# An IoT based Smart Parking System using LoRa

Ravi Kishore Kodali
*Department of E. C. E.*
*National Institute of Technology, Warangal*
WARANGAL, 506004, INDIA
ravikkodali@gmail.com

Krishna Yogi Borra, Sharan Sai G. N. and Jehova Honey Domma
*Department of E. C. E.*
*National Institute of Technology, Tadepalligudem*
Andhra Pradesh, 534101, INDIA

***Abstract*—Internet of Things (IoT) plays a fundamental role in connecting the ecological things around us to a network. It helps us monitor the parameters of the things with the usage of sensors that are familiarize for remote sensing of the specific data and forward the information over the network cloud by means of Internet Connection. This paper centers around the idea of knowing the status of parking availability in a parking lot through Internet with the help of Internet of Things Technology. This uses Ultrasonic sensor to detect the vehicle in the parking slot, TTGO-ESP32-LoRa (transmitter) boards placed at different parking lots in different places to transmit the data. TTGO-ESP32-LoRa (receiver) receives the data which is placed near to the parking lots and also sends the slot information to IBM Watson IoT platform through WiFi protocol present in the Esp32 board. The status of the parking availability can also be viewed in the Android Phone.**

***Keywords*—IoT, sensor, LoRa, Smart Parking, Smart city, ESP-32, IBM Watson.**

## I. Introduction

One of the significant issues that we are looking in the present society is traffic congestion mainly because of the unavailability of sufficient parking lots [2], [8], [9]. This has become a major problem in urban cities where there are shopping malls, cinema theatres, metro stations, etc.

The parking system we propose is implemented using Esp32 TTGO LoRa transmitter, receiver and ultrasonic sensors. LoRa receiver can receive the data from multiple transmitters as packets. The LoRa transmitter is installed in various parking lots to transmit the data of parking availability so that we don't need to use WiFi at every parking lot.

LoRa Esp32 module can transfer the data upto 5 km range. We keep a LoRa recevier at that range to receive the data from multiple parking lots. So, If we have three parking lots and we find a point which is nearly in the range from the three lots then we place the LoRa receiver at that point. Instead of three Wifi modules at three parking lots, we keep three LoRa transmitters and a receiver.

This reduces the cost of using internet provided by Internet service providers(ISP). WiFi protocol is used only at the receiver side i.e., ESP32 LoRa receiver to transfer the received data onto the cloud and also to a local wifi server to access the data in our android phone [3]. The receiver is placed such that it is equally nearer to the transmitters.

The rest of the paper is organized as follows: Section II gives us the fundamental survey of the past work done in this area. Section III includes the advantages of the proposed system over the current ones and also the advantages of using LoRa. Section IV describes the design of the proposed system and how it is implemented. Section V and VI presents the hardware and software realizations respectively of the proposed system. The results are given in Section VII.

## II. Previous Work

Different parking systems [15], [16], [17] have been proposed which utilize the ESP8266 WiFi module or Arduino Board to transfer the data into the cloud. These ESP8266 WiFi modules are installed in each parking lot. This increases the cost because we need to provide internet access for each WiFi module [2].

In the proposed system, instead of Wifi modules at parking lots, we keep LoRa transmitters and one receiver which transfers the data into the cloud through WiFi protocol. Only receiver needs internet access to transfer the data onto the cloud. Thus, the cost is reduced.

## III. Advantages

- Use of Lora technology helps in avoiding recurring charges that were produced by internet service providers.
- As Lora uses unlicensed band there will be no restriction on usage
- Lora tech covers a range of 3-5 Km so all the data can be received by a single Lora receiver within that range.
- A smart way to track the vacant and non-vacant slots at any place.
- Effective Utilisation of vacant place within a specific lot.
- Reduction in the manual handling of slots in the parking lot.

## IV. Design and Implementation setup

The Ultrasonic sensors are connected to the TTGO ESP32 LoRa board. The sensors placed in each parking slot measures the distance(in cm) of the obstacle present. If the distance measured is less than the given threshold value (25 cm in this case) then the slot is marked as parked. We set flags for each slot (flag=1 if parked, 0 if vacant). To distinguish the slot information in each parking lot, we send names of the places in which the parking lots are present. Esp32 LoRa board sends the flag values along with the lot name(lot1,lot2,etc., in this case) to the Esp32 LoRa receiver which transfers the data into the cloud.

