitable for open parking.[40,41]

4.4 Vehicular Ad-Hoc network (VANET) based SPS

The Mobile Ad Hoc Network (MANET), which makes use of a wireless network of portable devices, is the foundation of VANET. The Parking Side Unit (PSU), Roadside Unit (RSU), and On-Board Unit (OBU) are the three primary parts of SPS using VANET. The vehicles have OBUS installed, parking spaces have PSUs installed, and the roads next to the parking spaces have RSUs installed. For this kind of system, the OBU of the vehicle must be authorized by a reliable authentication authority. When a car is parked in a smart parking structure, the OBU of the car informs the PSU that the parking lot is reserved. Following that, the PSU sends this information to the RSU. the passing traffic on the route where the RSU is located.[42,43,44].

4.5 Internet of Things (IoT) based SPS

LoT, in which all gadgets are connected via the internet, is the rage in today's world. Every device linked to the internet has a unique identification (UI). These devices can be digital, mechanical, or computational. They can transport data without interacting with other people or computers One. of the most significant technologies used by developers of SPS is IoT technology. All the sensors and computing components in a lot hasted SPS are connected via the internet and are capable of data transfer without the need for human intervention. A wireless link or a cable connection can be used to connect sensors, computing equipment, and storage units to the Internet.[45,46,47]

4.6 Machine learning (MI) based SPS

A system can learn and get better at a certain activity from datasets or experiences using machine learning (ML), a subset of artificial intelligence (AI), without having to be explicitly programmed. To determine the status of the parking lot, a machine learning-based SPS analyzes the data from the parking lot. Furthermore, parking lot occupancy status can be forecasted for the following days, weeks, or even months using ML and Al-based SPS, which can also offer a dynamic pricing structure. Smart parking spaces can be monitored for traffic congestion on specific roadways using Mi-based solutions.[48,49]

4.7 Deep learning (DI) based SPS

In terms of processing data and extracting features to make judgments, DL is a subset of ML and an application of Al. Instead of using conventional sensors, DL algorithms may identify vacantly occupied spaces and designated parking areas in an SPS, which lowers the system's need for sensors and cameras. To forecast parking lot occupancy, it is also employed. [50,51]

4.8 Neural Network (NN) based SPS.

NN is a combination of algorithms that extracts features and underlying relationships from sets of data through a process that mimics human brain function [30]. In SPS, NN is used for license plate recognition using real-time video data. CNN and machine vision have been applied to detect parking lot occupancy status. CNNs are also capable of providing road traffic conditions for different routes.[52]

4.9 Global Positioning-Based SPS

The use of GPS is crucial in many smart parking strategies. However, GPS is unable to collect information about parking lot occupancy or offer other intelligent parking options. However, GPS can offer a vehicle guidance feature that enables the user to travel in the direction of empty parking lots. Using CNN or DL algorithms, many systems can forecast parking lot occupancy and traffic congestion from GPS data. The quantity of GPS receivers affects its accuracy.

GPS accuracy for a single frequency receiver is about 7.8 m. A two-frequency receiver, however, offers approximately 0.715 m of accuracy using GPS.[53]

5 Implemented Sensors in SPS

5.1 IR (infrared) sensor

An electrical device known as an IR sensor is used to find and gauge the infrared radiation that an object emits. Any object with a temperature of 5 or higher emits infrared radiation. The primary uses of IR sensors are for temperature measurement and motion detection. Active and passive infrared sensors are the two main categories of IR sensors that can be used.[54,55]

5.2 Cellidor Sensor

The sensors that are housed inside a smartphone are called cellular seniors. The most used sensors on a smartphone are the SPS, Accelesteseter, Gyroscope, and Magnetometer. These sensors track the motion, orientation, and direction of the user.[56,57]

5.3 Magneto-Resistive (MR) sensor

The applied magnetic field can be detected by MR sensors without the need for any electrical contact. The MR sensor operates on a very simple principle. Any electrical conductor experiences a change in resistance when a magnetic field is applied. The direction of the magnetic field lines affects resistance changes. In parking lots, MR is primarily employed for vehicle detection. [58]

An acoustic array sensor picks up sound or vibration at frequencies to pinpoint the location and orientation of the sound source or reflector. The Panive Acoustic Location Technique is the name given to this kind of localization method (74, 100). In SPS, the use of an acoustic array sensor for surveillance and parking lot vacancy detection is common.

5.4 Ultrasonic sensor

Any object that reflects an acoustic wave is detected by an ultrasonic sensor using acoustic waves between 25 and 50 kHz [100]. Due to its susceptibility to malfunction in weather changes like snow and rain, this sensor is best suited for indoor applications. To detect vehicles, ultrasonic sensors are used in enclosed and indoor parking garages. These sensors are typically mounted on the ceiling. Additionally, with proper implementation, this type of sensor can distinguish between a passing vehicle and a person. Ultrasonic sensors are inexpensive and require little upkeep.[59]

5.5 Camera

Many SPS researchers have adopted the use of a network of cameras for vehicle detection and parking lot surveillance. For billing, reservations, and authentication purposes, many researchers have used cameras and various computational tools (such as computer vision, image processing, etc., techniques). Using a camera or network of cameras for SPS offers users a reliable parking solution. However, the deployment and upkeep costs of camera-based SPS are frequently high.[60]

5.6 Inductive Loop Detector

An inductive loop detector is a vehicle detection method that utilizes the electromagnetic induction principle. This type of detector is Installed under the road to detect vehicles These detectors, along with some techniques, can classify different kinds of vehicles.
Vehicle loop detectors are expensive and their installation costs are also high. This type of sensor is suitable for both open and closed parking lots.

