Internet of Things for Smart Parking System Vehicle Presence Detection

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Abstract

Growing urbanisation is a problem since more and more people are settling into big cities. Here, many urban areas are turning to technological solutions that boost efficiency and output while reducing their negative effects on the environment. One of the most important is smart transport, which promises to keep up with the ever-increasing demand for passenger services and is crucial for urban mobility. Many factors have contributed to the ease of implementing an Internet of Things (IoT) smart parking system. We must comprehend the related problems and principles if we are to realise its maximum potential. Understanding the principles of the Internet of Things (IoT), how the layers work in vehicle detection, and introducing various Internet of Things (IoT) sensors enabled by various technologies—including cloud computing, big data, RFID, and WSN—that enable the smart parking system are the primary goals of this paper. This paper will first evaluate the possible Internet of Things (IoT) applications in smart parking systems' vehicle presence detection. Then, it will list the pros and cons of these applications, as well as provide some suggestions for how businesses and government agencies can choose the right sensors for various situations.

Introduction

The world population is distributed unevenly and highly concentrated in urban areas causing urbanization problems [19]. Besides, there is only a limited amount of parking facilitates provided for the citizens resulting in various parking problems such as illegal parking, traffic safety issue, and energy waste. Therefore, it encourages the government to develop a smart parking system so as to make good use of the existing parking utilities to meet the high demand of citizen needs. Along with the rapid development of the Internet of Things (IoT), cloud computing, and big data, it helps the traditional parking system become smarter and move towards the Mobility as a Service goal [12] to achieve a sustainable transportation society.

Literature survey

Akyildiz, I. F., Melodia, T., & Chowdhury, K. R. (2007). A survey on wireless multimedia sensor networks. Computer Networks, 51(4), 921-960. doi:10.1016/j.comnet.2006.10.002

The availability of low-cost hardware such as CMOS cameras and microphones has fostered the development of Wireless Multimedia Sensor Networks (WMSNs), i.e., networks of wirelessly interconnected devices that are able to ubiquitously retrieve multimedia content such as video and audio streams, still images, and scalar sensor data from the environment. In this paper, the state of the art in algorithms, protocols, and hardware for wireless multimedia sensor networks is surveyed, and open research issues are discussed in detail. Architectures for WMSNs are explored, along with their advantages and drawbacks. Currently off-the-shelf hardware as well as available research prototypes for WMSNs are listed and classified. Existing solutions and open research issues at the application, transport, network, link, and physical layers of the communication protocol stack are investigated, along with possible cross-layer synergies and optimizations. Wireless sensor networks (WSN) [22] have drawn the attention of the research community in the last few years, driven by a wealth of theoretical and practical challenges

Atzori, L., Iera, A., & Morabito, G. (2010). The Internet of Things: A survey. Computer Networks, 54(15), 2787-2805. doi:10.1016/j.comnet.2010.05.010.

This paper addresses the Internet of Things. Main enabling factor of this promising paradigm is the integration of several technologies and communications solutions. Identification and tracking technologies, wired and wireless sensor and actuator networks, enhanced communication protocols (shared with the Next Generation Internet), and distributed intelligence for smart objects are just the most relevant. As one can easily imagine, any serious contribution to the advance of the Internet of Things must necessarily be the result of synergetic activities conducted in different fields of knowledge, such as telecommunications, informatics, electronics and social science. In such a complex scenario, this survey is directed to those who want to approach this complex discipline and contribute to its development. Different visions of this Internet of Things paradigm are reported and enabling technologies reviewed. What emerges is that still major issues shall be faced by the research community. The most relevant among them are addressed in details. The Internet of Things (IoT) is a novel paradigm that is rapidly gaining ground in the scenario of modern wireless telecommunications..

Guilbert, D., Le Bastard, C., Sio-Song, I., & Yide, W. (2016). State Machine for Detecting Vehicles by Magnetometer Sensors. IEEE Sensors Journal, 16(13), 5127-5128. doi:10.1109/JSEN.2016.2560903.