978-1-7281-0974-9/18/$31.00 ©2018 IEEE
DOI 10.1109/CyberC.2018.00039

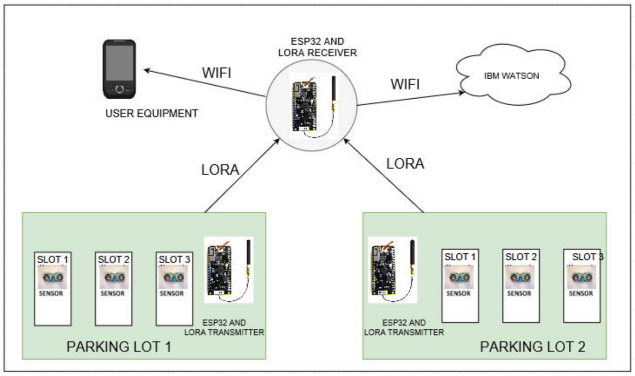


Fig. 1. Block Diagram.

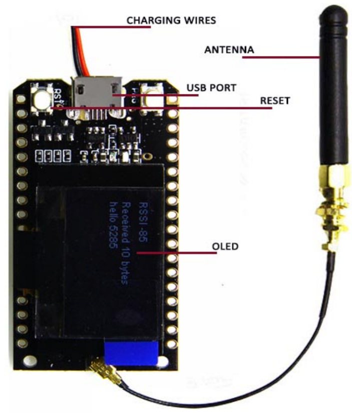


Fig. 2. TTGO ESP32 LoRa module.

### A. Components required

1) TTGO ESP32 LoRa
2) Ultrasonic Sensor
3) Accessible WiFi
4) Mobile phone to check slot information

### B. TTG0 Esp-32 LoRa Module

This is an Esp-32 module which consists of 0.96 inch blue OLED and a Lithium battery charger onboard. It comes with a SX1276 chip based LoRa module with 868-915 MHz frequency which has high transmission range and highly reliable. We can programm the board using Arduino IDE with some libraries pre-installed [6]. We need to select Esp32 Dev module as board-type and install CP2102 USB drivers on windows. The required libraries are Esp32, OLED, LoRa that can be downloaded from the GitHub site.

TABLE I
TTGO ESP-32 LoRa Specifications

| ***Parameters*** | ***Specifications*** |
|---|---|
| Operating voltage | +3.3V to +7V |
| Operating Temperature | -40°C to +90°C |
| WiFi | 802.11 b/g/n (2.4GHz) |
| Bluetooth | v4.2 (BLE) |
| SRAM | 520kB |
| ROM | 448kB |
| Frequency (LoRa) | 868-915MHz |

### C. LoRa Technology

LORA [11] is an asynchronous protocol, based on ALOHA. At present days LPWAN(Low power Wide Area Networks) [10] is implemented in the Internet of things. LoRaWAN utilised in this comes under LPWAN. Lora has its significance in data link and physical layer. It has a low bit rate which is utilised by present IoT devices. At physical layer of Lora, the signal modulation is extended version of frequency shift keying. It was named as chirp spread spectrum [1]. As in case of FSK two different frequencies are used for the indication of 1 and 0, but in the case of chirp spread spectrum there will be a sweep from one frequency to the other for a successful representation of the single bit.

Chirp spread spectrum [13] mainly depends on the bandwidth and sweep rate [1] [11]. Sweep rate, in turn, can be named as spreading factor. There are mainly 6 different spreading factor starts from 7,8,9,10,11,12.. the lesser the spreading factor, more is the sweep rate. Bandwidth plays a major role in the implementation of the Lora technology. Different countries set different limits on bandwidth ranging from 500khz to 125khz [14].

More is the sweep rate more the data can be transferred, but reliably the more the error will be i.e., lesser the spreading factor more will be the data transmission.

