Smart Parking System Based on IoT

B.E. Dissertation

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(Electronics & Telecommunication Engineering)

by

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University of Mumbai

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Certificate of Approval by Examiners

This is to certify that the dissertation entitled **"Smart Parking System Based on IoT"** is a bonafide work done by **Ansari Mohammed Afzal Murtuza**, **Sahibole Saifullah Abdul Hamid**, **Sawant Vaibhav Waman** and **Shaikh Mohammed Afzal Ahmed** under the guidance of **Prof. Chaya.S.** This dissertation has been approved for the award of **Bachelor's Degree** in **Electronics & Telecommunication Engineering**, **University of Mumbai**.

Examiners:

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Examiner 1

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Examiner 2

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Abstract

The major goal of this project is to make use of the basic concept of IoT for Smart Parking System in smart cities. The services provided by the smart parking can be constitutive part of a basic IoT operational platform for smart cities due to its features and benefits. The increasing population and there needs increases the number of vehicles on the road. Mismanagement of available parking space has resulted in parking related problem. There is a need of secure system which can lead us for the availability of parking space and its location. To implement such system we use raspberry pi as a controller and opencv for image processing. The camera will capture the parking area and this system will compare the vacant slots in parking area and sends the information to the users using the concept of IoT with the help of the application or web browser. This will help to save the time of user and also help in proper parking management.

Keywords: IoT (Internet of Things), Raspberry Pi, OpenCV, Canny Edge Detection, Contours.

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Chapter 1

Introduction

1.1 Objective and Goals

The main objective of this project is to develop a system to locate the nearest parking areas and vacant slots in it using Raspberry Pi to ease the people for finding the parking which result in saving of time and fuel. Status of SPS can be accessed and traced (mapped) from any remote location through Internet by using application or web browser. Thus it also reduces carbon footprints in an atmosphere.

The Smart Parking System can be designed by making use of Hardware such as Raspberry Pi, Beagle Bone Black boards etc. which can interact with internet. Here we are focusing on less power consumption and more performance device. So we are using Raspberry Pi which is more suitable with our requirement.

The goal of this work is to,

- Create a web address or application for car parking slot.
- User can log onto the web address or application and enter his/her car number and parking duration via his/her mobile devices.
- Camera module in the parking lot give information in order regarding the accessibility of the car in the slots of the exacting parking lot.
- According to the period of the drivers require, slot are allocated.

- As of request by driver, free parking slot will be displayed in his/her mobile device, thus dropping the time spent for discovering free space.

1.2 Need of Smart Parking System

Urban India has spoken most decisively about what it sees as the most pressing issue for itself. Already reeling under acute time pressure, it would like the smart cities to ease out some of it by significantly reducing its commuting woes. As many as 40 of the 51 cities (out of 98 selected smart cities) for which data is available, see traffic/transport/parking as one of the top three issues that smart cities should tackle.

Though it is being termed as a citizen poll to choose priorities for "smart cities", it is probably for the first time that urban administrative bodies have actually gone to citizens asking them what they want; and that too, simultaneously on a nation-wide basis.

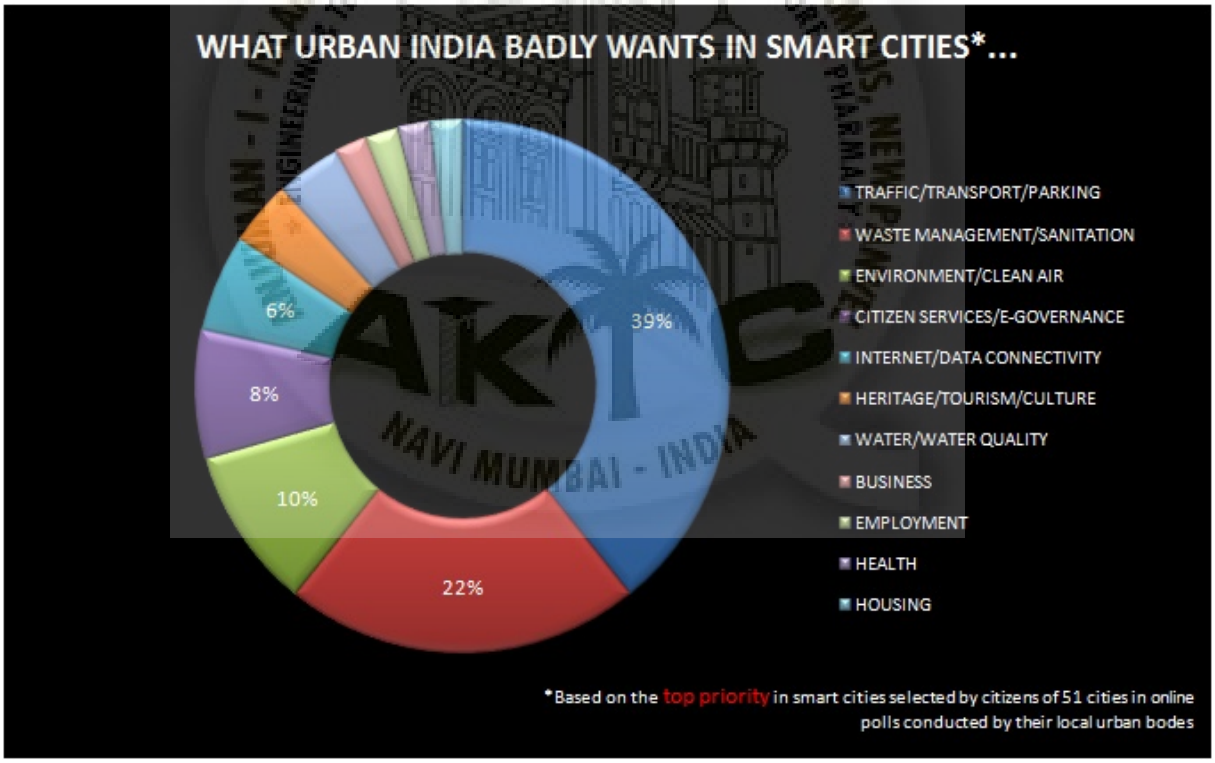

Fig. 1.1: **Smart city top priorities**

The polls are being conducted through both offline and online modes. The data presented in this report is from online polls only, as they appear in the government's mygov.in site. With

an upper class skew of Internet access in India, these results may also have that skew.

Also, not all the polls were designed very well often asking users to choose among "integrated multi-modal transport systems and "city-wide enterprise application"

Urban Mobility, Sanitation Keywords

As highlighted above, transport/traffic/parking half intellectually, half euphemistically called urban mobility by the government is clearly the top issue.

For as many as 39% of the cities, this is the top issue that they want tackled. For 78% of them, it is one of the top three issues. For some cities, various aspects of it (say traffic and public transport) are independently among top three issues. In other words, only 11 out of 51 cities for which data is available have not chosen it as one of the top three priorities. Most of them are comparatively smaller cities.

Beyond these, the choices are different for different cities. While smaller but economically advanced cities like Bidhan Nagar, Rajkot, Chandigarh have gone for better e-governance/citizen services, cities like Agra, Bhubaneswar, Oulgaret (Puducherry) and Bihar Sharif want their cities to be developed further for tourism, Rourkela in Odisha is the only city to explicitly expect direct citizen participation in decision making.

And which cities are most unanimous in their selection of top priority? The honour goes to Kanpurwhere 84% of those who have voted in online polls want an intelligent traffic management system to be implemented by their municipal authorities, implementing smart cities, 71% of residents in Dharamshala want a multi-modal public transport system to be implemented.

These polls may have their drawbacks but they are important because they are probably the first time in independent India that such polls have taken place. And some of the broad findings like traffic transport and sanitation are too loud to ignore.

Chapter 2

Literature Review

2.1 L. Atzori, A. Iera, and G. Morabito, "The Internet of things: a survey" Computer Networks, vol. 54, no. 15, pp. 2787-2805, 2010.

- 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.

2.2 Zhanlin Ji, Ivan Ganchev, Mirtn ODroma, Li Zhao and Xueji Zhang, "A Cloud-Based Car Parking Middleware for IoT-Based Smart Cities: Design and Implementation", 25 November 2014.