This letter presents a vehicle detection state machine for magnetometer sensors. The state machine designed by Chinrungrueng et al. [1] for a single lane is extended to n motorway lanes with multiple lane changes. The proposed method has good performance in terms of the detection rate and false detections which are mainly due to the interference from a vehicle in an adjacent lane and lane changing. The state machine is evaluated on a real motorway and compared to industrial sensors. The understanding of road traffic congestion phenomena, the cause of accidents and the environmental aspect due to pollutants requires observations of road traffic. Many projects in Europe such as the MOCoPo project [2] are installing observation areas with different types of sensors, among which, the magnetometer is a promising new road sensor. In the MOCoPo project [2], the magnetometers are used to detect vehicles on the entry and exit ramp of a French motorway (Fig. 1), a short (about 300m) and very congested section. Wireless 3D magnetometers are specially designed to detect and reidentify vehicles in a congested situation

Ji, Z., Ganchev, I., O'Droma, M., Zhao, L., & Zhang, X. (2014). A cloud-based car parking middleware for IoT-based smart cities: Design and implementation. Sensors (Switzerland), 14(12), 22372-22393.

This paper presents the generic concept of using cloud-based intelligent car parking services in smart cities as an important application of the Internet of Things (IoT) paradigm. This type of services will become an integral part of a generic IoT operational platform for smart cities due to its pure business-oriented features. A high-level view of the proposed middleware is outlined and the corresponding operational platform is illustrated. To demonstrate the provision of car parking services, based on the proposed middleware, a cloud-based intelligent car parking system for use within a university campus is described along with details of its design, implementation, and operation. A number of software solutions, including Kafka/Storm/Hbase clusters, OSGi web applications with distributed NoSQL, a rule engine, and mobile applications, are proposed to provide 'best' car parking service experience to mobile users, following the Always Best Connected and best Served (ABC&S) paradigm. In September 2009, the European Union (EU) endorsed an Internet of Things (IoT) Strategic Research Roadmap, proposed by the Cluster of European Research Projects (CERP), named CERP-IoT [1], with the purpose of promoting, sharing and propagandizing the research projects and related research outcomes in the IoT area, especially the application of sensor technology in IoT, such as Intelligent Transport Systems (ITS) [2], family-domain smart eHealth/mHealth, wearable sensing and computing, green buildings, smart homes, smart cities, *etc*.

Sundmaeker, H., Guillemin, P., Friess, P., & Woelfflé, S. (2010). Vision and challenges for realising the Internet of Things. Cluster of European Research Projects on the Internet of Things, European Commision, 3(3), 34-36.

Applications on a future Internet of Things require the provisioning of current, relevant and accurate context information to endpoints. Context information existing globally require organization into object-oriented models available locally in APIs as current, relevant and accurate views. Moreover, such applications require support for the highly dynamic interactions influencing continual changes in global context information. Existing approaches, such as the web services, are unable to provide this support partly due to the presupposed existence of a network service brokering context information, relying on DNS; or adopting a presence model for context which does not adequately scale. To this end, we propose a distributed framework for the interconnection of end-points and co-located agent entities, whereby agents are provided with local views of