TTGO Lora esp32 is powered with SX1276 chip by Semtech which provides the required hardware setup for esp32 to get equipped with Lora technology. It has mainly four different modes. Spreading factor, bandwidth, preamble length, sync word, FEC(forward error correction), parity, etc., are initialised and sent to the register of SX1276. These parameters are required for setting the Lora for receiving or transmission. These should be set, when a device in sleep mode and switched to required mode after setting the parameters.

### D. HC-SR04 Ultrasonic sensor

Ultrasonic sensor i.e., HC-SR04 is a 4 pin sensor which is used to measure distances. It has a transmitter module and a receiver module. Transmitter module transmits the ultrasonic wave in the air. If the wave is reflected back because of any material, the receiver module receives the reflected wave. It calculates the distance of the object using the time taken for the wave to return and the speed of the wave [4]. This sensor is an extremely mainstream sensor utilized as a part of numerous applications where we estimate distance or detect objects. The sensor has 4 pins which are Vcc, ground, echo and trigger. Vcc is used for power supply to the sensor. Ground pin is connected to the ground. Trigger pin is set high for 10us to start the measurement. Echo pin will give a high pulse when the reflected wave is recieved [4].

TABLE II
HC-SR04 SPECIFICATIONS

| ***Parameters*** | ***Specifications*** |
|---|---|
| Operating voltage | +5V |
| Measuring Distance (Theoritical) | 2cm to 450cm |
| Measuring Distance (Practical) | 2cm to 80cm |
| Measuring Angle (Maximum) | 15° |
| Operating Current (Maximum) | 15 mA |
| Operating Frequency | 40Hz |

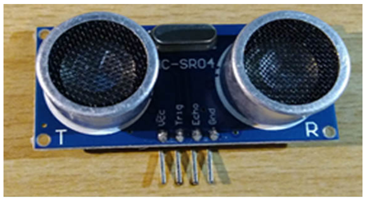


Fig. 3. HC-SR04 Ultrasonic Sensor

## V. IBM WATSON INTERNET OF THINGS PLATFORM

IBM watson is a secure cloud platform for data analytics owned by IBM. We use Bluemix which is a cloud service by IBM Watson generally used for IoT Data. First, we need to create an IBM account with gmail followed by creating an Internet of Things Platform instance. After creating Internet of Things Platform service, we need to launch it [5]. The bluemix dashboard will be opened. We need to go to devices and add Device type to add a device. Then add a device with an authentication code which has to be put in the program. After completion of adding device, we need to add a board in Boards section with some name [5]. Open the board and click 'Add New Card' to create a card and set event name and property to view the status of the parking slots.

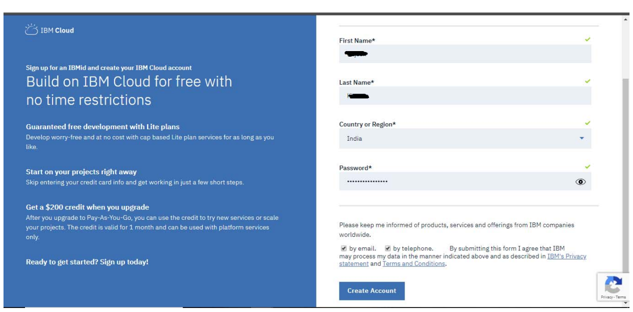


Fig. 4. Creating IBM Watson account

## VI. HARDWARE REALIZATION

The Vcc and ground pins of the Ultrasonic sensor are connected to the same of ESP-32 module respectively. Echo pin and trigger pin are connected to the gpio pins whose numbers are required in the software part. The LoRa is connected to the IPEX interface present on the ESP-32 module. The module should be powered up by either power bank or Lithium battery.