- An IoT cloud-based intelligent car parking system has been described in this paper. Considered as an important component of an Intelligent Transport System (ITS) for smart cities, the car parking system is built with three layers: Sensor, communication,

and application layer. The system middleware and corresponding operational platform have been described. In the implementation part, a sample car parking service for a University campus has been considered along with the supporting cloud applications, OSGi-based web applications, and Android mobile applications.

2.3 Faheem1, S.A. Mahmud, G.M. Khan, M. Rahman and H. Zafar "A Survey of Intelligent Car Parking System" , October 2013

- In this paper, various systems that provide intelligent parking services are discussed. These systems can counter the parking problems that arise due to the unavailability of a reliable, efficient and modern Parking system. The use of different modern techniques such as Expert Systems, wireless sensor based, fuzzy based, GPS based, Vehicular communication based and Vision based can reduce the parking related issues. Such system can help the economic, social and safety based aspects of the society. It also helps in preserving the environment, fuel and time.

Chapter 3

Problem Statement

3.1 Problem Statement

Vehicle parking is a major concern in most of the cities of India. Currently a user has to look for multiple vehicle parking station to finally get the space to park the vehicle. This could lead to wastage of money, fuel and time. Instead of this a real-time Smart parking mobile app can be designed which can provide us information about nearby space availability based on the location of the user. IOT and Cloud Computing technologies could be used to create this app.

3.2 Existing Design

The existing system that basically uses sensors to detect the empty parking slots in parking area. Hence, at every parking slots one or more sensors are used for detection, which increase the number of sensors that result in the bulky design and more failure chances.

The major drawbacks of the sensors are,

- Infrared frequencies are affected by hard objects (e.g. walls, doors) , smoke, dust, fog, sunlight etc. Hence it does not work through walls or doors.
- Infrared waves at high power can damage eyes.
- In monitor control application, it can control only one device at one time. Moreover it is difficult to control things which are not in LOS (Line of Sight). It requires line of sight

between transmitter and receiver to communicate.

- It supports shorter range and hence it performance degrades with longer distances.
- It supports lower data rate transmission compare to wired transmission.

3.3 Proposed Solution

Our proposed system has a advantage over the existing system in aspects such as size, cost, wide scope to advancement because we are making use of a cameras to make our system digital.

Fig. 3.1: **IoT based smart parking system using raspberry pi controller and USB camera**

The step towards digitization is the wide scope it provides to make better design with the inclusion of cameras and controller. And also provide inquiry and reservation services from any remote location through Internet by using application or web browser. It helps make our work simple and also we can attach to it other peripherals as per our wish to modify like we are providing an security facility.

Chapter 4

Theoretical Details

4.1 Internet of Things (IoT)

The Internet of things (IoT) is the network of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these objects to connect and exchange data. Each thing is uniquely identifiable through its embedded computing system but is able to inter-operate within the existing Internet infrastructure.

Fig. 4.1: **Drawing representing the Internet of things (IoT)**

The IoT allows objects to be sensed or controlled remotely across existing network infrastruc-

ture, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, virtual power plants, smart homes, intelligent transportation and smart cities.

"Things", in the IoT sense, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, cameras streaming live feeds of wild animals in coastal waters, automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring, or field operation devices that assist firefighters in search and rescue operations. Legal scholars suggest regarding "things" as an "inextricable mixture of hardware, software, data and service".

These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices.

The term "the Internet of things" was coined by Kevin Ashton of Procter Gamble, later MIT's Auto-ID Center, in 1999.

4.2 IoT Working

A complete IoT system integrates four distinct components: sensors/devices, connectivity, data processing, and a user interface.

Sensors/Devices

- First, sensors or devices collect data from their environment. This could be as simple as a temperature reading or as complex as a full video feed.
- Here uses "sensors/devices," because multiple sensors can be bundled together or sensors can be part of a device that does more than just sense things. For example, phone is a device that has multiple sensors (camera, accelerometer, GPS, etc), but phone is not just

a sensor.

- However, whether it's a standalone sensor or a full device, in this first step data is being collected from the environment by something.

Connectivity

- Next, that data is sent to the cloud, but it needs a way to get there.
- The sensors/devices can be connected to the cloud through a variety of methods including: cellular, satellite, WiFi, Bluetooth, low-power wide-area networks (LPWAN), or connecting directly to the internet via ethernet.
- Each option has tradeoffs between power consumption, range and bandwidth. Choosing which connectivity option is best comes down to the specific IoT application, but they all accomplish the same task: getting data to the cloud.

Data Processing

- Once the data gets to the cloud, software performs some kind of processing on it.
- This could be very simple, such as checking that the temperature reading is within an acceptable range. Or it could also be very complex, such as using computer vision on video to identify objects (such as intruders in house).

User Interface

- Next, the information is made useful to the end-user in some way. This could be via an alert to the user (email, text, notification, etc). For example, a text alert when the temperature is too high in the company's cold storage.
- Also, a user might have an interface that allows them to proactively check in on the system. For example, a user might want to check the video feeds in their house via a phone app or a web browser.

- However, it's not always a one-way street. Depending on the IoT application, the user may also be able to perform an action and affect the system. For example, the user might remotely adjust the temperature in the cold storage via an app on their phone.

- And some actions are performed automatically. Rather than waiting for to adjust the temperature, the system could do it automatically via predefined rules. And rather than just alert of an intruder, the IoT system could also automatically notify relevant authorities.

4.3 IoT layers

The three-layer architecture defines the main idea of the Internet of Things, but it is not sufficient for research on IoT because research often focuses on finer aspects of the Internet of Things. That is why, we have many more layered architectures proposed in the literature. One is the five-layer architecture, which additionally includes the processing and business layers. The five layers are perception, transport, processing, application, and business layers. The role of the perception and application layers is the same as the architecture with three layers. We outline the function of the remaining three layers.

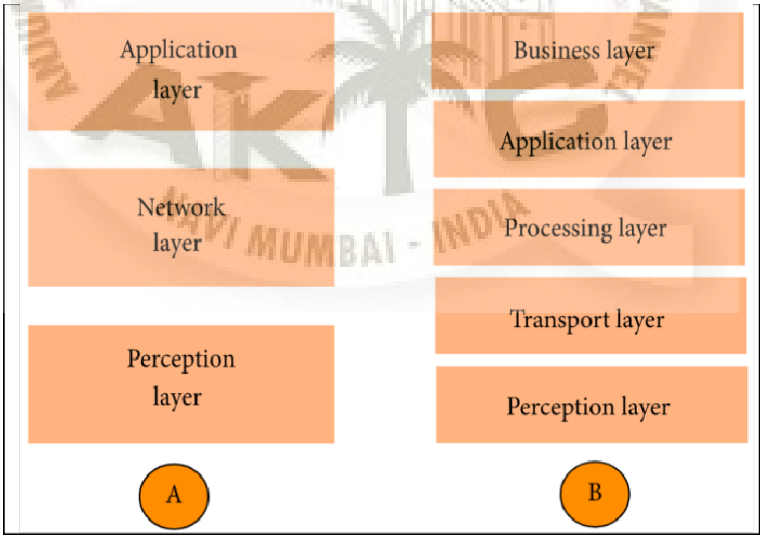

Fig. 4.2: **Architecture of IoT (A: three layers) (B: five layers)**

- The transport layer transfers the sensor data from the perception layer to the processing

layer and vice versa through networks such as wireless, 3G, LAN, Bluetooth, RFID, and NFC.

- The processing layer is also known as the middleware layer. It stores, analyzes, and processes huge amounts of data that comes from the transport layer. It can manage and provide a diverse set of services to the lower layers. It employs many technologies such as databases, cloud computing, and big data processing modules.
- The business layer manages the whole IoT system, including applications, business and profit models, and users' privacy. The business layer is out of the scope of this paper.

4.4 IoT Technology Roadmap

Before we know, how our future with IoT is going to be, let's have an understanding about the growth in technology with this technology road map.