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a relevant subset of global context information. We show how to achieve relevant local current views of global context information via ranking in an object-oriented context model. The distributed approach realizes the provisioning of context information in real-time, i.e., with predictable time bounds. Finally, we demonstrate the feasibility of the approach in a prototype based on P-Grid. The increasing interest in the provisioning of applications and services that deliver experiences based on context mandates the continual research into methodologies, architectures and support for delivering the context information required. Constraints on service delivery with respects to real-time availability underpins any such solution. A future connected things infrastructure with an installed device base exceeding billions [1], requires support for a wide range of context centric experiences ranging from personalized and seamless media access, to intelligent commuting and environmental monitoring. This incorporate devices such as mobile phones, personal computers or IPTV boxes; all merging towards the paradigm of everywhere computing [2]; the seamlessly connected new world. As users navigate a vast and seemingly endless connected things infrastructure, it becomes increasingly important to be provisioned with the relevant subsets of information required in order to be enabled with an experience relative to the users' current situation Within a future cityscape, he encounters multiple information points which maybe used to inform him of the state of his surroundings. Embedded into a digital ecosystem, he is capable of deriving enough information in support of the services wishing to effect changes or deliver him a unique context-based user experience. Such information include temperature, humidity and location as well more complex sources such as audiovisual devices, network connections or traffic conditions. With his smartphone, John is able to connect to and derive representations of context from these points in order to support his applications. Applications and services wishing to respond relevant to John's current context require this information to be organized and made available in globally accessible end-points. Approaches such as IMS [3] or Sense web [4] enables the required support, brokering context information via web service portals on the Internet They are, however dependent on DNS as a means of locating service portals, users and applications. Issues with DNS availability due to DoS attacks and configuration errors raises questions about its continued suitability and prompting research into Distributed Hash Table (DHT) based overlays such as Chord [5], Pastry [6] and Tapestry [7] as possible replacements [8]. To this end, early work surrounding the Media Sense architecture implemented the DCXP protocol [9], a Chord based approach capable of provisioning John's context information in support of his dependent applications and services. The DCXP approach produced the ranges in response times deemed adequate enough to support real-time context dependent services. Furthermore, it proved that distributed systems were more capable of achieving this than approaches building on mobile or web services. Other approaches such as [10] explore the option of building context provisioning solutions using DHTs. However, while a DHT provides for a more scalable and resilient approach, it relies on deterministic hashing algorithms for achieving the distribution, indexing and locating of information. Consequently, this places a limit on their ability to utilize self-organization towards realising a more homogeneous distribution of information located on the overlay. With regards to the persisting of context information, an additional disadvantage of DHTs is their inability to support queries of a range of values, critical in scenarios where John might be trying to locate a service in

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some approximate area or over a series of context values. While solutions such as [11] have sought to address this problem, this is not done natively, mandating the implementation of additional layers of complexity on the existing overlay.

Tang, Y., Zhang, C., Gu, R., Li, P., & Yang, B. (2017). Vehicle detection and recognition for intelligent traffic surveillance system. An International Journal, 76(4), 5817-5832.

Vehicle detection and type recognition based on static images is highly practical and directly applicable for various operations in a traffic surveillance system. This paper will introduce the processing of automatic vehicle detection and recognition. First, Haar-like features and AdaBoost algorithms are applied for feature extracting and constructing classifiers, which are used to locate the vehicle over the input image. Then, the Gabor wavelet transform and a local binary pattern operator is used to extract multi-scale and multiorientation vehicle features, according to the outside interference on the image and the random position of the vehicle. Finally, the image is divided into small regions, from which histograms sequences are extracted and concentrated to represent the vehicle features. Principal component analysis is adopted to reach a low dimensional histogram feature, which is used to measure the similarity of different vehicles in euler space and the nearest neighborhood is exploited for final classification. The typed experiment shows that our detection rate is over 97 %, with a false rate of only 3 %, and that the vehicle recognition rate is over 91 %, while maintaining a fast processing time. This exhibits promising potential for implementation with real-world applications. A traffic surveillance camera system is an important part of an intelligent transportation system [30]. It mainly includes automatic monitoring digital cameras to take snapshots of passing vehicles and other moving objects, as is shown in Fig. 1. The recorded images are highresolution static images, which can provide valuable clues for police and other security departments, such as a vehicle plate number, the time it passed, its movement path and the driver's face, etc. In prior days, massive amounts of stored images were processed manually, but this required hard work and resulted in poor efficiency. With the rapid development of computer technology, the latest in automatic license plate recognition software is utilized at an increasing rate in the field with great success [4]. Unfortunately, sometimes we may not discover the license plate of a vehicle because of cloned license plates, missing license plates, or because the license plate can't be recognized. This is why automatic vehicle detection and recognition is becoming the imminent requirement for traffic surveillance applications [22].