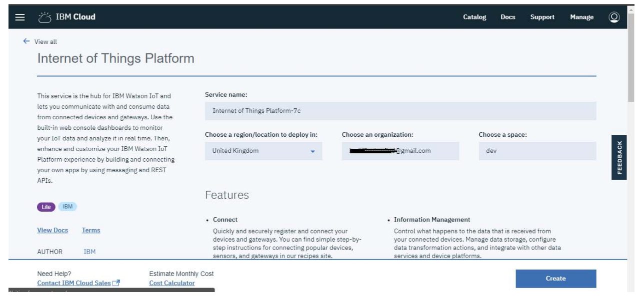


Fig. 5. Creating Internet of Things service

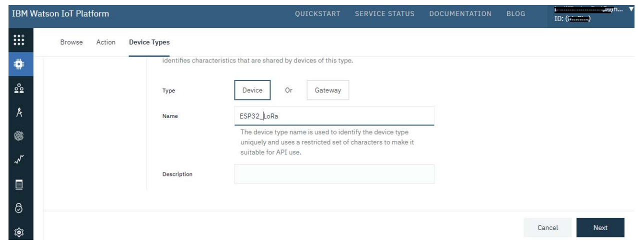


Fig. 6. Adding Device type

For accurate output, it would be better to use two ultrasonic sensors for one parking slot.

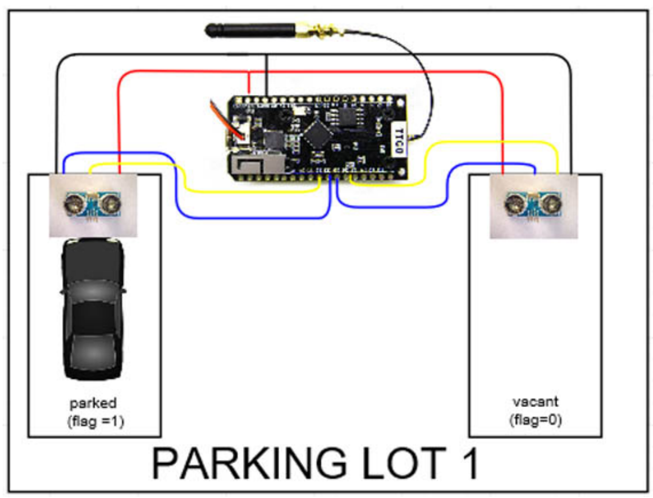


Fig. 7. Circuit Connection

## VII. SOFTWARE REALIZATION

TTGO ESP-32 module needs to be programmed using Arduino IDE software which can be installed in Windows or Linux os. To programm using Arduino IDE, we would need to pre-install the libraries i.e., ESP-32 library, HCSR04, Adafruit_SSD1306 and LoRa. ESP-32 dev module has to be selected as the board type. The COM port is to be selected after connecting the module to computer. There are some changes that should be made in the source code before uploading.

Wifi_ssid and wif_password should be replaced by the actual ssid and password. The IBM watson ORG, DEVICE_TYPE, DEVICE_ID, TOKEN are also need to be modified in the code as they are given in the IBM watson account. After completing all the steps, the code has to be compiled and uploaded to the module.

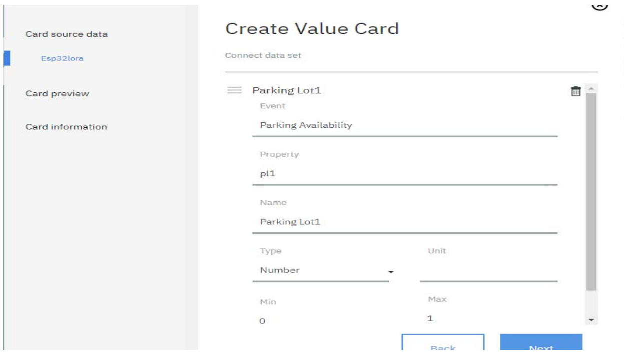


Fig. 8. Creating card for parking status in IBM Watson

## VIII. Results and Conclusion

After compiling and uploading the code, the ESP32 LoRa starts sending the data from ultrasonic sensor to the LoRa receiver. The receiver module transfers the data to the cloud (IBM Watson) and also a local wifi server. The data is checked using our Android Phone by typing the ip address of the module in any browser.

Using this smart parking system, One can easily check the availability of the parking slot using internet anywhere in the world. This would benifit a lot of smart cities which are facing problems with parking issues.