5.7 Light Detection and Ranging (LIDAR)

The LIDAR works by illuminating the target with a laser and measuring the reflected light with a sensor, this technique determines distance. By measuring the wavelength and time it takes to receive the reflected light, also the 3D image of the object of interest can be created. LIDAR is primarily used for vehicle detection in SPS.

5.8 Radio Frequency Identification (RFID) sensor

RFID technology uses electromagnetic fields to identify and track an .RFID technology uses a radio transponder that consists of an RFID receiver and an RFID tag. When the RFID tag gets scanned by the RFID receiver, it transmits digital data stored inside it. The receiver occupies the data for object identification and works accordingly. RFID technology is commonly used in smart parking systems.

5.9 LDR (Light Dependent Resistor)

LDR is the typical type of resistor that works on the photoconductivity principle which means that resistance changes according to the intensity of light. Its resistance decreases as the intensity of light increases. It works as an interference device when the vehicles enter the parking area the major advantage of this sensor is that it consumes less power works efficiently and is reliable.

6. A New Approach For SPS

The most basic technology for wireless data transmissions over networks is RFID. Although this technology has been around for a while, recent standardizations and affordability have greatly increased its usefulness. For communication and data collection from objects with RFID tags attached, this technology uses electromagnetic fields. Any industry that uses RFID tags has seen a significant rise in productivity and efficiency. It is widely used in automation, which is established by using artefact reader, artefact sensor, artefact controller, artefact writer and any number of devices. It has been widely used in tracking system, monitoring system and parking system. RFID Tags, RFID readers, or RFID sensors are used in this prototype. An antenna and integrated circuit make up RFID tags. The antenna determines the RFID tag's

reading range, and the integrated circuit is a microprocessor chip.

These are further separated into RFID tags that are active and passive. Active RFID tags have a power source, a high communication range, a low required signal strength, and a large read/write data storage capacity. The internal power source of passive RFID tags is absent, however. They have a limited read/write data storage capacity, a short communication range, and strong signalling A transceiver for data storage and an antenna for tag communication make up the RFID reader, an electronic device.

This article suggests a car parking system prototype with several customized features. An LDR sensor is used in this project to ascertain whether the slot is occupied or vacant. The microcontroller is connected to these sensors. Through the microcontroller, the output of these sensors is transmitted to the database. The outcome is shown on the video monitor at the parking level entrances as soon as the database has been updated. The command of the microcontroller URL, which is updated continuously, is used to display this result. The payment gateway is the other RFID module. Every vehicle will have an RFID Tag affixed to it. As soon as the car enters the parking lot, an RFID reader reads the tag to obtain the Unique ID, logs the entry into the database, and completes the transaction. When the car leaves, a different RFID reader reads the tag to deduct money from the user's account based on the amount of time they spend in the parking lot. Fig. 2 represents the approach of the study.

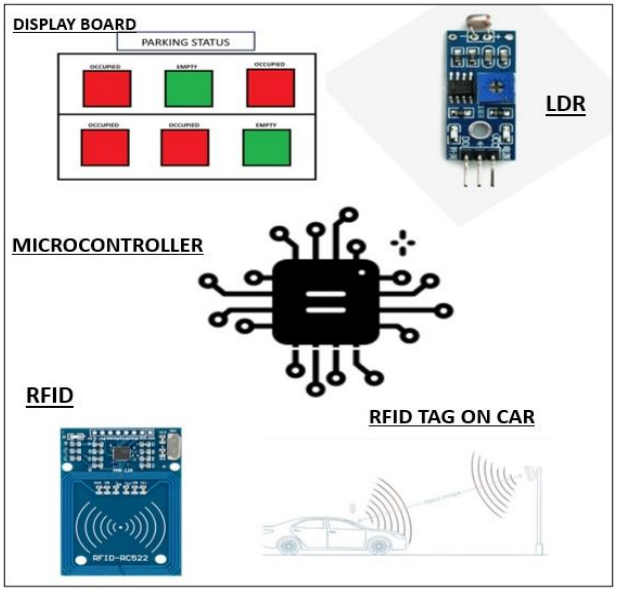

Fig No 2: Integrating RFID and LDR

7. Conclusion

The paper systematically talks about different Approaches to developing their smart parking system and their suitability for different parking lots. The approaches for SPS have been classified into 12 major groups and approaches have been provided to determine their strengths and weaknesses. The paper also provides information about different smart parking sensors and their usage in different conditions. Due to the rapid increase in urban population and planned urbanization, the number of urban parking spaces is decreasing. Hence we conclude that this new approach combines RFID technology and light-dependent resistors (LDR) to efficiently manage parking spaces. It helps drivers easily locate available parking spots and optimizes parking space utilization. It's a great solution that enhances convenience reduces congestion and will contribute to a smart city.

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