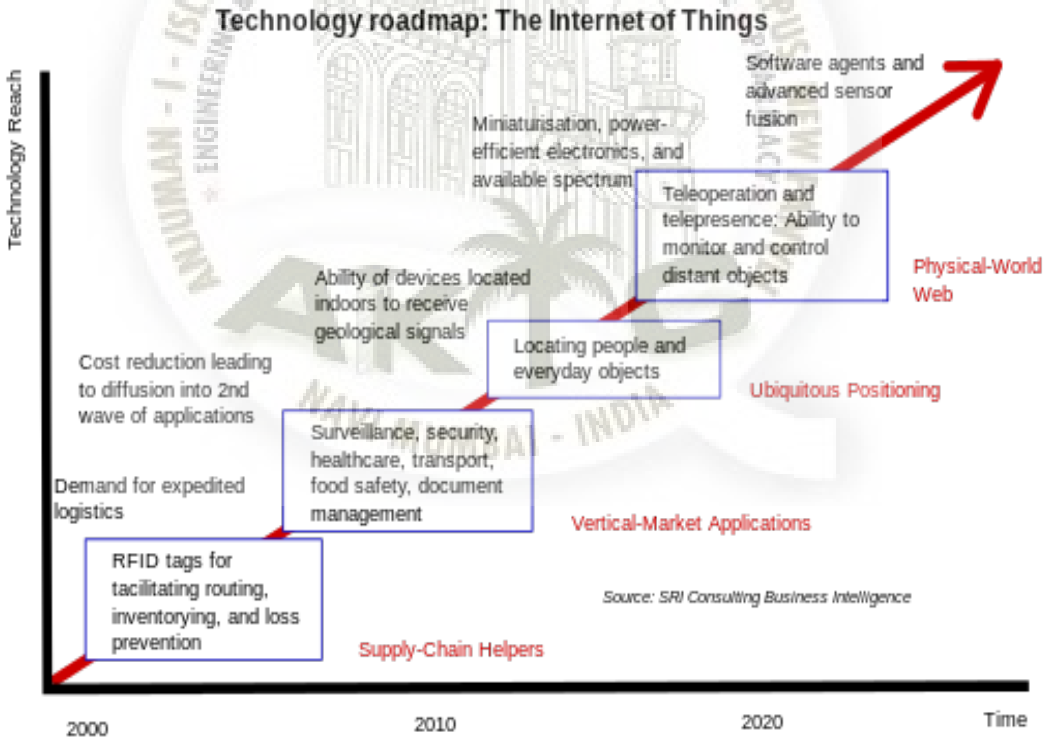

Fig. 4.3: **Technology road map of the Internet of things**

From this graph we can see the massive advancement in technology since the year 2000 till

date and still more to go in future.

Back in 2000 we had RFID tags for identifying objects and facilitating routing. Then came surveillance, security, healthcare, transport management. We are now living at a time where we can locate people and everyday objects.

That is how lives are going to be. With the rapid advancement in technology we can take care of our near and dear ones, our possessions even from another corner of the world.

4.5 IoT Standards

This is a list of technical standards for the IoT, most of which are open standards, and the standards organizations that aspire to successfully setting them.

Standards and standards organizations			
Short Name	**Long Name**	**Standards Under Development**	**Other notes**
Auto-ID Labs	—	Networked RFID (radiofrequency identification) and emerging sensing technologies	
EPCglobal	—	Standards for adoption of EPC (Electronic Product Code) technology	
FDA	U.S. Food and Drug Administration	UDI (Unique Device Identification) system for unique identifiers for medical devices	
GS1	—	Standards for UIDs (unique identifiers) and RFID of fast-moving consumer goods (consumer packaged goods), health care supplies, and other things	Parent organization comprises member organizations such as GS1 US

IEEE	Institute of Electrical and Electronics Engineers	Underlying communication technology standards such as IEEE 802.15.4	
IETF	Internet Engineering Task Force	Standards that comprise TCP/IP (the Internet protocol suite)	
MTConnect Institute	—	MTConnect is a manufacturing industry standard for data exchange with machine tools and related industrial equipment. It is important to the IIoT subset of the IoT.	
OCF	Open Connectivity Foundation	Standards for simple devices using CoAP (Constrained Application Protocol)	OCF (Open Connectivity Foundation) supersedes OIC (Open Interconnect Consortium)
OMA	Open Mobile Alliance	OMA DM and OMA LWM2M for IoT device management, as well as GotAPI, which provides a secure framework for IoT applications	
XSF	XMPP Standards Foundation	Protocol extensions of XMPP (Extensible Messaging and Presence Protocol), the open standard of instant messaging	

Table 4.1: **IoT Standards**

4.6 Applications of IoT

1. Smart home
2. Wearables
3. Smart City
4. Smart grids
5. Industrial internet
6. Connected car
7. Connected Health (Digital health/Telehealth/Telemedicine)
8. Smart retail
9. Smart supply chain
10. Smart farming
11. many more...

4.7 Benefits Analysis of Smart Parking

1. Accurately predict and sense spot/vehicle occupancy in real-time.
2. Guides residents and visitors to available parking
3. Optimize Parking Space Usage
4. Simplifies the parking experience and adds value for parking stakeholders, such as drivers and merchants
5. Help traffic in the city flow more freely leveraging IoT technology.
6. Enables intelligent decisions using data, including real–time status applications and historical analytics reports

7. Smart Parking plays a major role in creating better urban environment by reducing the emission of CO2 and other pollutants

8. Smart Parking enables better and real time monitoring and managing of available parking space , resulting in significant revenue generation

9. Provides tools to optimize workforce management

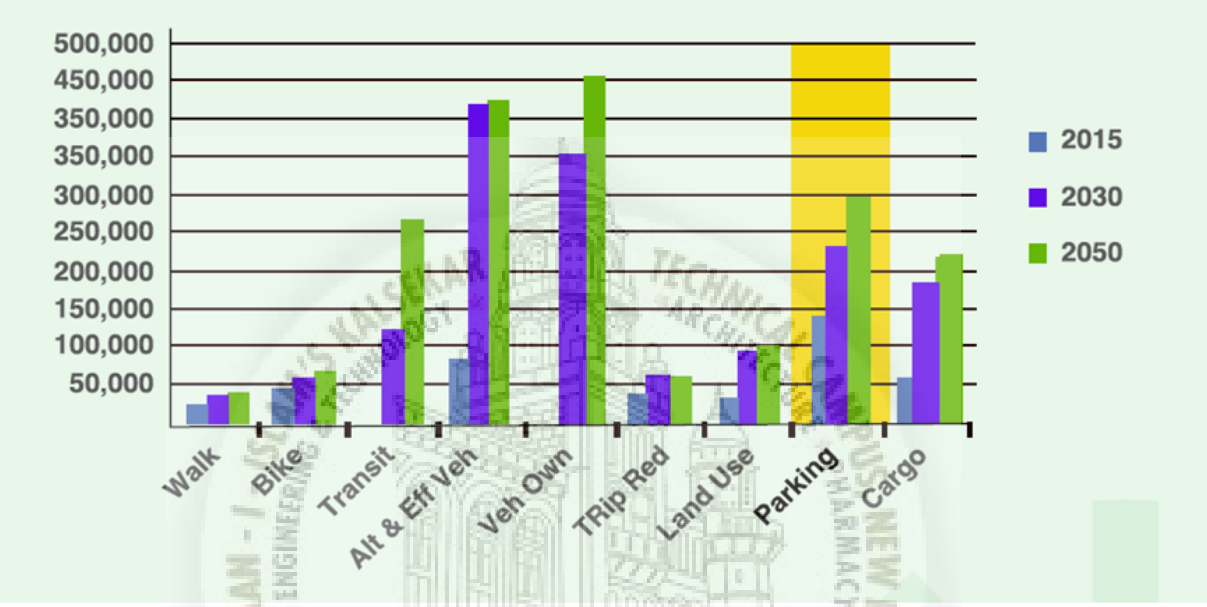

Fig. 4.4: **Fuel saving by smart parking through years**

According to a report, Smart Parking could result in 2,20,000 gallons of fuels saving till 2030 and approx. 3,00,000 gallons of fuels saved by 2050 , if implemented successfully.

Chapter 5

Technical Details

5.1 Methodology

Parking area is monitored through camera which gives the information of the parking slots to the controller. Controller will detect the empty and full parking slots with the help of edge detection technique. First we will divide the image according to the standard parking slot measure were cars are going to park.

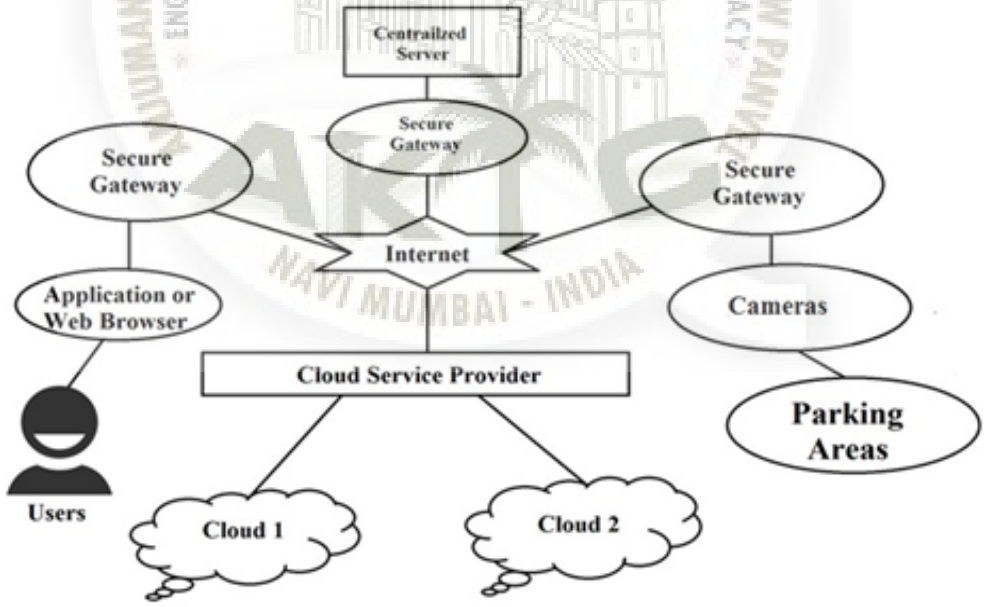

Fig. 5.1: **Cloud based Intelligent IoT framework**

According to the section part the controller will detect whether the slot is vacant or full by edge

detection technique. The results will be stored in the database which will be update frequently to provide proper information for the users through concept of IoT.

5.2 Project Requirements

5.2.1 Software Requirements

The followings are the software, programming language, library and commands requires for this project:

OpenCV (software)

OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products. Being a BSD-licensed product, OpenCV makes it easy for businesses to utilize and modify the code

The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together to produce a high resolution image of an entire scene, find similar images from an image database, remove red eyes from images taken using flash, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc.

It has C++, Python, Java and MATLAB interfaces and supports Windows, Linux, Android and Mac OS. OpenCV leans mostly towards real-time vision applications and takes advantage

of MMX and SSE instructions when available. A full-featured CUDA and OpenCL interfaces are being actively developed right now. There are over 500 algorithms and about 10 times as many functions that compose or support those algorithms. OpenCV is written natively in C++ and has a templated interface that works seamlessly with STL containers.

Python (programming language)

Python is an interpreted high-level programming language for general-purpose programming. Created by Guido van Rossum and first released in 1991, Python has a design philosophy that emphasizes code readability, and a syntax that allows programmers to express concepts in fewer lines of code, notably using significant whitespace. It provides constructs that enable clear programming on both small and large scales.

Python features a dynamic type system and automatic memory management. It supports multiple programming paradigms, including object-oriented, imperative, functional and procedural, and has a large and comprehensive standard library

Python interpreters are available for many operating systems. CPython, the reference implementation of Python, is open source software and has a community-based development model, as do nearly all of its variant implementations. CPython is managed by the non-profit Python Software Foundation.

Matplotlib (library)

Matplotlib is a Python 2D plotting library which produces publication quality figures in a variety of hardcopy formats and interactive environments across platforms. Matplotlib can be used in Python scripts, the Python and IPython shells, the Jupyter notebook, web application servers, and four graphical user interface toolkits.

Matplotlib tries to make easy things easy and hard things possible. You can generate plots, histograms, power spectra, bar charts, errorcharts, scatterplots, etc., with just a few lines of code. For examples, see the sample plots and thumbnail gallery.

For simple plotting the pyplot module provides a MATLAB-like interface, particularly when combined with IPython. For the power user, you have full control of line styles, font properties, axes properties, etc, via an object oriented interface or via a set of functions familiar to MATLAB users.

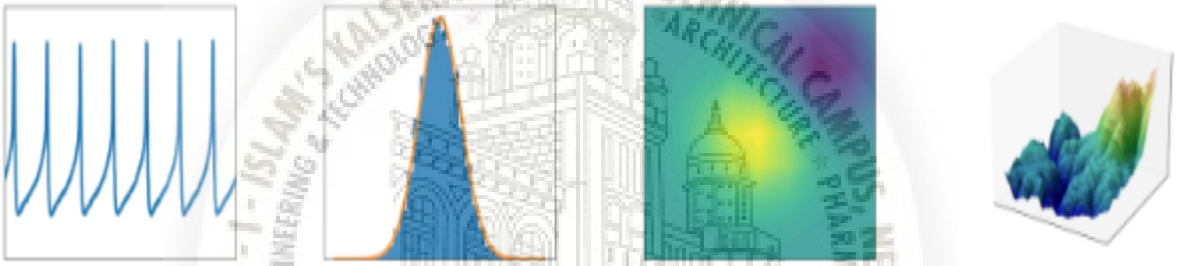

Fig. 5.2: **Matplotlib plotting**

Canny Edge Detection (command): cv2.Canny()

OpenCV puts all the above in single function, **cv2.Canny()**. We will see how to use it. First argument is our input image. Second and third arguments are our minVal and maxVal respectively. Third argument is aperture size. It is the size of Sobel kernel used for find image gradients. By default it is 3. Last argument is L2gradient which specifies the equation for finding gradient magnitude. If it is True, it uses the equation mentioned above which is more accurate, otherwise it uses this function: `Edge_Gradient` (G) = $|Gx| + |Gy|$. By default, it is False.

1. **import cv2**
2. **import numpy as np**

3. **from matplotlib import pyplot as plt**
4. **img = cv2.imread('messi5.jpg',0)**
5. **edges = cv2.Canny(img,100,200)**
6. **plt.subplot(121),plt.imshow(img,cmap = 'gray')**
7. **plt.title('Original Image'), plt.xticks([ ]), plt.yticks([ ])**
8. **plt.subplot(122),plt.imshow(edges,cmap = 'gray')**
9. **plt.title('Edge Image'), plt.xticks([ ]), plt.yticks([ ])**
10. **plt.show**()

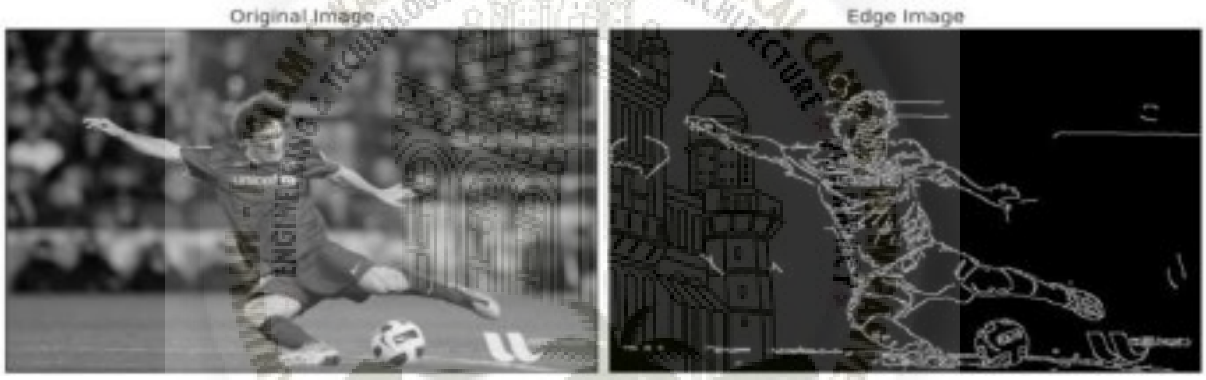

Fig. 5.3: **Canny edge detection**

Contours (command): cv.findContours(), cv2.drawContours()

Contours can be explained simply as a curve joining all the continuous points (along the boundary), having same color or intensity. The contours are a useful tool for shape analysis and object detection and recognition.

- For better accuracy, use binary images. So before finding contours, apply threshold or canny edge detection.
- Since OpenCV 3.2, findContours() no longer modifies the source image but returns a modified image as the first of three return parameters.

- In OpenCV, finding contours is like finding white object from black background. So remember, object to be found should be white and background should be black.

to find contours of a binary image:

1. **import numpy as np**
2. **import cv2 as cv**
3. **im = cv.imread('test.jpg')**
4. **imgray = cv.cvtColor(im, cv.COLOR_BGR2GRAY)**
5. **ret, thresh = cv.threshold(imgray, 127, 255, 0)**
6. **im2, contours, hierarchy = cv.findContours(thresh,cv.RETR_TREE,cv.CHAIN_APPROX_SIMPLE)**

to draw the contours:

To draw all the contours in an image:

- **cv2.drawContours(img, contours, -1, (0,255,0), 3)**

To draw an individual contour, say 4th contour:

- **cv2.drawContours(img, contours, 3, (0,255,0), 3)**

But most of the time, below method will be useful:

1. **cnt = contours[4]**
2. **cv2.drawContours(img, [cnt], 0, (0,255,0), 3)**

there are three arguments in **cv.findContours()** function, first one is source image, second is contour retrieval mode, third is contour approximation method. And it outputs a modified image, the contours and hierarchy. contours is a Python list of all the contours in the image. Each individual contour is a Numpy array of (x,y) coordinates of boundary points of the object.

Fig. 5.4: **Contours approximation**

5.2.2 Hardware Requirements

The followings are the hardware requires for this project:

Raspberry Pi 3 Model B

The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries.

Fig. 5.5: **Raspberry Pi 3 Model B**

The Raspberry Pi 3 is the third-generation Raspberry Pi. It replaced the Raspberry Pi 2 Model B in February 2016.

Specifications:

- Quad Core 1.2GHz Broadcom BCM2837 64bit CPU
- 1GB RAM
- BCM43438 wireless LAN and Bluetooth Low Energy (BLE) on board
- 40-pin extended GPIO
- 4 USB 2 ports
- 4 Pole stereo output and composite video port
- Full size HDMI
- CSI camera port for connecting a Raspberry Pi camera
- DSI display port for connecting a Raspberry Pi touchscreen display
- Micro SD port for loading your operating system and storing data
- Upgraded switched Micro USB power source up to 2.5A

USB Camera

USB Cameras are imaging cameras that use USB 2.0 or USB 3.0 technology to transfer image data. USB Cameras are designed to easily interface with dedicated computer systems by using the same USB technology that is found on most computers. The accessibility of USB technology in computer systems as well as the 480 Mb/s transfer rate of USB 2.0 makes USB Cameras ideal for many imaging applications. An increasing selection of USB 3.0 Cameras is also available with data transfer rates of up to 5 Gb/s.

Fig. 5.6: **USB camera**

Edmund Optics offers a variety of USB Cameras suited to meet many imaging needs. EO USB Cameras are available in both CMOS as well as CCD sensor types making them suitable across a larger range of applications. USB Cameras contain out-of-the-box functionality for quick setup. USB Cameras using low power USB ports, such as on a laptop, may require a separate power supply for operation.

Chapter 6

Working

6.1 Work Flow Analysis

1. One single Gateway covers an area of about defined distance.
2. The gateway sends the information via the internet to the the database in real time.
3. The occupancy is instantly reported to the the users via apps and illuminated panels in the street.
4. The central control can get real time analytics about parking bays occupancy per areas and time of the day.
5. When connected to the payment method system, the authority can identify non-paying cars and with the use of tablet apps.
6. When car parks over the camera , it is detected and the camera relays the information to the gateway.

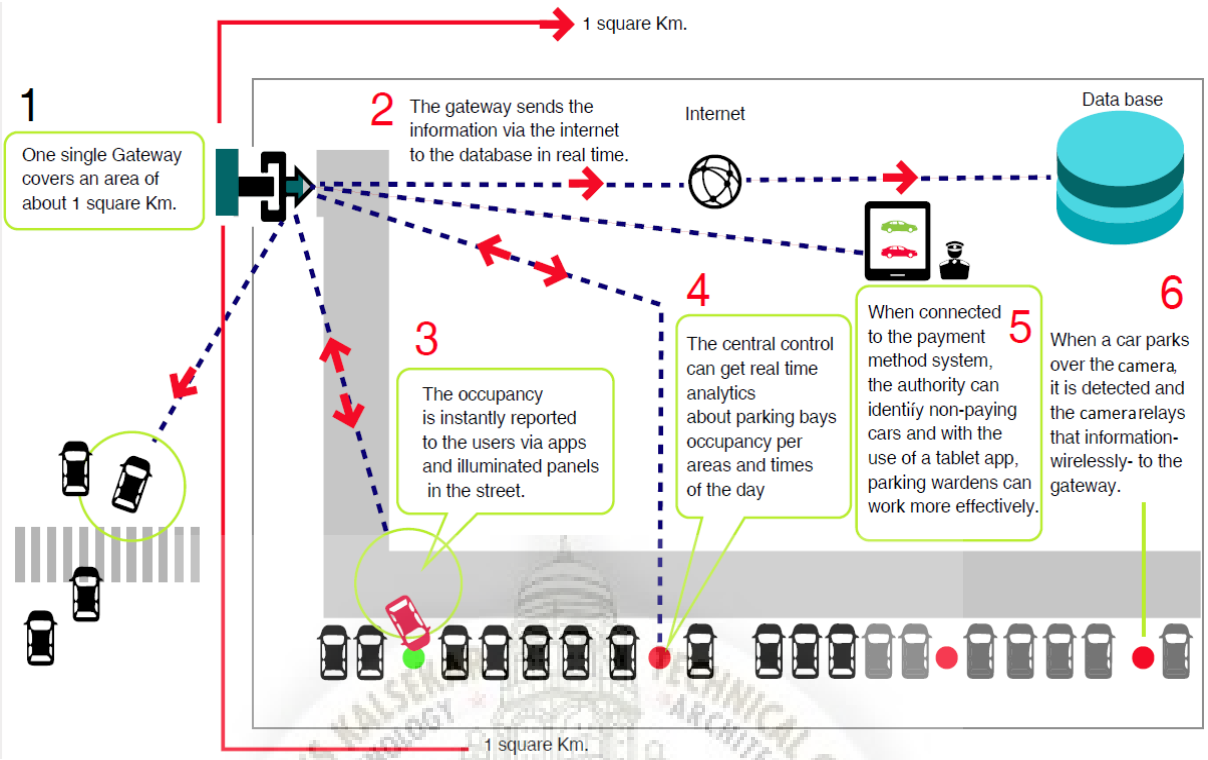

Fig. 6.1: **Smart parking work flow analysis**

6.2 Parking Assistance System Description

1. The Parking Assistance System include three modules-Monitoring module, Control module and a displaying unit. Along with above three module it will also have centralized supervisory system to maintain a data base of parking space and will have a SMS gateway.

2. The monitoring module includes USB camera which identifies the free parking spaces and transmits the Information to control unit through controller Raspberry Pi 3 Model B.

3. Apart from detecting the car the camera also provides additional information like the stretch of time the car has been parked and also its health status.

4. The control units processes the information and sends the information to Centralized supervisory system.

5. Centralized supervisory system receives information of parking space from the controller through UDP. It then sends the information such as slot allotted, time parked, billing

information and directional details to the user's mobile phone

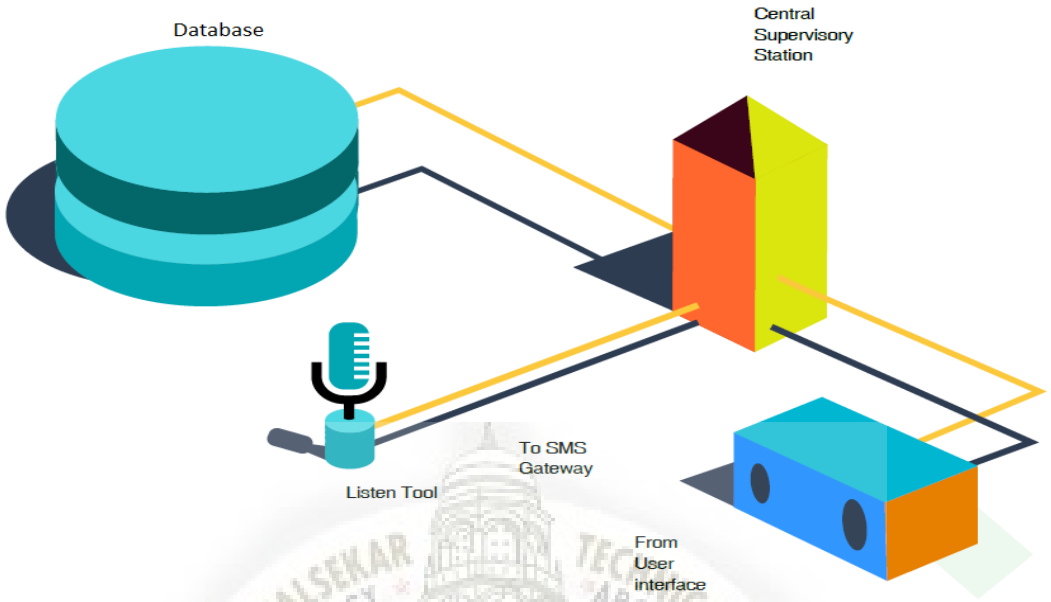

Fig. 6.2: **Parking assistance system**

6.3 Actors Involved

Since, it is a system therefore lots of actors involved in this with their respective roles. Here is the list of actors who are involved in this system:

Fig. 6.3: **Actors involved in the smart parking system**

6.4 Cases

Case 1:

1. The M2M (Machine to Machine) service platform checks the parking lots with the parking provider of the malls or the streets and notify the details of parking availability to the user.
2. The smartphone navigator sends the car's location (near to the mall or the street) to the parking provider in the mall or on the street.

Case 2:

1. The smartphone navigator sends the car's location (near to the mall or the street) to the parking provider in the mall or on the streets.
2. The M2M service platform checks the parking lots with the parking provider of the mall or the street and sends the details of parking availability.

Case 3:

1. The smartphone navigator sends the car's location (near to the mall or the street) to the parking provider in the mall or the street.
2. The M2M service platform checks the parking lots with the parking provider of the mall and the street.
3. The parking provider would offer parking discount (if any) on the go.
4. The parking provider would recommend parking space to the navigator
5. The smartphone app would direct the vehicle and the parking provider to 'Start Parking'

Case 4:

1. The smartphone app would direct the vehicle and the parking provider to 'Start Parking'
2. The parking provider would offer parking discount (if any) on the go.

3. After the parking period is over, the provider would intimate the charges.

6.5 Flow Process Diagram:

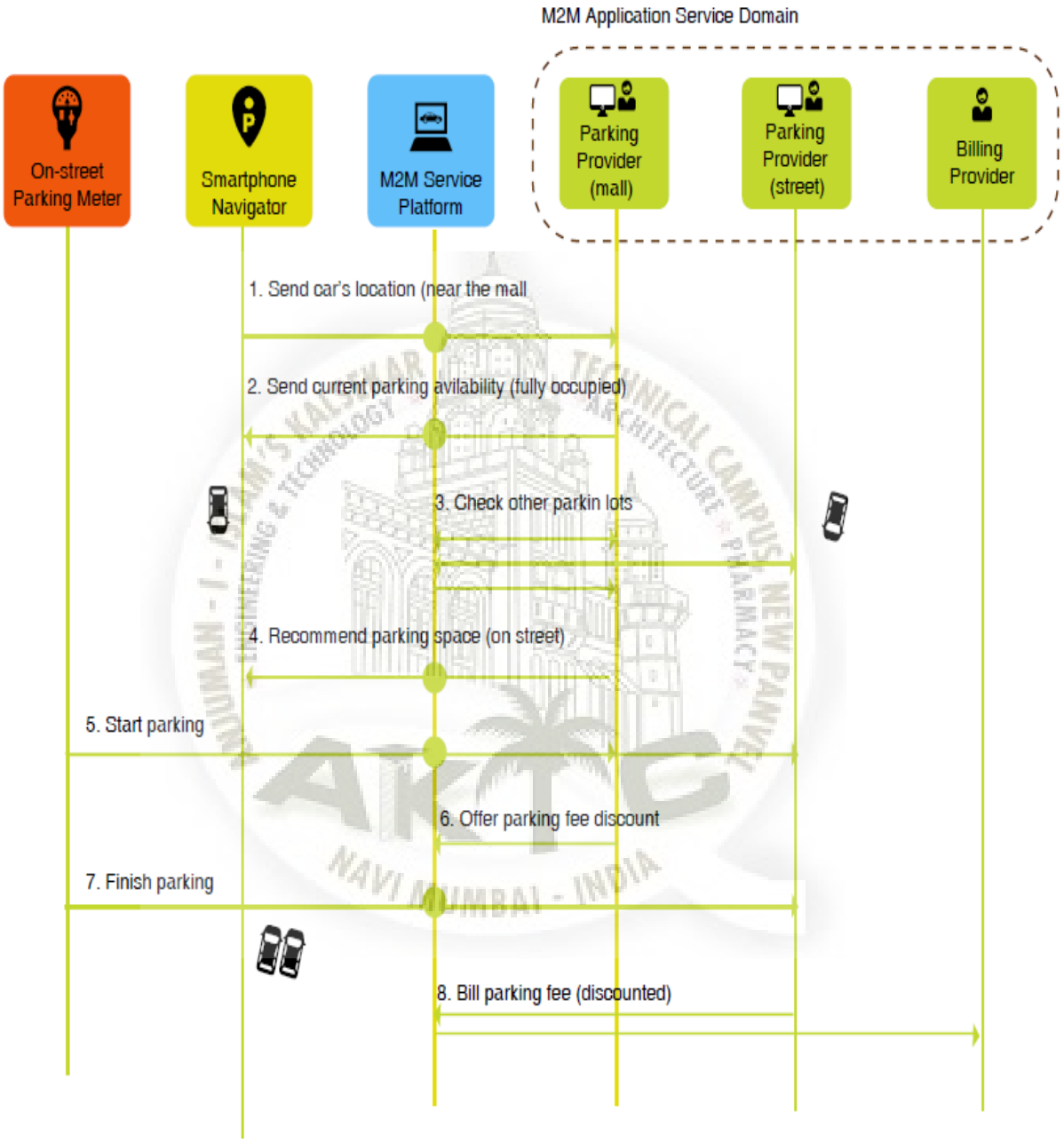

Fig. 6.4: **Use case**

Chapter 7

Results

Chapter 8

Applications of Smart Parking System

The major applications of smart parking systems are:

1. **Parking Guidance and Information System (PGIS) -**
   The implementation of Parking Guidance and Information System (PGIS) encompasses two major categories. The PGIS can either include the entire city area or function only within the car park facility. Setting aside the differences, both the PGIS implemented in many major cities in Europe, Japan, the United Kingdom and the United States offer similar advantages similar to those of smart parking system. Both provides information which aids the decision making process of the drivers in reaching their destination location and aids them in locating a vacant parking space within the car park facility. The city wide PGIS is indeed helpful in assisting drivers to car park with vacant parking spaces via the information occupancy status for various car parks around the city as well as other relevant information. On the other hand, guidance in locating the vacant parking space within the car park is ultimately provided by PGIS implemented within the car park.

2. **Transit based information system -**
   The functionality of transit based information system implemented in countries such as France, Germany, Ireland, Japan, Switzerland, the United Kingdom and the United States is actually similar to PGIS. The difference exist in the fact the Transit Based Information System concentrates on guiding user to park-and-ride facilities. It provides real-time information on the status of each car park and public transportation such as the schedules and traffic condition to the public. The additional information provided enables

the patrons to plan for transit in advance without getting into any inconvenience. Among its benefits includes increase in the utilization of public transportation as the primary means of transportation as they can leave their vehicle in the car park and switch to public transportation with ease. This will indirectly lead to an increase in the transit revenue.

3. **Smart payment system -**

   The smart payment system is implemented in the effort to overcome the limitation of the conventional payment methods by revamping the payment method via parking meter and introduce new technologies. This is because the conventional method causes delay and inconvenience for the patrons as they have to deal with cash. It also reduces maintenance and staffing requirement for payment handling purposes as well as traffic control. In general, the Smart Payment System implemented in places such as Finland, Italy, London and United States consists of contact method, contactless method and mobile devices. While the contact method involves the use of smart cards, debit cards and credit cards, the contactless method involves the use of contactless cards, mobile devices as well as Automated Vehicle Identification (AVI) tag whereby RFID technologies are utilize. As contact methods requires contact of the cards with parking meter or payment machines in the facility, the latter offers more convenience to the patrons.

4. **E-parking -**

   E-parking provides an alternative for patrons to enquire the availability and/or reserve a parking space at their desired parking facility to ensure the availability of vacant car park space when they arrive at the parking facility. The system can be accessed via numerous methods such as SMS or through the internet. Some of the additional benefits of using the E-parking system aside from those collectively gained by smart parking system are that it can be extended easily to incorporate the payment mechanism of smart payment system whereby payments by the patrons are made hassle free using the technologies discussed previously. Customized information can also be provided to the patrons either before or during their trip to the car park.

5. **Automated parking -**

   Automated parking involves the use of computer controlled mechanism, which allows

patrons to drive up to the bay, lock the cars and let the machines automatically place the vehicle in the allocated space. This type of car park offers maximum utilization of space as it is machine controlled unlike conventional car park where space is needed for navigation of vehicle within the car park. Among its benefits are that the implementation works great in locations, where there are limited room for expansion due to its structure. Besides that, the Automated Parking System also offers efficiency in car storage as it allows car stacking and the patron does not even need to go into the car park which indirectly provides extra safety measures which covers both the vehicles and patrons.

Chapter 9

Marketing Details

9.1 Potential market landscape

The rapid growth in the number of vehicles worldwide is intensifying the problem of the scarcity of parking space. Again according to industry data, 30% of traffic congestion occurs due to vehicle drivers struggling to find parking space. These in turn are magnifying the necessity of smart and efficient parking systems. Today's intelligent parking management systems are capable of providing extreme level of convenience to the drivers, as well as simplifying and automating the business operation and administrative functions of the parking site owners.

Following are the trends having the greatest effect on Parking Industry:

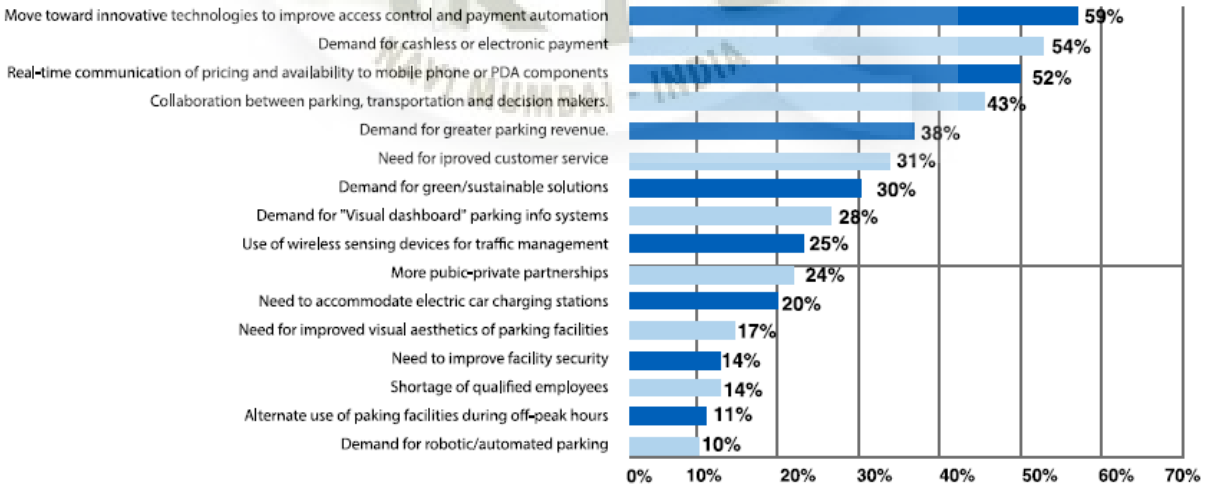

Fig. 9.1: **Emerging trends in parking**

The high growth rate in the registration of new cars worldwide, with major boom from regional economies such as Asia Pacific (APAC), will open the window of opportunities for parking management business. The ongoing and upcoming smart city projects worldwide will create room for the intelligent parking management systems. The global parking management industry is expected to grow at a Compound

Annual Growth Rate (CAGR) of 11.4% from 2014 to 2019.

The parking management market is estimated to be at $ 5,025.9 million in 2014. The market is expected to grow in tandem with the growth in vehicle ownerships and parking facilities development. Need for smooth traffic flow, business benefits to the parking site operators, and decreasing hardware and connectivity costs are the key drivers for the parking management industry.

Traffic congestion and gasoline prices leads the list for the major societal changes having significant influence on parking.

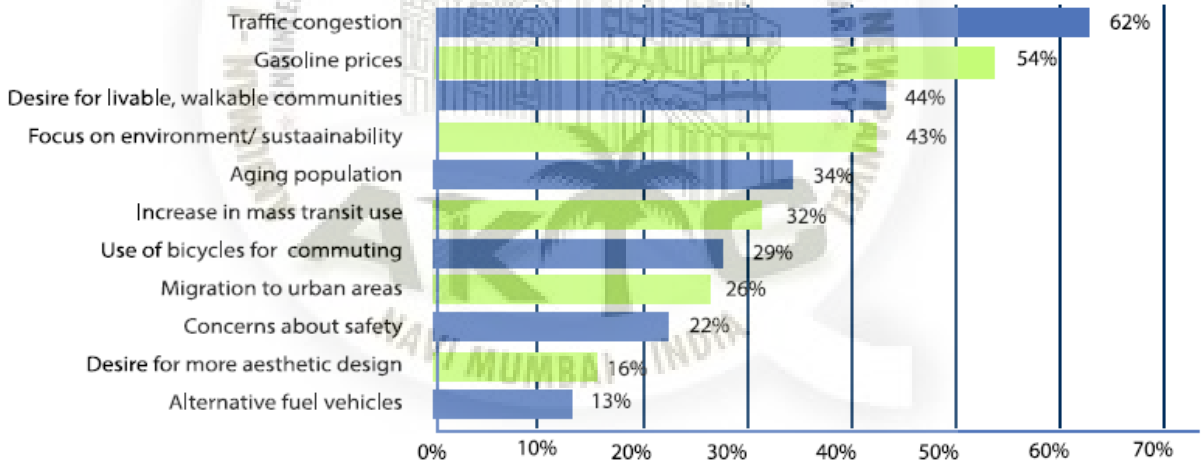

Fig. 9.2: **The major societal changes having significant influence on parking**

The high growth rate in the registration of new cars worldwide, with major boom from regional economies such as Asia Pacific (APAC), will open the window of opportunities for parking management business. The ongoing and upcoming smart city projects worldwide will create room for the intelligent parking management systems. The global parking management industry is expected to grow at a Compound Annual

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9.2 Challenges and Major Pain Points

1. The major challenge in Parking Systems is of system integration due to wide variety of hardware and software platforms involved and hence possess a great threat or concern to the system scalability.

2. The technology platform supporting PE , PARC and PUCRS systems comprises of a myriad of hardware sensors, dynamic messaging systems and traffic control devices, wireless and wireline telecommunications systems, computer clients and servers and hardware drivers and application interfaces.

3. Enabling all these devices from thousands of different vendors to communicate and tying them together into one platform is the greatest challenge in reducing the cost and complexity of smart parking. The variety of infrastructure hardware and software systems that need to be integrated is enormous and add to it the conventional older hardware making investment in Smart Parking solution highly risky and fragmented.

4. Another major pain point comes from the electronic payment vendors. These payment processors provide permit based electronic payment, typically for a convenience fee. The key to many of these hosted solutions is scalability, the ability of the transaction processor to support over wide geographical, market and service areas, with minimal cost

9.3 Indian Specific Ecosystem Challenges

1. Absence of a robust billing platform leading to possible revenue leakages

2. Interoperability between devices/lack of standards.
3. Although other countries have solutions deployed, Smart parking does not really provide much solution to two wheelers as yet in India.
4. Various Security issues and threats to the installed on-site parking meter.
5. The IoT enabled Parking System shall support mechanisms to correlate charging data/records from different IoT Application Service Providers.
6. The IoT enabled Parking System shall support triggering M2M Devices to report on-demand information regarding collected data from other M2M Devices
7. Smart parking providers will need to establish reliable application programming interfaces (APIs) that enable service partners to provide consumers with access to smart parking services on-line through a variety of channels, including the web, mobile phone apps, connected personal navigation devices and car telematics services

Chapter 10

Benefits and Limitations

10.1 Benefits of the Proposed System

1. It uses camera instead of sensors which covers more area
2. Updating the system frequently with real-time
3. Ease of inquiry and reservation
4. Easy navigation
5. Security
6. Increase employment for engineers and professionals
7. Increase revenue and profit

10.2 Limitations

1. Power failure
2. Hardware/Software failure
3. Network dependent

Chapter 11

Conclusion

We can ensure that using the concept of IOT to designed a smart parking system, is made well managed to access and map the status of vacant parking slots from any remote location through web browser or application. Thus reduces the striving of finding nearest parking area of desire location and vacant parking slot, so it reduces time and fuel consumption.The major enablers or drivers for smart parking, essentially are the problems of urban livability, transportation mobility and environment sustainability. Primarily Smart Parking technology is about enhancing the productivity levels and the service levels in operations. Some of the underlying benefits could be lowering operating costs, while building value for customer to drive occupancy, revenues and facility value. We have evolved from traditional servicing channels like toll-booth and parking attendants to incorporate automated pay stations, meters and gates. The majority of investments has always been in creating energy-efficient hybrid and electric vehicles, which in-turn still doesn't solve the problem of global gridlock causing the same burden on urban gridlock. Finally, in the long run, smart parking can actually transform the very makeup of our urban landscapes, making them more amenable to people rather than cars. Street to Vehicle communication would be pivotal and crucial along with the Vehicle to Vehicle communication as the success and market readiness of Autonomous vehicle ecosystem lies in collecting and interpreting the data at the Street Level.

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Smart Parking System based on IoT Using Raspberry pi

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***Abstract*: This paper presents the basic concept using IoT for Smart Parking System in smart cities. The services provided by the smart parking can be constitutive part of a basic IoT operational platform for smart cities due to its features and benefits. The increasing population and there needs increases the number of vehicles on the road. Mismanagement of available parking space has resulted in parking related problem. There is a need of secure system which can lead us for the availability of parking space and its location. To implement such system we use raspberry pi as a controller and opencv for image processing. The camera will capture the parking area and this system will compare the vacant slots in parking area and sends the information to the users using IoT with the help of the Application or web browser. This will help to save the time of user and also help in proper parking management.**

Keywords—IoT, Raspberry pi, open cv, camera module.

I. INTRODUCTION

The Internet of Things (IoT) platform is a suite of components that enable: Deployment of applications that monitor manage, and control connected devices. Remote data collection from connected devices. It also gives independent and secure connectivity between devices.

According to the literature survey people are facing more problem due to parking and traffic in a city. To solve the parking issues we design a Smart Parking System (SPS) which provide the user the availability of nearest parking area and vacant slots if any. It will reduce the time to find the parking and also avoid unnecessary travelling through filled parking slot which also reduces the fuel consumption. Thus it reduces carbon footprints in an atmosphere.

The Smart Parking System can be designed by making use Hardware such as Raspberry Pi, Beagle Bone Black board's etc. which can interact with internet. Here we are focusing on less power consumption and more performance device. So we are using Raspberry Pi which is more suitable with our requirement.

The goal of this work is to,

- Create a web address or application for car parking slot.
- User can log onto the web address or application and enter his/her car number and parking duration via his/her mobile devices.
- Camera module in the parking lot give in order regarding the accessibility of the car in the slots of the exacting parking lot.
- According to the period of the drivers require, slot are allocated.
- As of request by driver, free parking slot will be displayed in his/her mobile device, thus dropping the time spent for discovering free space

.

II. OBJECTIVE OF THE PROJECT

The main objective of this project is to develop system to locate the nearest parking area and a vacant slot in it using Raspberry Pi to ease the people for finding the parking which result in saving of time and fuel. Status of **SPS** can be

accessed and traced (mapped) from any remote location through internet by using web browser or application.

III. Related Work

The Parking System is designed by making use of some IOT supportable hardware's such as raspberry pi, arduino boards, Beagle Bone Black board's etc. here we focus on less power consumption and better performance device, so raspberry pi is most suitable microcontroller for our implementation. And NOOBS installer is uploaded into the storage device of raspberry pi. This installer which consists of various hardware supportable operating systems such as mac os, tiny os, raspbian os etc. are some of this operating systems which generally consumes less power.

IV. Implementation and Working:

The parking system is designed in such a way that it shows filled slots and empty slots in parking. The figure shows the cloud based IOT design for the system which contains cloud service provider which provides cloud storage to store the needed information about status of parking slots in a parking area and etc. The centralized server which manages to store the systems information such as number of empty slots, parked vehicles etc. And these information will be accessed through some secured gateways with the help of internet on web browser or application.

This smart parking system which consists of several components. And theirs functionality includes:

- Controller: Raspberry Pi is used as a controller to implement our parking system and camera is attached to raspberry pi.
- Interfacing camera: To monitor the parking area we are connecting pi camera to the Raspberry Pi which capture the image and compare to determine the empty slot in area.
- Analyzing and Updating: Analyzing the empty parking space and updating the database according to it.
- Navigation System: Will provide the location of the parking area to the user.
- Fetching: The user can connect to our system and can access it with their smart phones for finding the parking area and empty parking slot to park their vehicles.

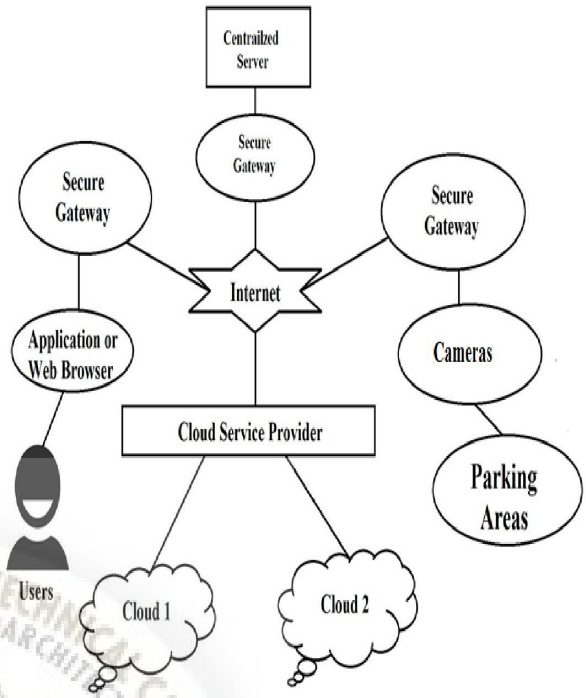

Fig : Cloud Based Intelligent IoT Framework

The system which integrate the features of raspberry pi and attached camera module. Where camera is mounted on the top of the parking area which can easily monitored the whole parking space. Thus camera is capable of capturing image of empty and filled parking slots in parking area continuously. The image of total empty parking area with its marking is stored in the system to compare it with new image for checking the empty slots in it. It will compare the images continuously for real time update.

When the availability of parking slots changes immediately the information is updated to the centralized server. The user can access this information using browser or application from any location through internet.

V. Result

The expected outcomes are the SPS app in the users smartphones can be able to show the nearest parking area from its desire location and also shows vacant space for parking and guide towards it. It also allow the user to pre book the desire parking slot to secure the slot before reaching there, so it can help the travelers from long distance.

VI. CONCLUSSION

We can ensure that using the concept of IOT to designed an smart parking system, is made well manage to access and map the status of vacant parking slots from any remote location through web browser or application.

Thus reduces the striving of finding nearest parking area of desire location and vacant parking slot, so it reduces time and fuel consumption.

VII. FUTURE ASPECT

There is further scope to adapt this smart parking system so that the availability of space could be displayed even on a **satellite navigation device** so that drivers will always be aware of whether there are free spaces or not.

And also this system will accounts the weather condition of an environment.

Concept of **Smart Cities** can be include in this project such as monitoring the street light, intelligent traffic management, integrated multi-modal transport and many more.

VIII. ACKNOWLEDGEMENT

We are highly grateful to the prof. Mujib Tamboli, HOD of Electronic and Telecommunication Department, Kalsekar Technical Campus (New Panvel), for providing this opportunity to carry out the project. We would like to express our gratitude to other faculty members of Electronics & Telecommunication Engineering Department for providing academic inputs, guidance and encouragement throughout this period.

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Finally, we express our indebtedness to all who have directly or indirectly contributed to the successful completion of this project.

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Certificate of Presentation

Dr./Prof./Mr./Ms. Afzal Ansari of

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Declaration

We declare that this written submission represents ours ideas in ours own words and where others ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in ours submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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