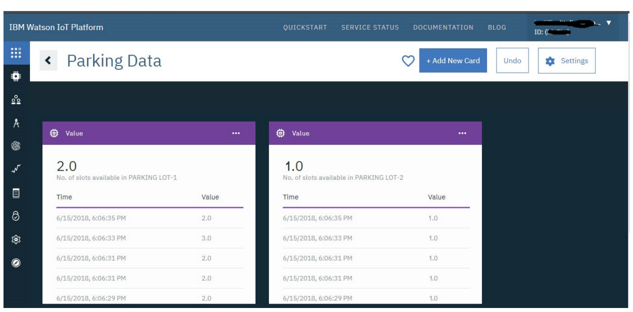


Fig. 9. Slot status uploaded in IBM Watson

## References


[1] M Farooq and D Pesch, "Analyzing LoRa: A use case perspective," 2018 IEEE 4th World Forum on Internet of Things (WF-IoT).

[2] S Mendiratta, D Dey and D Rani Sona, "Automatic car parking system with visual indicator along with IoT," 2017 International conference on Microelectronic Devices, Circuits and Systems (ICMDCS).

[3] I Allafi and T Iqbal, " Design and implementation of a low cost web server using ESP32 for real-time photovoltaic system monitoring," 2017 IEEE Electrical Power and Energy Conference (EPEC).

[4] https://components101.com/ultrasonic-sensor-working-pinout-datasheet

[5] https://console.bluemix.net/docs/services/IoT/index.html

[6] https://github.com/osresearch/esp32-ttgo

[7] Susanna Spinsante, Gianluca Ciattaglia, Antonio Del Campo, Davide Perla, Danny Pigini, Giovanni Cancellieri, Ennio Gambi, "A LoRa enabled building automation architecture based on MQTT" 2017 AEIT International Annual Conference.

[8] Zhongsheng Wang, Zhichao Lian, Kang Han, "Designing of Intelligent Parking Lot Based on MQTT" 2017 International Conference on Computer Network, Electronic and Automation (ICCNEA).

[9] Abhirup Khanna, Rishi Anand, "IoT based smart parking system" 2016 International Conference on Internet of Things and Applications (IOTA).

[10] Xihai Zhang, Mingming Zhang, Fanfeng Meng, Yue Qiao, Suijia Xu, Seng Hout Hour, "A Low-Power Wide-Area Network Information Monitoring System by Combining NB-IoT and LoRa" 2018 IEEE Internet of Things Journal.

[11] H. Mroue, A. Nasser, S. Hamrioui, B. Parrein, E. Motta-Cruz, G. Rouyer, "MAC layer-based evaluation of IoT technologies: LoRa, SigFox and NB-IoT" 2018 IEEE Middle East and North Africa Communications Conference (MENACOMM).

[12] Shie-Yuan Wang, Yo-Ru Chen, Tzu-Yang Chen, Chia-Hung Chang, Yu-Hsiang Cheng, Chun-Chia Hsu, Yi-Bing Lin, "Performance of LoRa-Based IoT Applications on Campus" 2017 IEEE 86th Vehicular Technology Conference (VTC-Fall).

[13] Ádám Knapp, László Pap, "Performance analysis of pulse position based chirp spread spectrum technique for multiple access".2017 25th International Conference on Software, Telecommunications and Computer Networks (SoftCOM)

[14] Brecht Reynders,Sofie Pollin, "Chirp spread spectrum as a modulation technique for long range communication" 2016 Symposium on Communications and Vehicular Technologies (SCVT).

[15] B M Mahendra, Savita Sonoli, Nagaraj Bhat, Raju, T. Raghu "IoT based sensor enabled smart car parking for advanced driver assistance system" 2017 2nd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT).

[16] Sarthak Mendiratta, Debopam Dey, Deepika Rani Sona, "Automatic car parking system with visual indicator along with IoT" 2017 International conference on Microelectronic Devices, Circuits and Systems (ICMDCS).

[17] Shyam Ravishankar, Nrithya Theetharappan, "Cloud connected smart car park" 2017 International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC).