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RESEARCH ARTICLE

SMART DECISION-MAKING SYSTEM FOR CAR PARKING

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Abstract

The idea of smart city now seems to be achievable due to internet of Things. Consistent efforts are being made in the field of IoT in order to maximize the productivity and reliability of urban infrastructure. Problems such as, traffic congestion, limited car parking facilities and road safety are being addressed by IoT. In this paper, we propose an IoT based smart car parking system. The Smart Parking system is used to monitor and signalize the state of availability of single parking space for efficient and easy way of parking the vehicles by checking the availability of slots. The Infrared Sensor is utilized with Arduino to indicate the empty slot. By measuring and detecting infrared radiations in the surrounding environment using infrared sensor, drivers are able to find the empty slot in parking easily and thus reducing the searching time.

Introduction:-

The term Internet of Things generally refers to scenarios where network connectivity and computing capability extends to objects, sensors and everyday items not normally considered computers, allowing these devices to generate exchange and consume data with minimal human intervention [1]. The Internet of Things is an emerging topic of technical, social, and economic significance. Consumer products, durable goods, cars and trucks, industrial and utility components, sensors, and other everyday objects are being combined with Internet connectivity and powerful data analytic capabilities that promise to transform the way we work, live, and play[2]. Projections for the impact of IoT on the Internet and economy are impressive, with some anticipating as many as 100 billion connected IoT devices and a global economic impact of more than $11 trillion by 2025[3].At the same time, however, the Internet of Things raises significant challenges that could stand in the way of realizing its potential benefits. News headlines about the hacking of Internet-connected devices, surveillance concerns, and privacy fears already have captured public attention. Technical challenges remain and new policy, legal and development challenges are emerging. The concept of combining computers, sensors, and networks to monitor and control devices has existed for decades [4]. The recent confluence of several technology market trends, however, is bringing the Internet of Things closer to widespread reality. Some of the key IoT research areas include some of the most pressing challenges and questions related to the technology. These include: Security and privacy.

Security:
While security considerations are not new in the context of information technology, the attributes of many IoT implementations present new and unique security challenges. Addressing these challenges and ensuring security in IoT products and services must be a fundamental priority. Users need to trust that IoT devices and related data services are secure from vulnerabilities, especially as this technology becomes more pervasive and integrated into

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our daily lives. Poorly secured IoT devices and services can serve as potential entry points for cyber attacks and expose user data to theft by leaving data streams inadequately protected. As a matter of principle, developers and users of IoT devices and systems have a collective obligation to ensure that they do not expose users and the Internet itself to potential harm. Accordingly, a collaborative approach to security will be needed to develop effective and appropriate solutions to IoT security challenges that are well suited to the scale and complexity of the issues [5].

Privacy:

The full potential of the Internet of Things depends on strategies that respect individual privacy choices across a broad spectrum of expectations. The data streams and user specificity afforded by IoT devices can unlock incredible and unique value to IoT users, but concerns about privacy and potential harms might hold back full adoption of the Internet of Things. This means that privacy rights and respect for user privacy expectations are integral to ensuring user trust and confidence in the Internet, connected devices, and related services. In order to realize the opportunities, strategies will need to be developed to respect individual privacy choices across a broad spectrum of expectations, while still fostering innovation in new technology and services [5]. The paper is organised as follows: Section II contains the Framework of the proposed model and Section III explains the working of the model followed by the conclusion.

Proposed Framework

There are mainly four categories of car park guidance systems using different technologies wired sensor-based, wireless sensor-based, image-based and counter-based[6]. We are using wired sensor based technology which is using detection sensors such as infrared sensors which are installed at each parking lot. These sensors are wired to a central control unit that store and manage the parking occupancy information. This information is then forwarded to display panels at intentional locations in the car park. The display panels provide information, direction and guide the drivers to vacant parking slots.

The car parking system should be able to allow the driver to get his ticket after he presses the button of the gate barrier. The system should record the entire cars that pass through the entrance. The system should allow the gate to open whenever a driver has pressed the button and taken his ticket. Allow the drivers to make payment: if it's of commercial use, the system should enable the drivers to make payment of their charges before exiting. Finally, allow the driver to exit: if the driver has paid his charges and require exiting, the system should open the gate to allow him exiting. The Proposed IoT Based Smart Parking System using NodeMCU ESP8266 is shown below in Fig.1.

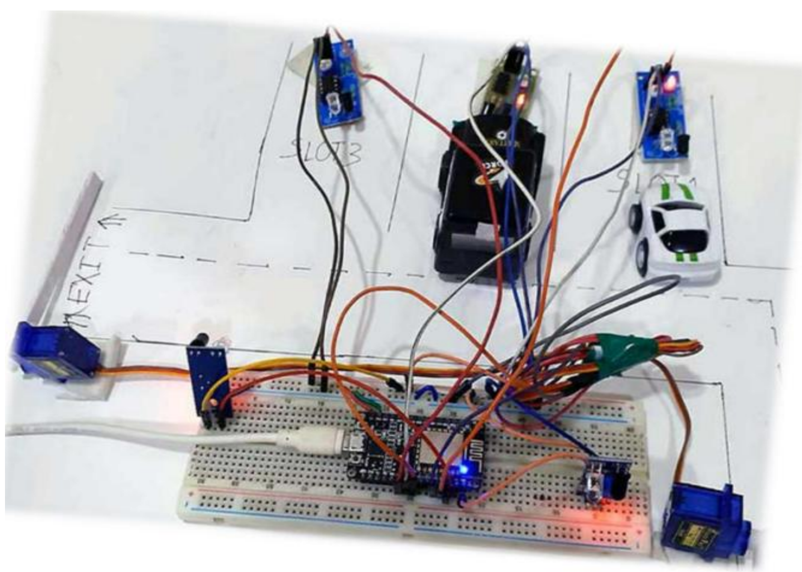

Fig1:- IoT based Car Parking System.

The hardware components required are Node MCU ESP8266 , IR Sensor, Servo Motors , Breadboard and Jump Wires. Also the Online Services required are Adafruit IO and Arduino IDE. Two IR sensors are used at entry and exit gate to detect the car while three IR sensors are used to detect the parking slot availability. Servo motors are used to open and close the gates according to the sensor value. Here we are using the Adafruit IO platform to publish the data on cloud which can be monitored from anywhere in the world. The main components are discussed below:

1)NodeMCU ESP8266:

NodeMCU ESP8266 is an open-source Lua based firmware and development board specially targeted for IoT based applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Express if Systems and hardware which is based on the ESP-12 module, and like this, it can also be programmed using Arduino IDE and can act as both Wi-Fi Hotspot or can connect to one. It has one Analog Input Pin, 16 Digital I/O pins along with the capability to connect with serial communication protocols like SPI, UART, and I2C. NodeMCU has 128 KB RAM and 4MB of Flash memory to store data and programs. Its high processing power with in-built Wi-Fi / Bluetooth and Deep Sleep Operating features make it ideal for IoT models. Its applications include prototyping for IoT devices, low powered battery-operated applications, and applications requiring I/O interface with Bluetooth and Wi-Fi capabilities.

2) IR Sensor Module:

The IR Sensor module consists of an IR transmitter LED which transmits IR light, this light will then be picked up by an IR receiver LED if it gets reflect by any object in front of it. It is commonly used in Line following robots, proximity sensing, object detection etc. It has three pins, in which two are used to power the sensor and the 3rd pins gives the output as high/low based on the proximity of the object in-front of it. The line follower sensor module also has a potentiometer to adjust the sensitivity of the sensor. This IR sensor module consists of an LM358 op-amp, an IR LED, photodiode, a 10K pot, led indicator, 2 resistors of 330 Ohms and 10K Ohms as shown in Fig.2.