Existing system

Implementing IoT (Internet of Things) in the vehicle presence detection of a smart parking system can enhance efficiency, reduce congestion, and improve the overall user experience. Here's how you can integrate IoT into an existing smart parking system .Deploy IoT-enabled sensors in parking spaces: Use sensors such as ultrasonic sensors, infrared sensors, or cameras to detect the presence of vehicles in each parking space. Connect sensors to a microcontroller or IoT gateway: The sensors should be connected to a device that can collect and transmit data. This could be a microcontroller or an IoT gateway. Choose a communication protocol: Select a communication protocol (e.g., MQTT, CoAP, HTTP) to enable the sensors to transmit data to a central server or cloud platform. Ensure secure communication: Implement security measures, such as encryption and authentication, to secure the communication between sensors and the central system. Set up a cloud platform: Use a cloud service (e.g., AWS,

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Azure, Google Cloud) to collect and process data from the sensors. Develop an IoT backend: Create an IoT backend that can receive, store, and analyze data from the parking sensors. This backend should also provide APIs for interaction with other components. Implement data processing algorithms: Analyze the sensor data to determine the status of each parking space (occupied or vacant). Use machine learning for predictive analysis: Implement machine learning algorithms to predict parking space availability based on historical data. Develop a user interface: Create a user-friendly interface for both administrators and end-users to check real-time parking space availability. Mobile app integration: Develop a mobile application that users can use to find and reserve parking spaces, receive notifications, and make payments. Integrate with payment systems: Allow users to make payments for parking through the mobile app or other payment gateways. Implement automated payment processing: Use IoT data to automate the payment process based on the duration of parking .Provide real-time alert Implement a system that sends alerts to users when a parking space is about to become available or when their parking time is about to expire. Allow users to provide feedback on the parking experience, which can be used to improve the system. Ensure scalability: Design the system to handle a growing number of sensors and users as the smart parking system expands. Regular maintenance and updates: Schedule regular maintenance to ensure sensors are functioning correctly and update the system to address any security vulnerabilities or performance issues. By incorporating these elements, you can enhance the efficiency and functionality of a smart parking system using IoT technology.

Proposed system

The integration of IoT (Internet of Things) technology in vehicle presence detection for a Smart Parking System offers several advantages, improving efficiency, reducing traffic congestion, and enhancing overall parking management. Install IoT-enabled sensors in each parking space to detect the presence of a vehicle. Utilize various sensor technologies such as ultrasonic, infrared, or magnetic sensors. Sensors should be capable of wirelessly communicating with a central system. Establish a robust communication network, such as Wi-Fi, Zigbee, or LoRa, to connect the parking sensors with the central server. Ensure secure and reliable data transmission between sensors and the central system. Implement a central server to collect, process, and manage data from all parking sensors. Use cloud-based solutions for scalability, data storage, and accessibility. Incorporate a database to store real-time and historical parking occupancy data. Develop a user-friendly mobile app for drivers to check parking availability in real-time .Enable features like navigation to available parking spots and mobile payments for parking fees. Provide a web-based interface for parking administrators to monitor and manage the entire parking system. Include features for analytics, reporting, and system configuration. Implement data analytics to derive insights from parking occupancy patterns. Use machine learning algorithms to predict parking space availability based on historical data, events, and trends. Collaborate with navigation system providers to integrate real-time parking data into their platforms. Enhance driver experience by providing seamless navigation to available parking spaces. Integrate a secure and automated payment system for parking fees. Utilize mobile payment options to enhance user convenience. Implement security protocols to protect the system from unauthorized access and data breaches. Ensure the confidentiality and integrity of data transmitted between sensors and the central server. Design the system to be scalable, allowing for the addition of more sensors and parking spaces. Plan for future upgrades and technology advancements in IoT and smart parking solutions. Efficient utilization of parking spaces, reducing congestion and optimizing available resources. Drivers can easily find available parking spaces, reducing search time and frustration. Parking administrators can make informed decisions based on data analytics and insights. Reduced fuel consumption and emissions due to decreased time spent searching for parking. Implementing an IoT-based vehicle presence detection system in smart parking not only addresses current parking challenges but also contributes to creating more sustainable and efficient urban environments.

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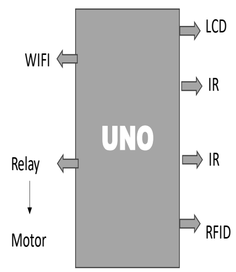
Block diagram



HARDWARE COMPONENTS

LCD (Liquid Cristal Display)

Introduction:

A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular to each other. Without the liquid crystals between them, light passing through one would be blocked by the other. The liquid crystal twists the polarization of light entering one filter to allow it to pass through the other.

A program must interact with the outside world using input and output devices that communicate directly with a human being. One of the most common devices attached to an controller is an LCD display. Some of the most common LCDs connected to the contollers are 16X1, 16x2 and 20x2 displays. This means 16 characters per line by 1 line 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively.

SENSOR

An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measure only infrared radiation, rather than emitting it that is called a passive IR sensor. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation. These types of radiations are invisible to our eyes, that can be detected by an infrared sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode

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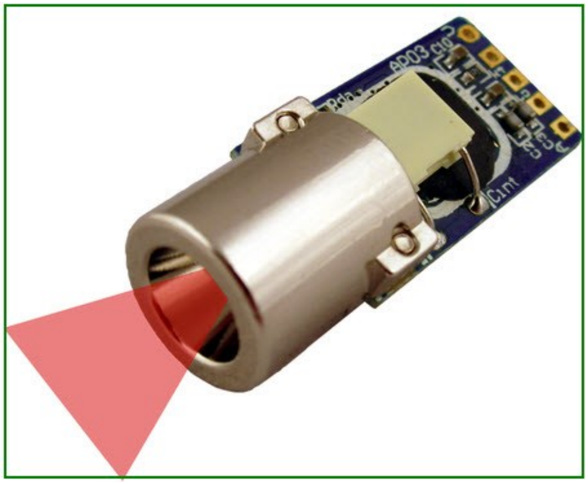
that is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, the resistances and the output voltages will change in proportion to the magnitude of the IR light received.



IR Sensor

Conclusion

There are three main IoT sensors for vehicle presence detection. For city street parking lots management, it is more suitable to install a wireless magnetometer sensor due to street parking may include both indoor or outdoor spaces which require flexibility on installation location. Besides, the wireless magnetometer sensor is able to withstand normal weather condition disruption. In addition, installing wireless magnetometer sensors only require a small inch drill hole which can be done quickly making it an ideal choice for large scale city implementation. However, an IoT smart parking system affects a whole network environment thus emphasizing the importance of personal security and privacy protection. It is the government's responsibility to establish related regulations to monitor data usage and avoid privacy issues from happening [4]. Besides, since the traffic system involves life safety issues, at the design stage, the government should take safety issues into consideration and educate the designers with effective prevention approaches such as mitigate the impact of security vulnerabilities through patching and establish vulnerability management policies to promote security updates. According to the U.S. Federal guidance report of the automotive industry aiming to improve motor vehicle cybersecurity [13], it indicated that it is important for infrastructure operators and cloud computing service providers to bear the notification obligations. In other words, the government needs to clarify the data acquisition level among different official departments and local companies and sets up proper information security management systems to undergo key actions including education and training of information security, monitor and management approach, safety inspection, and testing. oT realizes the vision of connecting and communicating with individuals through computing and analyzing a vast amount of information sources. However, to successfully adopt new technology requires a proper framework and clear understanding of the potential challenges and associated issues.

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