

Smart Parking System using IoT technologies

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Abstract— Smart Cities have long been dreamt of even before all places began connecting through internet. In present era where there is internet everywhere and Internet of Things is trending, a possibility of smart city and smart country seems achievable. Problems such as, traffic congestion, limited car parking facilities and road safety are being addressed by IoT. In recent times the most important problem arising due to overpopulation in cities is the problem of an efficient parking system. In this project, we are implementing an IoT based cloud integrated smart parking system. The proposed Smart Parking system consists of IoT devices in the form of IR sensors and microprocessors. A mobile application is also provided that allows an end user to check the availability of parking space and book a parking slot accordingly. The app shows all the details of the parking spaces and once the user enters the parking the app will navigate him/her to the reserved spot.

Keywords—Smart Parking System, IoT, free of cost, Raspberry pi, http, requests

I. INTRODUCTION

The concept of Internet of Things (IoT) started with things with identity communication devices. The users can have the power to track, control or monitor these devices using remote computers connected through Internet. IoT extends the use of Internet providing the communication, and thus inter-network of the devices and physical objects, or 'Things'. In IoT systems nodes or devices can be said to communicate with each other and the environment using the internet protocols. IoT has started the beginning of new era where everything can be automated. The idea of creating a Smart City is now becoming possible with the emergence of the Internet of Things. One of the key issues that smart cities relate to are car parking facilities and traffic management systems. In present days conditions it becomes very difficult for private cars owners to find a parking spot as population growth is on the rise and almost everyone owns a private car now. This situation can be seen as an opportunity for smart cities to undertake actions in order to enhance the efficiency of their parking systems thus leading to reduction in searching times, traffic congestion and road accidents. Problems pertaining to parking and traffic congestion can be solved if the drivers can be informed in advance about the availability of parking spaces at and around their intended destination.

There has been a lot of work previously done on the possibilities of fully automated smart parking system. With evolution in technology and embedded technologies it is gaining a larger ground. In this paper we present a smart parking model which is both user friendly and costs very low. It works with simple IR sensor module connected to raspberry pi which sends sensor data to cloud and end-users can access that data using the android app.

II. LITERATURE REVIEW

A. Thanh Nam Pham, Ming-Fong Tsai, Duc Binh Nguyen, Chyi-Ren Dow, Der-Jiunn Deng – “A cloud-based smart parking system based on internet of things technologies”

In their paper Rajeshwari M. has given a wide view of the possibilities of improving the prevailing cloud-based parking systems. The paper introduces algorithms to increase the efficiency. The research implements a system prototype with wireless access in an open-source physical computing platform based on Arduino with RFID technology. [2]

B. Mr. Basavaraju S R – “Automatic Smart Parking System using Internet of Things”[5]

In this study he designs a Smart Parking System (SPS) which enables the user to find the nearest parking area and gives availability of parking slots in that respective parking area. And it mainly focuses on reducing the time in finding the parking lots and also it avoids the unnecessary travelling through filled parking lots in a parking area. Thus, it reduces the fuel consumption which in turn reduces carbon footprints in an atmosphere.

C. Abhirup Khana, Rishi Anand – “IoT based Smart Parking System”

In this paper Khanna and Anand talks about a parking system which can show user which slots are free and in which region. This system is basically developed just to check the availability of parking slots. [1]

III. PROPOSED METHOD

All the works in the field of Smart Parking Systems deals with mostly RFIDs, Camera module and other stuffs which surely improves the performance of the system but also increases the cost of the system. In our project we have kept in mind the low-cost implementation of the idea so that the parking facility can be free for the users. We tried to reduce the components as less as possible and finally our project just needs some IR sensors, raspberry pi, a free of cost cloud service from google and some low-cost touch systems to run admin app. The algorithm is not much complex and thus also keeps time complexity in check. Therefore, we had tried to develop a free speedy and efficient Parking System for users.

A. Basic working explained via algorithm:

1. **For detecting presence of vehicle in parking slots:**

IF IR detects vehicle:

Read location of Sensor or parking slot

Update reading in cloud (0 means occupied)

IF object moved out or IR doesn't detect vehicle:

Read location of Sensor or parking slot

Update reading in cloud (1 means empty)

2. For booking using App:

IF slot prebooked:

Show Reserved

IF slot full:

Show Unavailable

IF slot if empty:

Show Available

User clicks on it

Enter details of user and time slot for booking

Confirm Booking

Send data to server:

Update reservation value for that slot to 0.

Update OTP value for that slot in cloud.

Add user booking data to bookings node.

Show booking ticket to user with OTP

3. User goes to park in Parking Spot

The admin panel will ask for OTP

IF user not reserved previously:

Show instructions for user to reserve a slot

ELSE:

User enters OTP

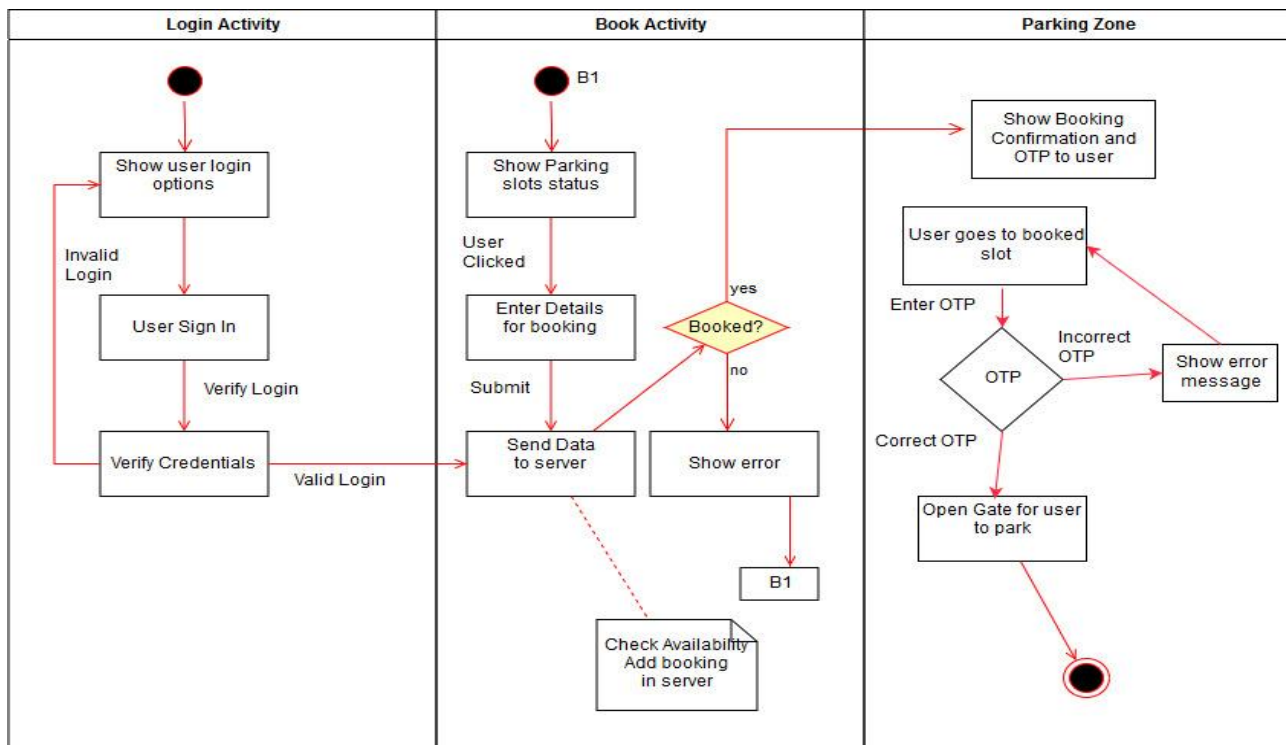
IF OTP == ServerOTP:

Raise the bar and let user park the vehicle

ELSE:

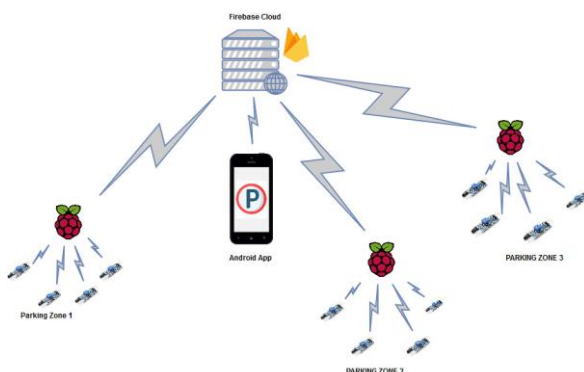
Show OTP error

B. Activity Diagram for booking:



IV. SYSTEM ARCHITECTURE

This section shows the architecture diagram for our project. Below is the architecture diagram of our project for the smart parking system.



A. Parking Sensors – IR sensors:

For the parking system we have used infrared (IR) sensors to detect the presence of vehicle in parking slot. The sensors are connected to cloud using raspberry pi. The sensors are connected to a 5V supply from raspberry pi. The raspberry pi is connected to external power source.

B. Processing Unit – Raspberry Pi

It is a processor on chip. The raspPi is responsible to act like a communicator device between the sensor and the cloud. All the sensors are plugged into different GPIO pins of Raspberry Pi and these pins are used for unique identification of slots. There are 40 GPIO pins. The ground and power supply for the sensors can be given by the raspPi voltage and ground pins. The raspPi has a python code which runs to check the status of the sensors. If the sensor reports any change in the presence of vehicle then the raspPi sends

the sensor value to the Google's firebase cloud server through Firebase API calls for HTTP requests.

C. Cloud:

Google's firebase server is one the powerful and easy to use cloud server service. It maintains a hierarchical form of database and uses secured HTTP protocols to send and receive data. Firebase provides services like cloud storage, authentication services for users, analytics as well as ML kit. It works on real-time database which means as soon as data is changed in server immediately change is visible to all the users using the app. It keeps track of every user connected to the system and maintains information such as time at which the car was parked and time duration for parking a car.

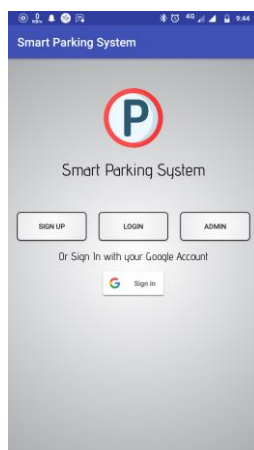
D. Mobile Application:

The application provides an easy to use interface for the user to see the status of the parking slot and it also allows the user to reserve a parking spot for empty slots. The application is made using Android Studio and is seamlessly connected to firebase servers using the firebase APIs. The data is transferred from and to server in JSON format. There is no need for the mobile and raspberry pi to be on the same network as firebase provides message passing over the internet without any constraint of a particular channel.

V. IMPLEMENTATION & WORKING

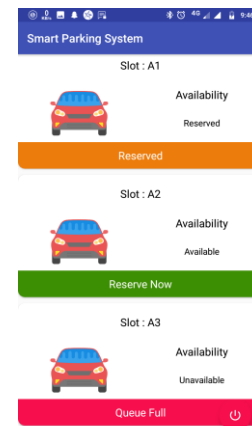
The complete process of working of the system is explained as key points in this section:

1. Once the user downloads the app when he opens the app for the first time the following screen comes:



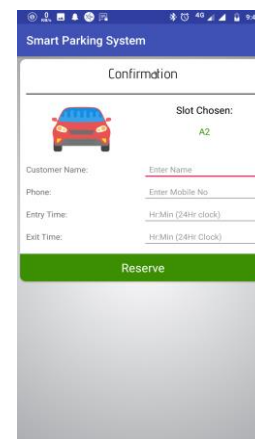
User can either signup if first time use or can simply login through Google Signin option.

2. Once logged in user can either see the parking layout or go to booking page or see their account info. The booking page looks like this:



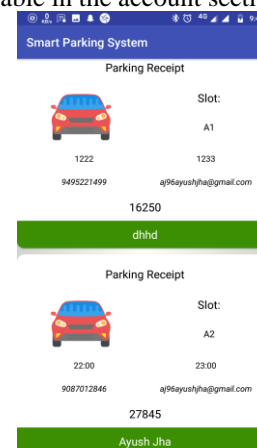
The slots which are already reserved by others are shown in orange with Reserved written, Available slots are in green and non-available slots are in Red.

3. On clicking the available slot:



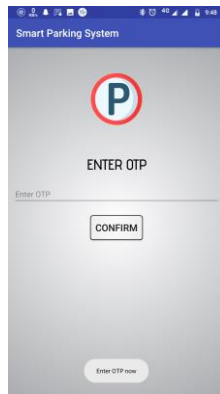
User details needs to be entered on this screen to get the booking and then clicked on reserve.

4. If booking is done successfully the following ticket will be available in the account section of the user:



The 5-digit number on the ticket is the OTP which needs to be entered in the admin panel in the parking slot to gain access to the slot.

5. In the parking zone the admin panel outside the parking slot will display the following screen:



Once the user enters the correct OTP the welcome message is displayed and the bar is raised for the user to park the vehicle.

Once the car is parked in the slot the value of the sensor will change and it will show Slot full to other users till the car is not removed.

Since the system is free for use time constraint is very important. Once the user crosses the time limit of stay which is max for 1 hour for free use the user will be notified about the exceeding time and that his parking is now be levied a fine on an hourly basis. To facilitate easy payments online payment option is given. If the user wants to raise the bar to his slot and take the car out without paying it will not be possible. He will have to pay first and then leave.

VI. DATA ANALYTICS

Steps to analyze which slot is more preferable by users while booking based on past bookings done by users:

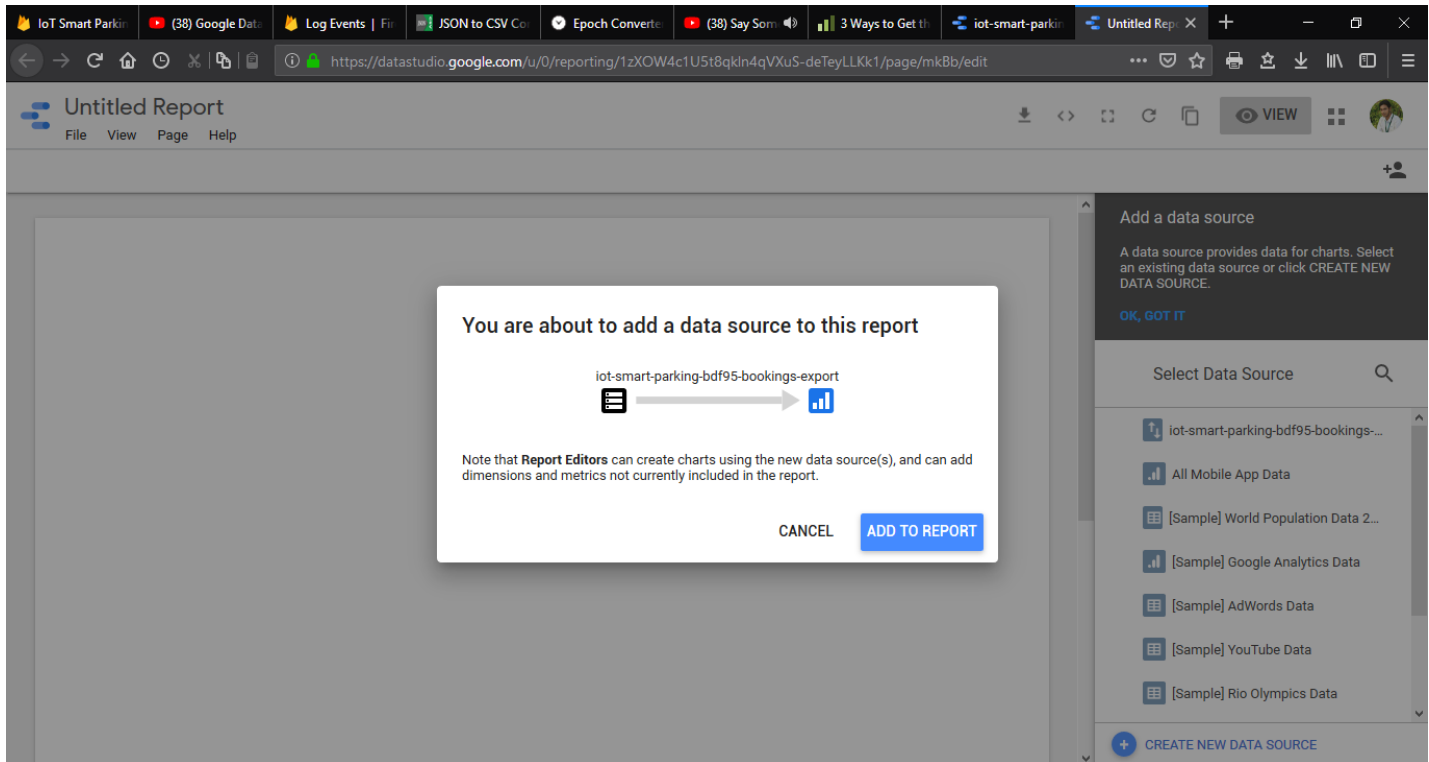
Analyzer/Visualizer used: Google Data Studio

Step 1: Import Data from google cloud database of the project:

Index	Field	Type	Aggregation	Description
1	UID	ABC Text	None	
2	Count Distinct UID	123 Number	Auto	
3	BookTime	ABC Text	None	
4	Slot	ABC Text	None	
5	Count Slot	123 Number	Auto	
6	CustName	ABC Text	None	
7	Book Date	ABC Text	None	
8	BookDay	ABC Text	None	
9	ExitTime	ABC Text	None	
10	OTP	ABC Text	None	
11	Email	ABC Text	None	
12	EntryTime	ABC Text	None	
13	Phone	ABC Text	None	

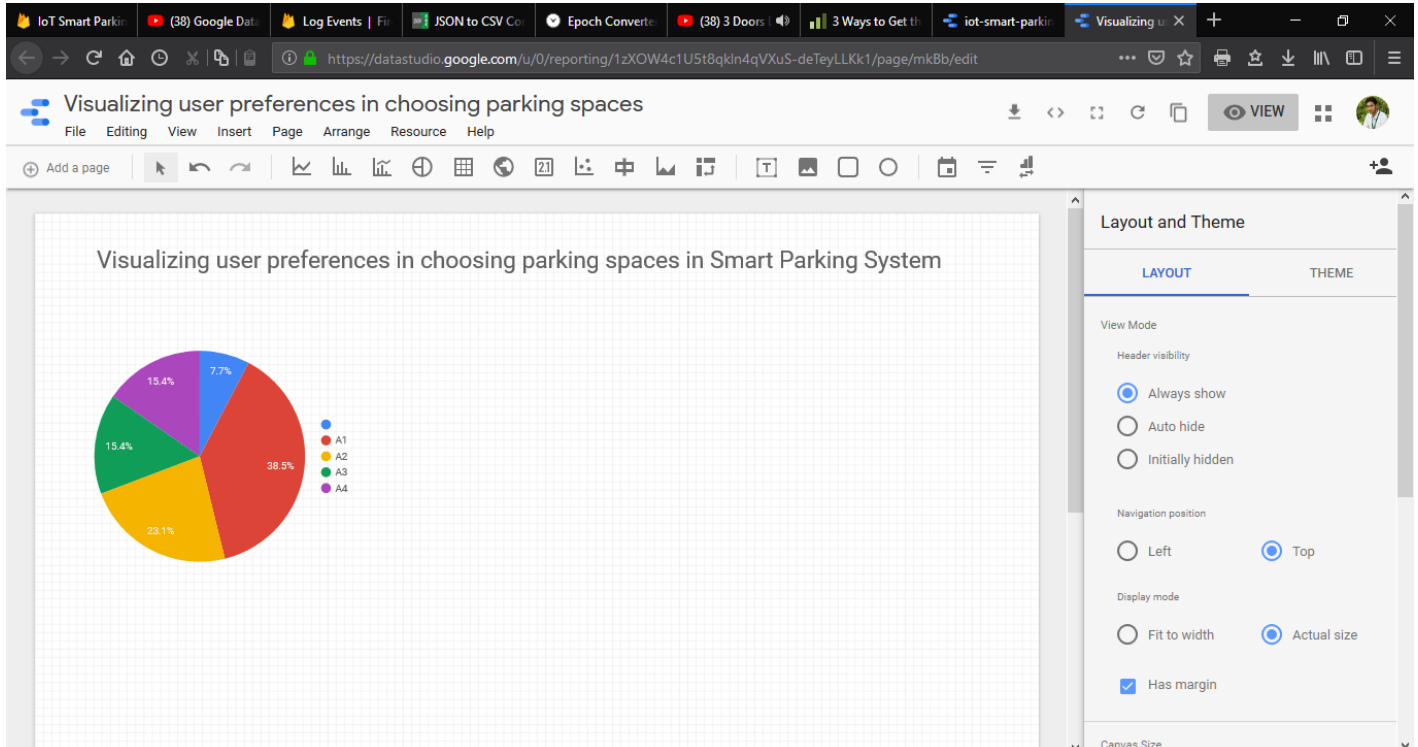
REFRESH FIELDS 13 / 13 Fields

Step 2: Click on “Create Report” on top right panel and then confirm on next window:

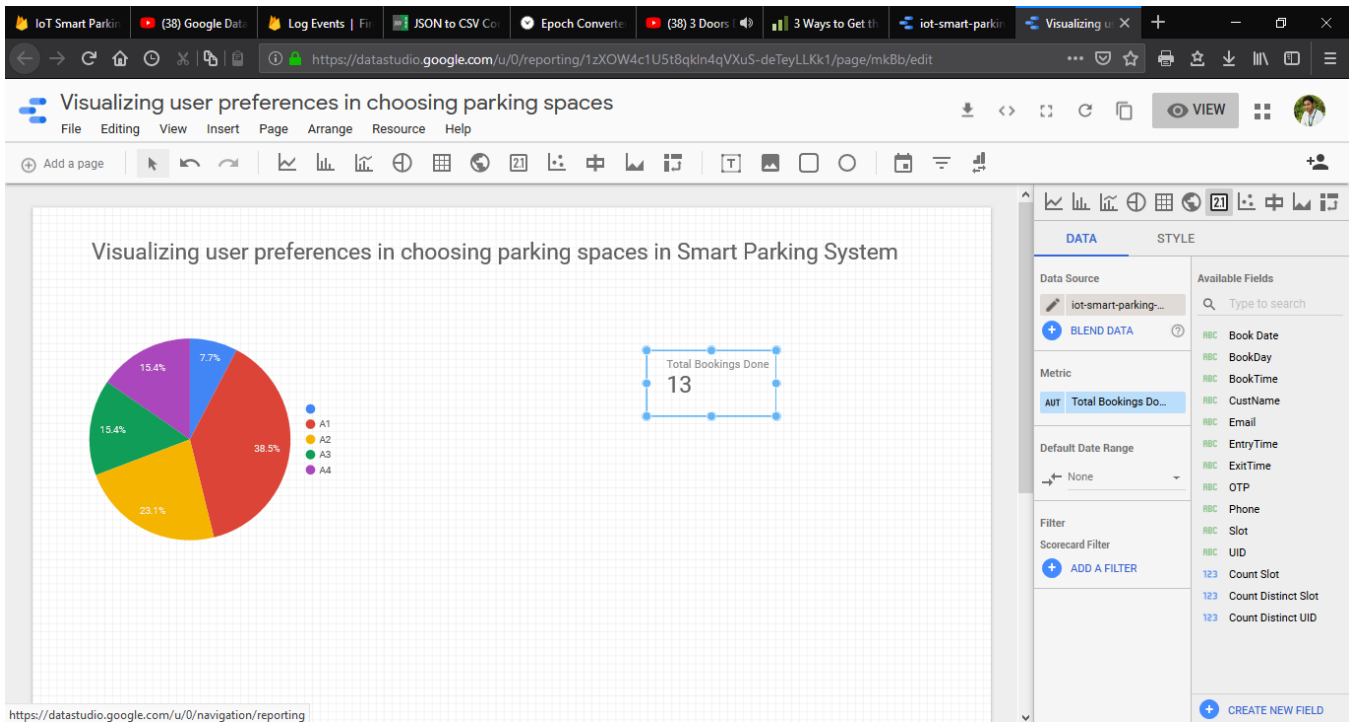


This will connect the data source to google data studio for analyzing purposes

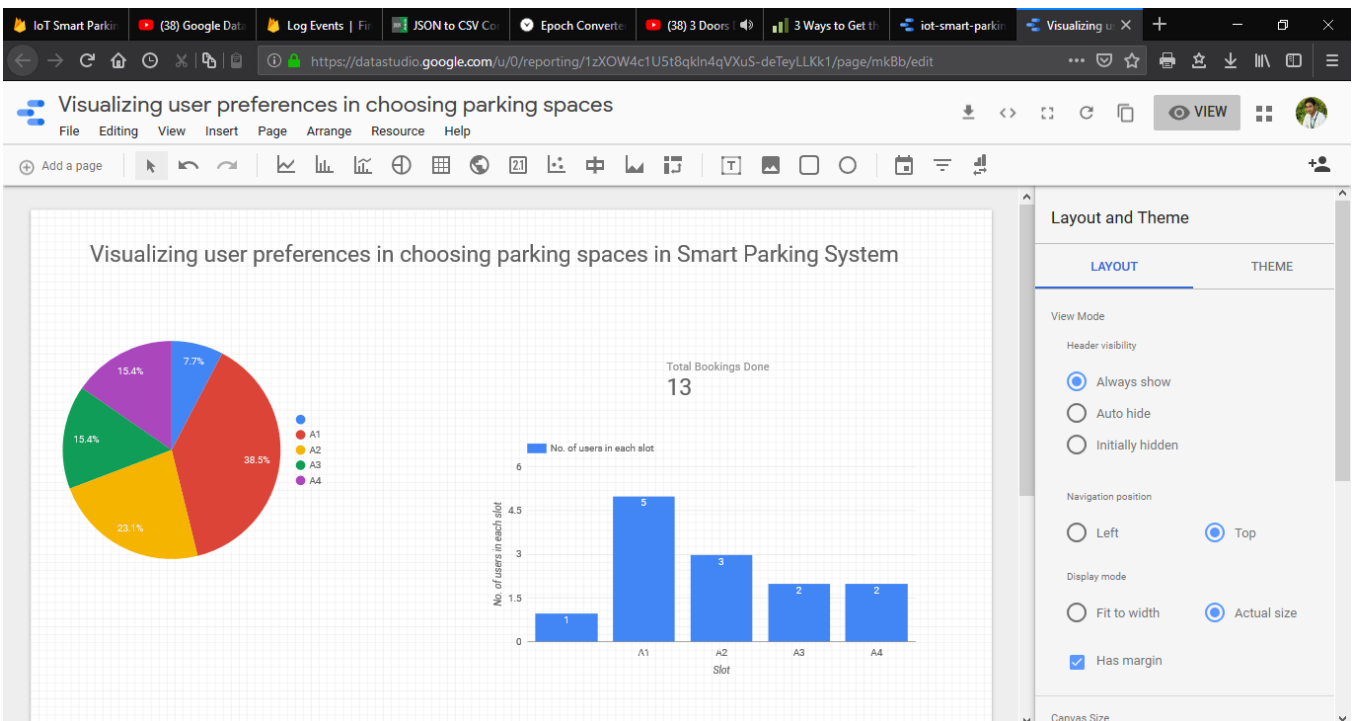
Step 3: Lets make a Pie Chart to visualize slot booked so far by users:



Step 4: We will add a “scorecard” to the dashboard which will show total bookings done so far by users:



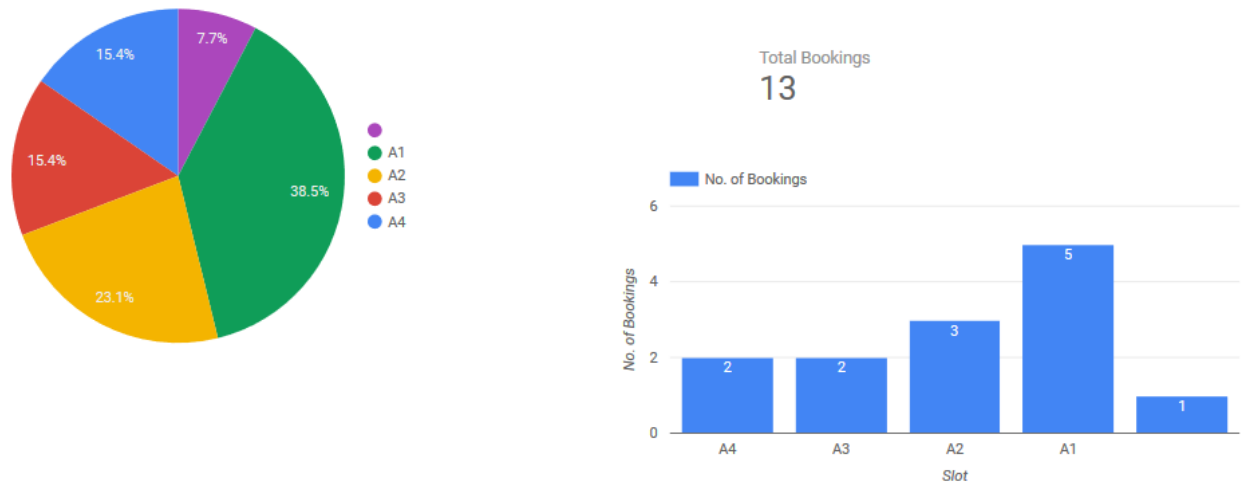
Step 5: Now we add a bar chart to visualize the slot bookings as bar plots:



The bar plot is plotted with X-axis: Slots & Y-Axis: No. of bookings done by users.

Final Dashboard Created:

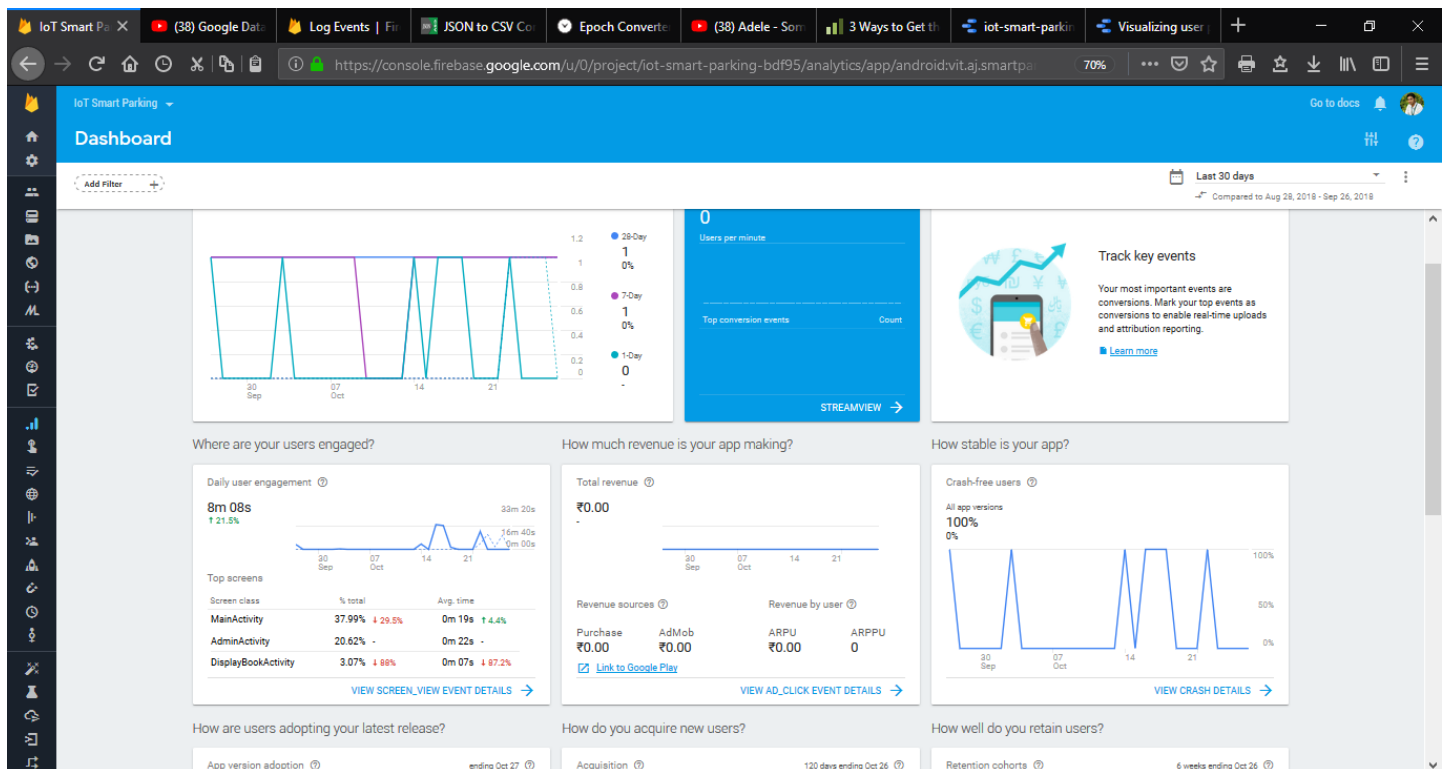
Visualizing User Preferences in Choosing Parking Spaces in Smart Parking System



We see that most users prefer to reserve slot **A1** for parking their vehicles where as A4 and A3 are least favored

We see about **38.5%** bookings are done for **A1** slot thus it stands out as one of the most favorable parking spaces by the users. Using this stats we can predict which slot the new users would like to book on their visit.

Any Anomalies in the system can be tracked by firebase analytics by using the dashboard provided:



CONCLUSION

The concept of Smart Cities has created an interest in the minds of various developers who want to develop some systems for the betterment of the city and society. In this paper we addressed the problem of parking and gave the solution for a low-cost, efficient Smart Parking System that uses IoT technologies. With easy to use application it will be easy for users to know status or availability of parking slots in various places and they can easily book their slots. Thus, it will lead to a better parking management.

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