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IOT BASED ENABLED PARKING SYSTEM IN PUBLIC AREAS

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ABSTRACT

Due to the increased use of cars everywhere, vehicle parking became a heavy issue today. so as to permit users to observe and reserve parking spaces, we are presenting an IoT-enabled parking system. At the entry gate, we've got installed an RFID reader for security reasons. This project's main objective is to make it simpler for users to work out whether parking spaces are available in an exceedingly parking location before visiting it. This creates a more intelligent and effective parking mechanism that greatly lowers all parking system challenges. The sensor at each slot continuously monitors slots condition and update the status to the cloud platform & application from where a user can check the provision of parking and book a parking slot.

Key Words: Smart & secured parking, IoT, Sensors, Cloud platform.

1. Introduction

Internet of Things (IoT) connects various physical devices & objects over the globe via internet. IoT is a system that connects computing devices, machines etc. that are provided with unique identifiers (UIDs) and IoT provides ability to transfer data over a network without requiring any interaction between the devices [1-4]. IoT is largely expansion of services provided by Internet [5-8]. Internet of Things (IoT) is that the network of physical objects like devices, instruments and other items embedded with electronics, circuits, software, sensors and network connectivity that permits these objects to gather and exchange data over a network without requiring human-to-human or human-to-computer interaction [9-11]. Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructure, also creating opportunities for more direct integration of the physical world into computer-based systems, and leading to improved efficiency and accuracy [12-16].

The evolution of the IoT we can classify it into five eras:

- The Internet of Documents: e-libraries, etc.
- The Internet of Commerce: e-commerce, etc.
- The Internet of Applications: Web 2.0
- The Internet of People: Social networks.
- The Internet of Things: Connected devices/machines.

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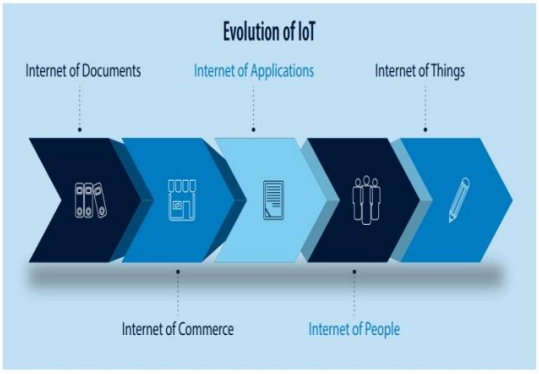

Fig.1: Evolution of IoT

IoT is able to interact without human intervention. Some primary IoT applications have been already developed in different fields. IoT technologies are at their infant stages; however, many new developments have occurred in the integration of objects with sensors in the Internet [17-21].

One of those IoT systems is smart parking. It is to know the status of parking slot via internet. This is related to parking problems which one of them is the difficulty of knowing the condition of vacant space in the parking area. Due to this problem, the driver spends his time in finding a parking place. Problems related to parking can be solved if driver can able to know the availability of parking space before reaching the destination [22].

Various approaches and researches have been done to overcome parking problems. Since the early 1970s, smart parking has been implemented throughout various countries. The initial system will be displaying parking information such as availability status and/other amount of space available. More complex smart parking incorporates more advanced technology to serve customers with advanced information like slot status, slot number which is empty [23]. And also providing an efficient feature of slot booking. Currently, there are certain parking systems that are able to provide real-time information about available parking spaces. Such systems require efficient sensors to be placed in parking lots to monitor parking spaces and rapid data processing units to collect the data from different sources [24].

Hence, the IoT has been the trend of the next Internet. Every available thing is getting smart. There is a wide scope for research in IoT. The future of IoT is very bright. From our bills to vehicles everything would be connected providing a better lifestyle [25].

2. Literature Survey

Parking management system is necessary to ensure proper utilization of the parking space in parking zone [26]. Many authors have worked on this parking management system in which few problems are addressed and solved by using our proposed system [27]. Due to unmanaged parking system, it was really difficult to use the parking space in effective way. Here, we addressed that ineffectiveness of space utilization in parking zone and solved that issue in our project (IoT Enabled parking) [28]. The design of our project leads to an effective utilization of parking slots in parking zone. It will reduce parking problems [29]. Node MCU is used as controller unit in our project. IR Sensors are deployed at slot, which keep sensing and updating the status of slot to Cloud platform [30]. We deployed RFID reader to provide better security in parking zone [31-35]. We used an MIT application, using which user can know status of parking slots from anywhere and allow user to book a slot [36-38].

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3. Proposed System

The proposed system is shown in below fig.2 in which we used Node MCU board. It consists of ESP8266Microcontroller and built in Wi-Fi which allows to build a connection with Cloud platform. IR sensors are used for vehicle detection in the slot. As IR Sensors are placed at every slot, they continuously detect the vehicle presence and accordingly the status is updated in LCD and also in MIT app. Now user can know the status of slots before reaching the parking zone. Hence the design of our project leads to an effective utilization of parking slots in parking zone. It will reduce parking problems.

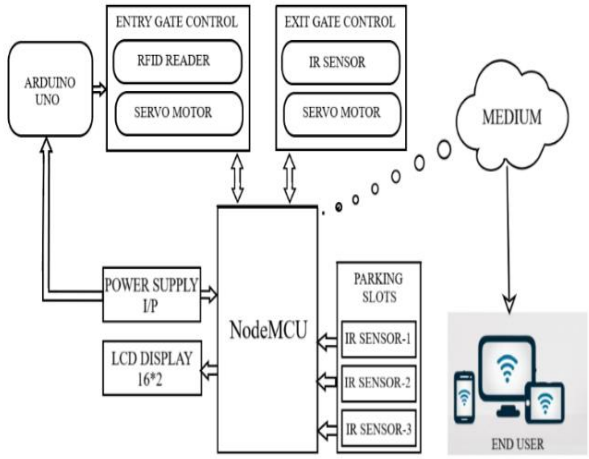

Fig.2: Proposed system block diagram

4. System Architecture

IoT Enabled Parking System" has two major sections. First section consists of Arduino UNO, RFID Reader and Servo Motor. Authorized user must place his card over the reader to enter into parking zone, so that the servo opens the entry gate. If unauthorized user tries to get into parking zone the access will be denied and the gate remains closed. The second section consists of Node MCU board, IR Sensors, Servo Motor and LCD display which is used to acknowledge about the availability of free parking space. As this section is connected with Cloud platform and application over internet, using this section user can acknowledge about the parking slot availability from the remote place.

4.1 Hardware Requirements

4.1.1 Node MCU

Node MCU is open-source software & hardware development environment that is built around a very inexpensive System-on-a Chip (SoC) called the ESP8266. Node MCU development board comes with the ESP8266 module chip having Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor supports RTOS and operates at 80MHz to 160 MHz adjustable clock frequency. Node MCU has 128 KB RAM and 4MB of Flash memory to store data and programs. Node MCU have 11 digital I/O pins, 1 analog pin and supports SPI, UART and I2C. The operating voltage of ESP8266 is 3 to 3.3v. Its high processing power with in-built Wi-Fi and Deep Sleep Operating features make it ideal for IoT project. In this prototype we used Node MCU module which was programmed using Arduino IDE.

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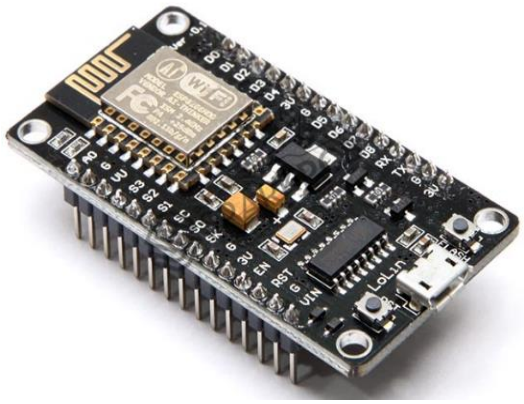

Fig.3: Node MCU ESP8266

4.1.2 Arduino UNO

Arduino UNO is a microcontroller board developed by Arduino.cc and is based on Atmega328 Microcontroller. There are 14 digital pins and 6 analog I/O pins. Arduino IDE software is used to program this board. Type B cable is used to connect computer and Arduino board. An external source between 7-20 volts can be used to power this board. The microchip ATMEGA328P is pre-programmed. Boot loader is used to upload new code in this microchip. It has flash, EEPROM storage of 32 kb. 0.5kb of this 32kb is used by boot loader. Operating voltage of this board is 5v. It consists of 2kb SRAM memory. Weight is around 25g. 6 of the digital pins give PWM output. This board has various facilities for communication with other microcontrollers. There is a library named software serial, which allows serial communication for all digital pins.

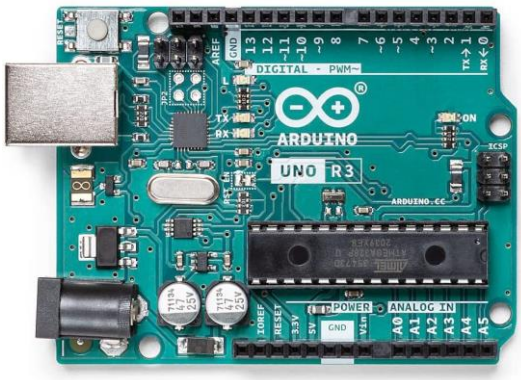

Fig.4: Arduino UNO (ATMega328P)

4.1.3 Infrared Sensor

It is used as Obstacle detector. The IR Sensor Module or infrared (IR) sensor is a basic and most popular sensor in electronics which is used in wireless technology like remote controlling functions and detection of surrounding objects/ obstacles. The IR sensor is one kind of electronic component, used to detect specific characteristics in its surroundings through emitting and detecting IR rays.IR sensors mainly consist of an Infrared (IR) LED and a Photodiode, this pair is generally called IR pair. An IR LED is a special purpose LED, it is can emitting infrared rays ranging from 700 nm to 1 mm wavelength. IR LED transmit an infrared signal, this infrared signal bounces back if there's any obstacle and the signal is

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received at the infrared receiver. These types of rays are invisible to our eyes. In contrast, a photodiode or IR Receiver LED detects the infrared rays.

Fig.5: Infrared Sensor

4.1.4 Servo Motor

Servo Motor SG90 is a tiny and lightweight motor with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds. You can use any servo code, hardware or library to control these servos. Good for to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. It comes with a 3horns (arms).

Fig.6: Servo Motor

4.1.5 16*2 LCD Display

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc. It includes 16 Columns &2 Rows so it can display 32 characters (16×2=32) in total & every character will be made with 5×8 (40) Pixel Dots. So, the total pixels within this LCD can be calculated as 32 x 40 otherwise 1280 pixels.

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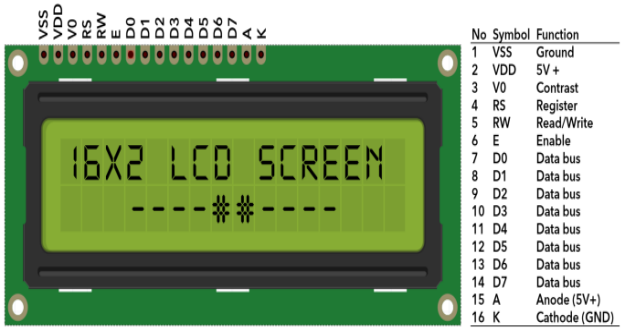

No	Symbol	Function
1	VSS	Ground
2	VDD	5V +
3	V0	Contrast
4	RS	Register
5	RW	Read/Write
6	E	Enable
7	D0	Data bus
8	D1	Data bus
9	D2	Data bus
10	D3	Data bus
11	D4	Data bus
12	D5	Data bus
13	D6	Data bus
14	D7	Data bus
15	A	Anode (5V+)
16	K	Cathode (GND)

Fig 7: 16*2 LCD Display

4.1.6 RFID Reader & Tags

RFID (radio frequency identification) is a form of wireless communication that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency portion of the electromagnetic spectrum to uniquely identify an object, animal or person. Every RFID system consists of 3 components: a transceiver, scanning antenna and a transponder. When the scanning antenna and transceiver are combined, they are referred to as an RFID reader or interrogator. The RFID reader is a network-connected device that can be portable or permanently attached. It uses radio waves to transmit signals that activate the tag. Once activated, the tag sends a wave back to the antenna, where it is translated into data. The transponder is in the RFID tag itself. The read range for RFID tags varies based on factors including the type of tag, type of reader, RFID frequency and interference in the surrounding environment or from other RFID tags and readers.

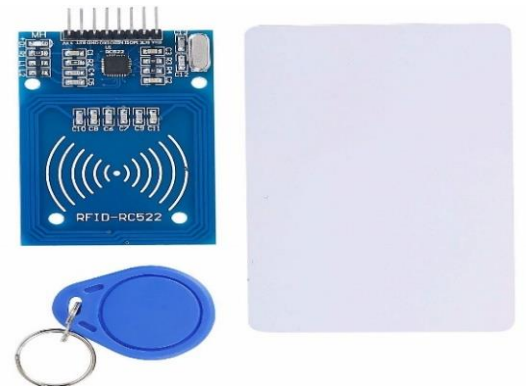

Fig.8: RFID Reader & Tags

4.2 Software Requirements

4.2.1 Arduino IDE

The Arduino Integrated Development Environment 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 and Genuine hardware to upload programs and communicate with them. Programs written in ArduinoIDE are considered to sketches. These sketches are written in the text editor and are saved with the file extension.ino. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor. It supports C/C++ language. Programming can be done for different boards using Arduino IDE.

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4.2.2 Firebase

Firebase is a platform developed by Google for creating mobile and web applications. It was originally an independent company founded in 2011. In 2014, Google acquired the platform and it is now their flagship offering for app development. Firebase first product was the Firebase Real time Database, an API that synchronizes application data across iOS, Android, and Web devices, and stores it on Firebase's cloud. The product assists software developers in building real-time, collaborative applications.

4.2.3 MIT App Inventor:

MIT App Inventor is a web application integrated development environment which is originally provided by Google, and now maintained by the Massachusetts Institute of Technology.MIT allows to create software application (apps) for operating systems (OS): Android, and iOS. It is free and open-source software. It uses a graphical user interface (GUI) very similar to the programming languages which allows users to drag and drop visual objects to create an application that can run on Android devices, while a App-Inventor Companion (The program that allows the app to run and debug on) that works on iOS running devices are still under development.MIT App Inventor is an intuitive, visual programming environment that allows everyone even children to build fully functional apps for smart phones and tablets.

5. Implementation & Working

This system is designed in such a way that RFID Reader module is deployed at the entry gate which provides better security by giving access to authorized users only. User must place tag In front of reader to enter into parking zone. RFID Reader detects the tag. When the tag is detected by the reader, its unique tag number is sent to the microcontroller (Arduino UNO).If the tag number is matched with saved unique number in code, the microcontroller will trigger servo motor to open the gate and allows the car in order to park. If the tag number is not matched the gate will remain closed.

IR sensors are deployed at the parking slots. IR Sensors are playing the key role for this parking system because these sensors have a capability to detect an obstacle in closer proximity. So, the characteristic of the sensor is utilized to find out the occupancy of slot in parking area. Along with these one more IR sensor is used at exit gate to detect the vehicle. When any vehicle is trying to cross the gate then the IR receiver can detect the discontinuity of Line of Sight (LOS) of the IR light and the same can be used as a trigger or interrupt for the system to create a condition for exit of a vehicle in the parking zone. Servo motor at exit gate is used to open and close the gate according to the sensor value. These IR sensors are directly connected to the microcontroller unit (Node MCU).16*2 LCD display is used as an output screen at parking area to display the status of each slot whether the slot is empty/filled. As Node MCU chip comprises of a self-contained SOC with integrated TCP/IP protocol stack that allows microcontroller to access Wi-Fi network. A connection is built between Node MCU and Firebase through Arduino IDE so that, the information which is collected by Node MCU will be updated to Firebase.

Using MIT, a web application is designed. After designing app on MIT app inventor, you can download it on your Android phone using the QR code. A Wi-Fi with the same user name & password used in code must be connected to Node MCU. So that the controller unit will be connected over internet. After compiling & uploading code to Node MCU. Node MCU then transmits this data to Firebase through Arduino IDE. Hence, Node MCU acts as mediator

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between the Sensors, Firebase and Application. Firebase acts as a database to store all the records & display in real time. User can able to know parking status from remote area and able to book a slot through application.

6. Results and Discussions

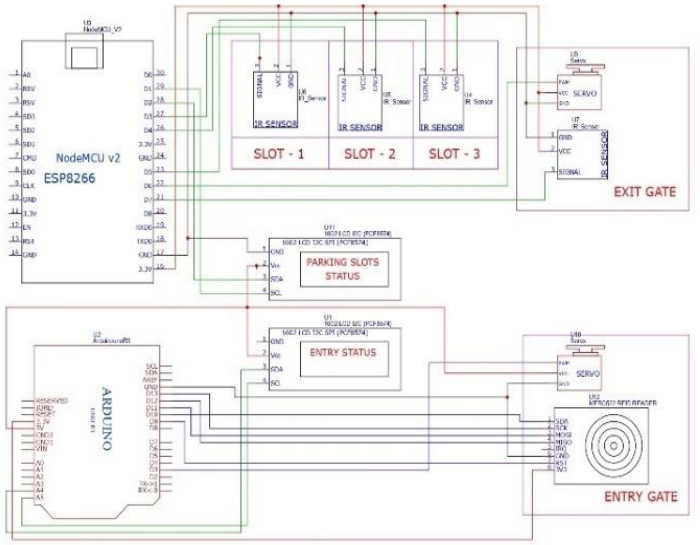

Fig. 9: Schematic Diagram

After implementing system as we had shown in the Schematic, then after we provide power supply to it, the model start executing the code and peripherals starts responding to according to the code. The working model of IoT Enabled Parking System" has been checked and the following results have been produced.

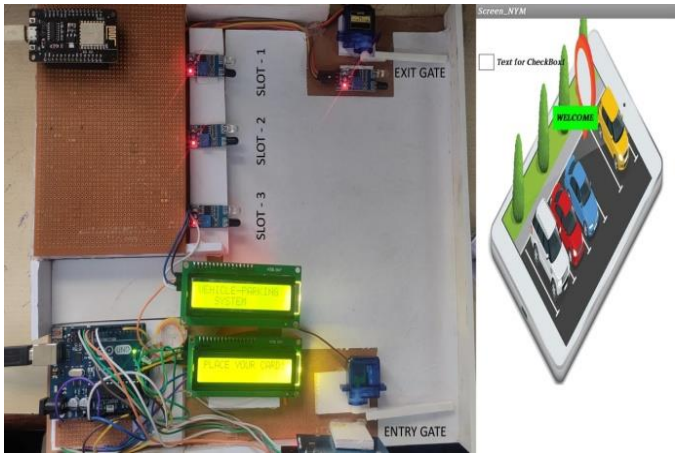

Fig.10: Initial Stage of Output

At the entrance gate when authorized user get access through RFID tag by placing it over RFID reader Node MCU triggers servo motor to open the barrier and allows user to get into parking zone.

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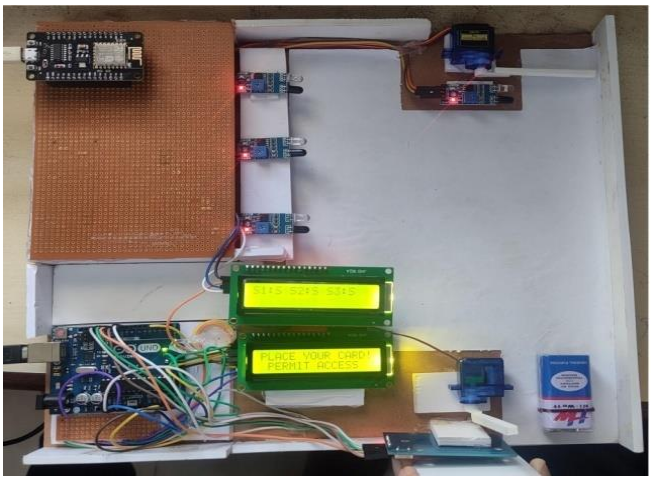

Fig.11: Arduino UNO Triggering Servo and Allowing Vehicle into Parking Zone

Slot Occupancy

When the user park the vehicle at parking slot the IR sensor detect the presence of vehicle and indicate us by glowing obstacle led & the results were found as shown in below diagrams.

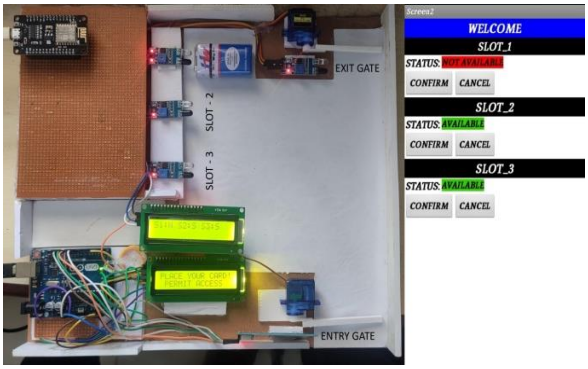

Fig.12: Slot 1 is occupied

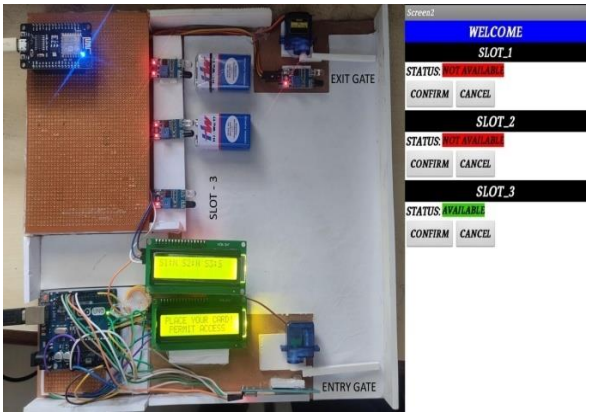

Fig.13: Slot 1 & Slot 2 are occupied

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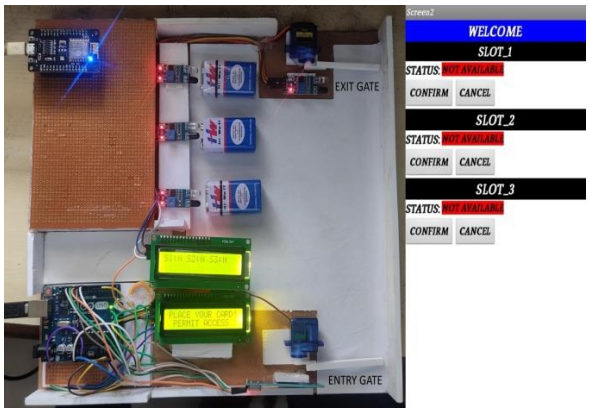

Fig.14: All the Three slots are occupied

When any vehicle is trying to exit the parking zone the IR receiver can detect the discontinuity of Line of Sight (LOS) of the IR light and the same can be used as a trigger or interrupt for the system to create a condition for exit of a vehicle in the parking zone.

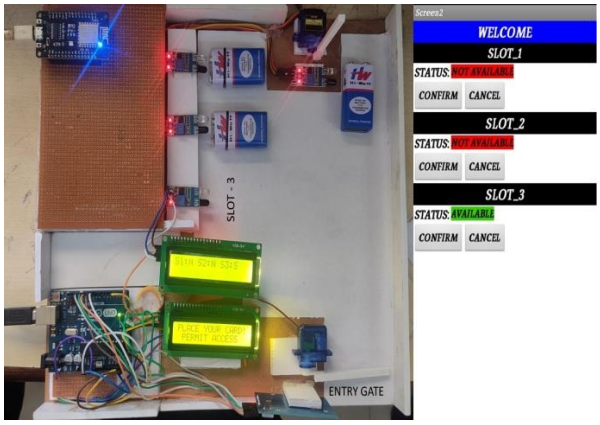

Fig.15: Node MCU triggering servo and allowing vehicle to exit.

7. Conclusion

Since the past couple of years large advancements have been made in making smart cities a reality. The growth of Internet of Things and Cloud technologies has given rise to new possibilities in terms of smart cities. Smart parking facilities & traffic management systems have always been at the core of constructing smart cities. In this paper, we address the issue of parking and present an IoT based Cloud integrated smart parking system. The system that we propose provides real time information regarding availability of parking slots in a parking area. Users from remote locations could book a parking slot for them by the use of our mobile application. The efforts made in this paper are indented to improve the parking facilities of a city and thereby aiming to enhance the quality of life of its people.

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