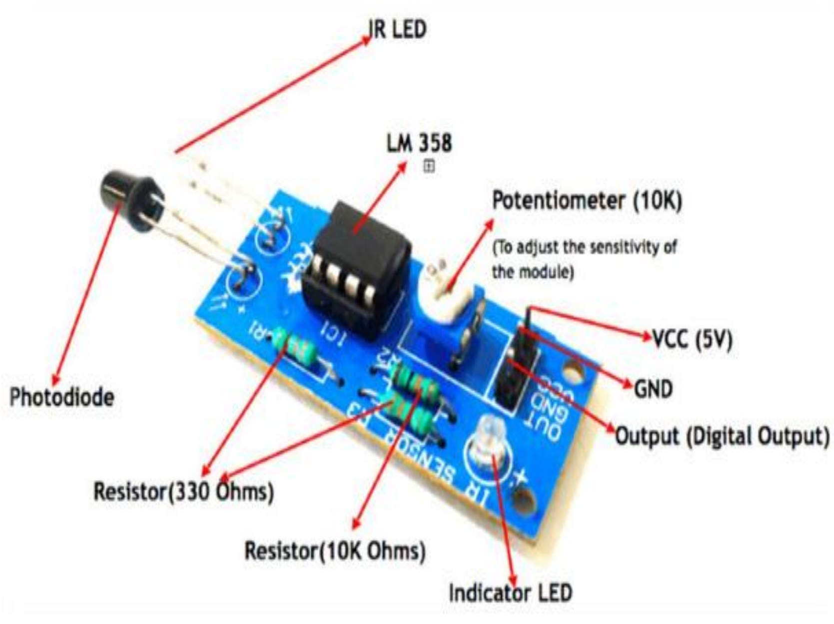

Fig 2:- IR sensor module.

The Working of IR Sensor Module:

Case 1:

When an object (Not of the black surface) is placed in front of the IR LED :In this situation,The IR waves emitting from the IR LED will strike the object (placed in the path transmitting IR waves) and gets reflected back. The photodiode is placed in such a way that it senses the reflected IR waves. When it senses the IR waves, its resistance decreases and acts as a short circuit. The current starts to flow into the R2 and voltage is appeared on the non-inverting terminal. If the voltage at the non-inverting terminal is greater than the voltage at the inverting terminal, the op-amp will give output high (5V) and the led starts glowing[7]. (Note: the voltage at the inverting terminal can be varied by varying the pot's resistance. This is done to change the sensitivity of the sensor. If the pot value is zero, even before the photodiode senses the IR waves, the output of the OP-amp will be high. This means that the sensor has high sensitivity.)

Case 2:
When no object is placed in front of the IR LED. In this case, the IR waves emitting from the IR LED will not be reaching the photodiode, as no object is present that can reflect back the IR waves. Due to this, the photodiode will be offering maximum resistance to the Vcc (supply voltage)[8]. As the current flowing through the resistor is minimum, the voltage at the non-inverting terminal will be minimum. As the voltage at the non-inverting terminal is less than the voltage at the inverting terminal, the output from the Op-amp will be a low value (0V).

3) Servo Motor:
Tiny and lightweight with high output power. Servo can rotate approximately 180 Degrees (90 in each direction), and works just like standard kinds but smaller. You can use any servo code, hardware or library to control these servos. It comes with a 3 horns (arms) and hardware. The specifications of the SG90 servo motor are: Operating Voltage: 3V to 7.2V , Stall torque @4.8V: 1.2 kg-cm and Stall torque @6.6V: 1.6 kg-cm. This servo motor can lift a maximum of 1.6 kg when suspended at 1cm distance from the shaft as shown in Fig.3.

Fig.3:- Servo motor.

4) Breadboard:
A breadboard is a solder less device for temporary prototype with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate as shown in Fig4.

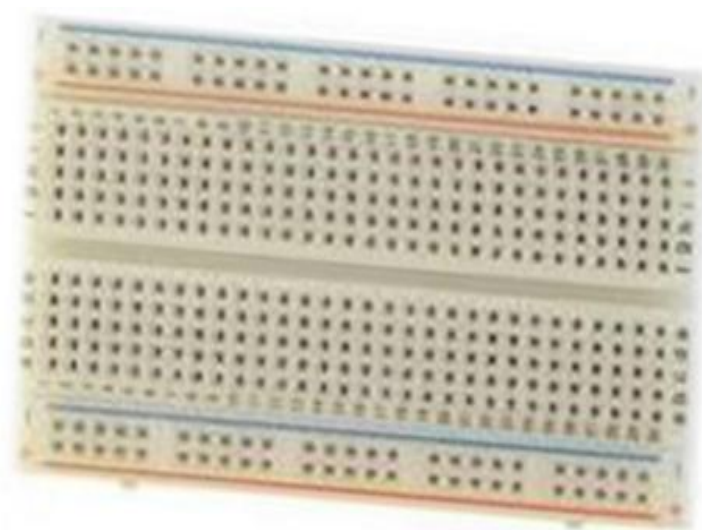
Fig.4:- Breadboard.

5) Jump Wire:
A jump wire (also known as jumper wire, or jumper) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering. Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment as shown in Fig. 5.

Fig.5:- Jump Wires.

6) Adafruit IO
IO Adafruit.io is a cloud service - that just means it runs for us and we don't have to manage it. We can connect to it over the Internet. It's meant primarily for storing and then retrieving data but it can do a lot more than just that. It can

- Display our data in real-time, online
- Make our model internet-connected: Control motors, read sensor data, and more!
- Connect model to web services like Twitter, RSS feeds, weather services, etc.
- Connect our model to other internet-enabled devices
- The best part? All of the above is do-able for free with Adafruit IO [9]

7) Arduino IDE
The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them [10] .

- **Writing Sketches:**

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right-hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor. Additional commands are found within the five menus: File, Edit, Sketch, Tools, and Help. The menus are context sensitive, which means only those items relevant to the work currently being carried out are available.

- **Sketchbook:**

The Arduino Software (IDE) uses the concept of a sketchbook: a standard place to store your programs (or sketches). The sketches in your sketchbook can be opened from the File > Sketchbook menu or from the Open button on the toolbar. The first time you run the Arduino software, it will automatically create a directory for your sketchbook. You can view or change the location of the sketchbook location from with the Preferences dialog.

- **Libraries**:

Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a sketch, select it from the Sketch > Import Library menu. This will insert one or more #include statements at the top of the sketch and compile the library with your sketch. Because libraries are uploaded to the board with your sketch, they increase the amount of space it takes up. If a sketch no longer needs a library, simply delete its

#include statements from the top of your code. Some libraries are included with the Arduino software. Others can be downloaded from a variety of sources or through the Library Manager.

Working of the proposed model

In this Smart Parking System using IOT, we are using five IR Sensors and two servo motors. IR sensors and Servo motors are connected to the NodeMCU. It controls the complete process and sends the parking availability and parking time information to Adafruit IO so that it can be monitored from anywhere in the world using this platform. Two IR sensors are used at entry and exit gate so that it can detect the cars at entry and exit gate and automatically open and close the gate. Two servo motors are used as entry and exit gate, so whenever the IR sensor detects a car, the servo motor automatically rotates from 45° to 140°, and after a delay, it will return to its initial position. Another three IR sensors are used to detect if the parking lot is available or occupied and send the data to NodeMCU. Adafruit IO dashboard also has two buttons to manually operate the entry and exit gate. The circuit diagram of IoT based smart parking system is given below in Fig.6.

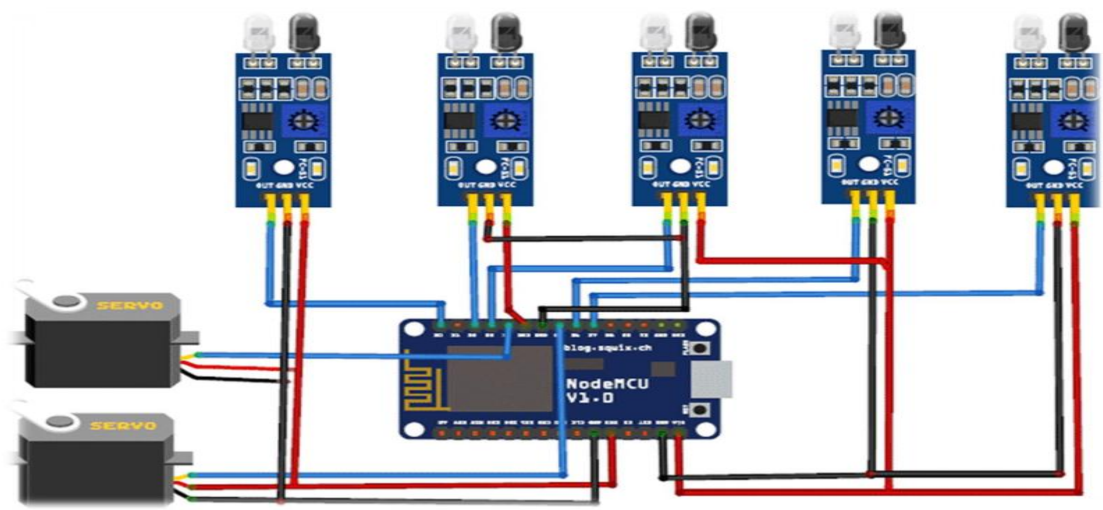

Fig 6:- Circuit Diagram.

Adafruit IO is an open data platform that allows us to aggregate, visualize, and analyze live data on the cloud. Using Adafruit IO, we can upload, display, and monitor our data over the internet, and make our model IoT enabled. We can control motors, read sensor data, and make cool IoT applications over the internet using Adafruit IO. For test and try, with some limitation, Adafruit IO is free to use.

To use Adafruit IO, first, you have to create an account on Adafruit IO. To do this, go to the Adafruit IO website and click on 'Get started for Free' on the top right of the screen. After finishing the account creation process, log in to your account and click on 'AIO Key' on the top right corner to get your account username and AIO key. When you click on 'AIO Key,' a window will be been popped up with your Adafruit IO AIO Key and username. Copy this key and username, which will be needed later in the code. Now, after this, you need to create a feed. To create a feed, click on 'Feed.' Then click on 'Actions,' and then on 'Create a New Feed'. After this, a new window will be opened to enter the Name and Description of the feed. Lastly, Click on 'Create,' and you will be redirected to your newly created feed.

For this model, we created a total of nine feeds for exit gate, entry gate, slot 1 entry & exit, slot 2 entry & exit, and slot 3 entry & exit. After creating feeds, now we created an Adafruit IO dashboard to show all of these feeds on a single page. To create a dashboard, we clicked on the Dashboard option and then clicked on the 'Action,' and after this, clicked on 'Create a New Dashboard.' As the dashboard has been created, we have added our feeds to the dashboard. To add a feed, click on the '+' in the top right corner. First, we have added two RESET buttons blocks for Entry and Exit gate and then seven TEXT blocks for parking details. To add a button on the dashboard click on the RESET block. whenever the button is pressed it will send the 'ON' string to NodeMCU, and NodeMCU will perform the further task. If we don't want to change the press value here than you can change the condition in the program. After this, we have followed the same procedure to create another block for the exit gate. Then we have created the rest of the blocks by following the same procedure. But instead of creating a RESET block we have created a TEXT block so that we can show the parking details. After 64 creating all the blocks, our dashboard looks like as shown in Fig.7. below. We can edit the dashboard by clicking on the settings buttons.

Fig.7:- Parking Details.

Conclusion:-

Developing a smart parking solution within a city solves the pollution problem, reduces traffic, enhances user experience, increases safety,etc**.** For the past couple of years large developments have been made in making smart cities a reality. The growth of Internet of Things has given rise to new opportunities in terms of smart cities. Smart parking facilities and traffic management systems have always been at the core of constructing smart cities. This paper, focuses on implementation of car parking system detection using Internet of Things. The benefits of smart car parking go well beyond avoiding time wasting.

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