A
Dissertation On

Advanced Parking and Smart Crossing Traffic Management System Using IoT

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In

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I hereby declare that the thesis entitled "**Advanced Parking and Smart Crossing Traffic Management System Using IoT"** which is being submitted to the **Delhi Technological University**, in partial fulfillment of the requirements for the award of the degree of **Master of Technology in Software Technology** is an authentic work carried out by me and has not been submitted to any university or institution for the award of any degree.

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ABSTRACT

Internet of things (IoT) and Artificial Intelligence (AI) both are currently in high demand and have a lot of scope in future as well. Nowadays, the concept of smart cities is very popular. IoT is a key player for achieving the idea of smart cities. Many efforts are being made in this sector of IoT for making a better infrastructure of any city. In urban cities, we are also facing many problems like very less parking facility, safety during travelling and congestion of traffic.

As the movement of world is very fast and seamless transportation system is not providing by current transport system. People are getting delay due to extra jam on traffic while they are on their own way to work, home or any other places. This is a major reason of fuel burning and time delay. Currently, almost every person who has a vehicle is facing a very serious problem of parking.

With proposed IoT solution we can solve these problems more efficiently. In our thesis, we have come up with an algorithm that can help in resolving traffic congestion and making parking system smarter. We have proposed an algorithm for reading car number plate i.e. License Number Plate (LNP) detection based on advanced algorithm for convergence of grey scale image and morphologic effect.

We suggested for traffic control, Intersection time deduction advanced techniques with the help of IoT sensors and AI (Fuzzy system). In given time duration number of passed vehicles can be maximized. We have also included Cloud based parking system with the help of IoT, Which uses IoT based module to scan vacant space in parking area.

Hereafter, we can work on AI techniques for Vehicle Over speed monitoring, automatically detecting road accident and contact emergency number, an IoT based system for privacy and security of data for Smart parking and improvement in traffic control.

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CHAPTER 1: INTRODUCTION

1.1 GENERIC APPROACH

In Present, Internet is a basic requirement of everyone and the things which is connected through internet is called IoT i.e. “Internet of Things”. Electronic things are now connected together and transfer information between information world and physical world and vice versa.

IoT came into the picture when any electronic devices or module started identification to other module or device. With the help of IoT daily life becomes very easy as we can detect, control and manage the things through internet. IoT may be any electronic systems like refrigerator, air conditioner, microwave, air purifier etc. There is also an advancement of these things when they will behave like a robot with some inbuilt sense features in them.

As we know IoT generates a lot of data which will be store in cloud. In future cloud computing and IoT will work together and things will become easier.

With the help of cloud and IoT together we can manage things and control them. System will become more perfect and there will be a flexibility to add and remove the modules (things).

1.1.1 Concept for Smart Parking System using IoT(SPSI):

With the help of SPSI we can reserve parking lot from your home or any other places from where you can access internet, by which user can save time and reduce the risk of not getting parking without any noise. Hence, we can also save petrol/diesel/CNG etc., indirectly saving money.

Its main objective is to provide better parking service and space to the driver and service provider as well. Which also helps to interact between service providers and also satisfy the specific requirement of driver.

It helps to deduct the number of drivers and improves traffic management. Control signals has been designed in such a way that parking can be easily selected by drivers. Detection of license plate technique has been used as an advance algorithm for updating the parking record. Another approach has also been suggested for calculating fastest entry and exit in large parking area for drivers.

1.1.2 System for management of traffic:

Fuzzy logic along with the IoT used for managing the traffic, with the help of fuzzy logic we can check the vehicles in all the way so that time can be manage for reducing the load and with the help of this ,light of the signal will work. If there will be no load(no vehicle) then time will automatically reduce for that side and will be manage for remaining ways. This approach is very useful for managing traffic easily and people can also save time, fuel etc.

1.2 MOTIVATION

Nowadays, everyone wants to use things easier and with the help of IoT things become really easier. Everything is now moving on digital, home becoming smart home city becoming smart city etc. Internet playing a great role in all the things which is becoming smarter because without internet connectivity cannot be become easy. Things connected through internet and perform required action very easily and efficiently, when artificial intelligent work together with IoT everything becomes smarter. IoT generates a lot of data which is managed by big data so cloud will also add-on with IoT for better usability of things.

In Present, many projects are already ongoing for making smart home and smart city. Our idea is to make parking system and traffic system smarter so that things can become smarter.

Now, we are facing a big problems [3] related to parking and traffic system like if we talk about parking problems mismanagement in parking space due to which traffic is increasing and wastage of fuel occurs, in traffic management problem like safety and time management. IoT really resolve these kind of problem related to traffic and parking, things now became smarter compare to the previous.

Above problems were the only reason for our thesis and below is the work which we did for making things easier:

1. Advance algorithm for detecting the number plate of vehicles.
2. For making parking system smarter online reservation system with IoT and cloud data base.
3. IoT and Fuzzy Logic used for making traffic system easy.

1.3 PREVIOUS WORK

1.3.1 Advance Parking System

In current time many works already done on smart parking system. In our work IoT used with wireless sensor network for managing the parking system easily and efficiently. With the help of wireless sensor network we can detect parking related information and can apply into our system of parking. Other advance algorithm namely LNP also used for monitoring parking lot with the help of detecting vehicles. Now we can save parking space as well as time in parking system with the help of this advance algorithm. Some previous related works are as below:

1.3.1.1 Cyber-Physical System (CPS)

CPS was a favorite topic for the researchers and it provides solution for the given problem which helps to solve that easily and efficiently, we can also see this in shared research [25]. CPS can handle many operations and can coordinate with them, it can control and manage the things that was used for coordinating and interacting [20]. CPS make us understand how physical things are connected to each other and interacting with the real world.

Present time, everything is very challenging and how CPS is working with it we can see in [15]. Transport system is one of the best topic of researchers related to CPS [22], security, environment, industrial [16], etc.

As per the earlier survey in US, transport system have the almost largest energy consumption which is around 30% in 2008, this kind of consumption was happened after so many years (35years) and increased by around 90% in U.S. [3].If we already set our mind for saving energy consumption by transport then can also save some energy. The main aim of CPS was, how to reduce energy consumption of transport and it did without driver. The best way of saving energy in transport was found in the research [17]. This solution of research was not related to only how to reduce energy of transport but also focus on environment related to transport.

As we know, CPS was mainly related to real life and physical system [20] that was only communicating, controlling and monitoring the physical things and interacting with the real word so, below is the challenge of CPS which includes many points:

1. CPS framework of objects
2. Reliability and strength of organization
3. Hybrid management
4. Computer based/Calculable competencies
5. Online structure
6. Knowledge and Learning
7. Paradigm-based and Detector-based

8. Examination, authentication and confirmation

Conveyance online-materialistic system (OMS) or cyber physical system [10][27][26][12] is a crucial relevance of CPS. It helps users to get to desired destination with protection and security. Air transportation is also based on same network. If there is any problem related to adverse weather or density, by which air transportation is suffering, then CPS comes up with a flexible gateway scheming facility with persistent association. In [27], the analyst has mentioned regarding the impression of the mobile network to transform with the help of the transportation cyber physical system.

1.3.1.2 VANET-Based Smart Parking

VANET stands for vehicle ad-hoc network which is another approach for making parking system more advance. Which the help of VANET we can reserve our parking very easily and efficiently.it is very user interactive and provide solution very fast. Earlier we used WSN for making reservation, maintaining reservation record, proper allotment of parking space for every vehicles. WSN was also a good approach and it is different from VANET.

Based on VANET, Rongxing Lu et al. [18] introduced a new Smart PARKing (SPARK) scheme. It is very useful in finding free parking lot firstly and accurately. We can track every vehicle at any time instant and do needful action if required.it is also very useful for security reason as we can track every time. . Finding new parking lot has been described in [11] by author.

1.3.1.3 Parking Lot Detection

Jake Reisdorff provided the efficient solution for finding the parking lot in [21]. Author described the method of webpage in which images of cars will be stored and with help of the image processing and saved record we can check the vacant parking lot and used parking lot as well. Firstly there will be a high resolution camera which will capture

the image and will send to the web server. On the basis of that image vacant and used parking lot can be detected and allotment will be done for new users. With the help of this method parking lot reservation is fast as detection was done very easily.

1.3.1.4 IoT based Smart Parking System

Khanna and Anand provide an application based service for reserving a parking lot [1]. Provided solution is for only small area and it's not stable and user-friendly. There is an application and with help of that we can reserve our parking and do payment with the help of debit card, credit card, e valet or cash etc. This system is only for booking the vehicle in small parking area but they didn't provide solution like finding parking lot fast, security and shortest path for entry and exit in large parking area.

1.3.2 LNP detection related work

Detection of objects automatically is very challenging currently and many researches are already doing their work on it. Some techniques of license number plate detection [7] like Neural Network, Color features, Detection of edge, Morphological, Picture transformations etc.

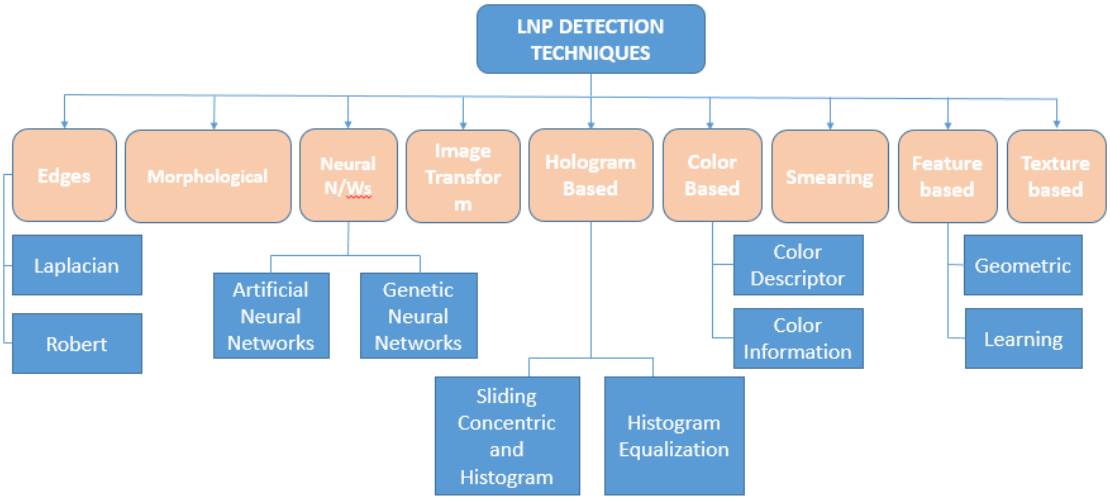


Figure 1.1: Different LNP detection techniques

As we know that LNP is a unique number for every vehicles. LNP with IoT [3] , With this method camera focuses on the area which have high energy and frequency . Picture could be the whole vehicle image or be the only license number plate. This technique used for saving the storage in surveillance of urban city.

In system of vehicle license plate recognition [28], actual image of license plate is cut down from whole image and this is the main advantage of cars license plate detection.

Another method is detection of edge vertically [29]. This method is useful when we detect first the two vertical of the images after that four corners of that image detected .This is a very perfect method for detecting the LNP, [30].

Morphological [31] based LNP method is useful for taking pictures in very contrast manner for more accuracy [31].

On the basis of color, one more method is color based for VLPR [32], from the different-2 color of the images detecting one color image of license plate is the color based detection method.

One of the best license number plate detection technique is based on network of neural [33].Detecting the region of the plate, character segmentation and character detection is the process of this method

1.3.3 Related approach for Smart management of traffic system

For minimizing the traffic load, there are many approaches suggested by the researchers and still ongoing many research on this. One of the approach is video based in which basically parameters of traffics are focused and on the basis of that parameters we can see the traffic load reasons, see [35].

We can say, detection of vehicle can be divided into two parts one part will be stereo and other can be monocular vision detection. Both techniques are based on the motion and appearance, [36]. The technique which used motion detection is stereo vision

detection which is basically recognize the motion by taking the 3D image. The technique which used appearance detection is monocular vision detection which is mainly uses image for detecting the vehicles.

Here machine learning is also useful for recognizing the image, accurate movement of object and for LNP localization, [37].

1.4 PROBLEM STATEMENT

We have already mentioned the previous work related to parking system and traffic system for making our city as much as smart.

Proposed algorithm for parking system is very useful and we used convergence of normal image to greyscale image with detection of distortion, noiseless and morphological operation. It is a perfect solution for finding parking slot because accuracy is very high with this method.

Also, we can track vehicle inside the parking because in cloud all the information of related object is stored with the help of number plate detection algorithm. With the help of this algorithm billing and other facilities will become smoother.

With the help of Fuzzy logic integrated with IoT we can calculate the load of the traffic in each side of the road and on the basis of that load we can manage traffic light operation smartly. With the help of this approach we can save time and transport energy of our city.

1.5 SCOPE OF THE THESIS

In our thesis, Cloud based method used for saving all the record of parking and it is a very big data base as we will check all the parking's in the city. With the help of this method driver can book parking lot either from the internet area or from the ruler area

with the help of the sensor and IoT. Which will provide needful solution to driver related to the parking.

Algorithm used for detecting the license plate of vehicle with high resolution camera and with this technique proper allotment of parking will be done. Shortest path algorithm used for entry and from parking lot to exit.

For traffic management we used IoT and AI (Fuzzy logic) which will the best solution and will remove the traffic related problem in real life.

As we know this is an era of IoT and AI, Proposed solution is for making the smart city with the help of IoT and AI. Advance algorithm for detecting vehicle number plate (changing normal image to greyscale image) and AI will really make traffic system and parking system smarter. Now people can enjoy their life very easily and it will be also time and fuel etc.

CHAPTER 2: LITERATURE REVIEW

2.1 IOT-CLOUD INTEGRATION

We can make our city as a smart city after doing some changes or with advancement. In present, parking and traffic system is a major issue for us so we will change it or provide better solution for it.

Nowadays, population is continuously increasing and number of vehicles are also increasing with the same ratio so it is obvious that there will be problem .with traffic and parking system. Government can only provide the space for parking but for using that space very efficiently we provided our solution. With the help of the application which will be based on the IoT, we can reduce time, energy and money. In traffic system we can also manage traffic load, energy consumption and time with the help of the AI and IoT in our system.

Sensors required in our parking system for sensing the available parking slot in parking area and also filled area record. All records about vacant and filled space in parking will be save in cloud data base. With available records in cloud we can make reservation and with sensors we can find information about availability.

IoT generates a lot of data so it was a challenge to IT companies about how to store big data. Cloud came in to the picture for data storage and with the help of cloud things become easy. The things were interacting with each other with the help of internet which is called IoT and data were getting stored with the help of cloud. Some benefits of IoT and Cloud togetherness is as bellows:

- Handling a large amount of data
- Security and Privacy

- Remote processing power
- Inter device communication
- Entry barrier for hosting providers

2.2 FUZZY LOGIC

Fuzzy means somethings which is not clear and fuzzy with logic is a method of reasoning that resembles human. It is basically a decision making method in which all possibilities includes. It is like a mathematical algebra and Boolean logic which includes all possibilities.

2.3 WIRELESS SENSOR NETWORK (WSN)

In WSN, Sensors are used and with the help of that sensors data is collated to different-2 ends. Data collectively used in one node called destination with the help of the wireless connection and other methods. In below diagram we can see the applications of the WSN namely Transportation, Factories, Farming, Privacy etc.

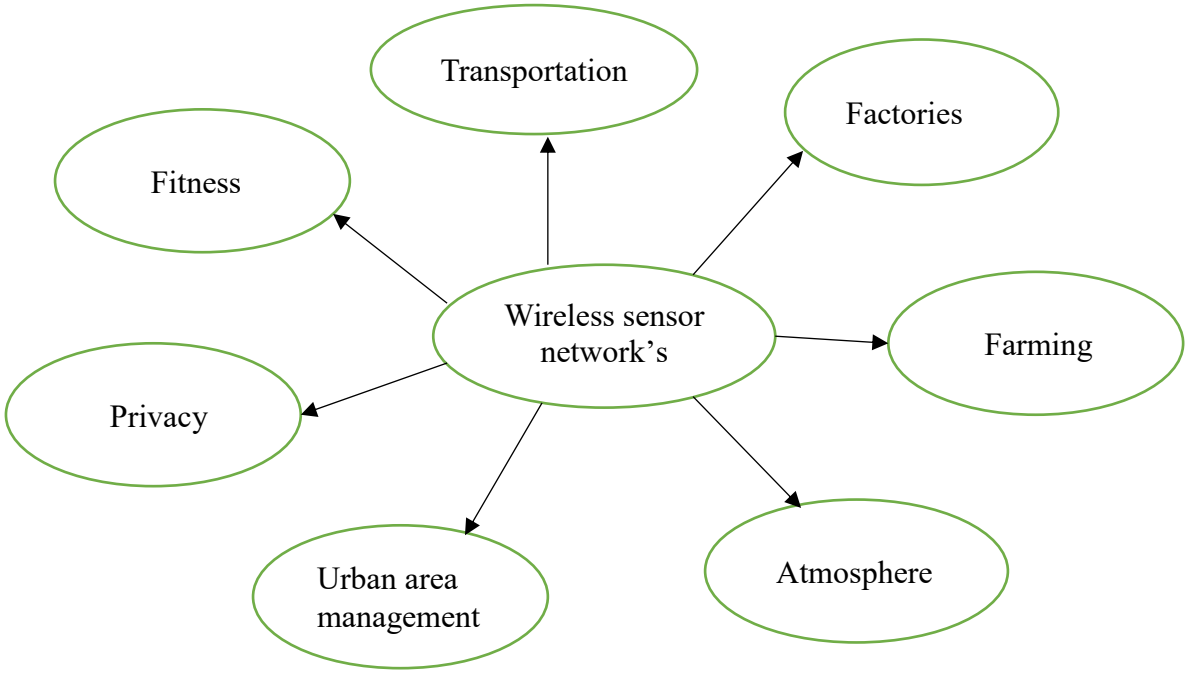


Figure 2.1: Wireless Sensor network's application

2.4 ALGORITHM FOR EXIT IN LARGE PARKING

We provided the solution for exit from large parking area. If, In large parking only one entry gate is present for entering and for exit multiple paths are present so for removing this kind of problem we provided an algorithm namely Dijkstra's algorithm. There will be LED light for each parking road and when our algorithm will find the shortest path, light will blink automatically and on the basis of that light blinking driver can exit as early as possible.

2.5 MORPHOLOGIC OPERATION

An operation that performs on set of image processing is called Morphologic that basically works on different kind of shapes of the images. In an input image structuring elements are applied which is a work of morphologic operation and on the basis of that input image there will be one output image produced by the morphologic operation with same size.

In this thesis, we also follow the same operation of morphologic and output image is replica of input image and on the comparison basis. On the basis of the closest node shape and size morphologic operation applied. Basically two methods are applied dilation (addition) and erosion (removal).In dilation basically pixels are added on the boundaries while in erosion pixels are removed from the boundaries of the image.

Maximum value of the pixel in output as per the neighbor pixel of all input is called dilation operation and minimum value of the pixel in output as per the neighbor pixel of all input is called erosion operation.

CHAPTER 3: PROPOSED WORK

3.1 AUTOMATIC DETECTION OF OBJECT USING IOT- ENHANCENT

After adding our approach in previous algorithm [3] related to images, we can see changes as bellows:

Distortion Minimization:

As we know, distortion occurs due the lens of camera so for detecting the number plate of any vehicles we have to correct the distortion. Number plate of the vehicles are generally black and if we took picture of the black portion then distortion will be maximum ,reason behind this is a some blank space between black numbers which is removed by the lens [5].

Noise Minimization:

Gaussian smoothing method used for doing images as blur with the help of the Gaussian function. It is basically used for reducing noise and details of the image. Below is the equation for image which is filtered:

$$I^* = \frac{1}{Wx} \sum_{y \in S} G\sigma s \left(\left|\left|x - y\right|\right|\right) G\sigma r(||\ Ix - Iy\ ||)Iy, \quad (3.1)$$

Where Wx = $\sum_{y \in S} G\sigma s \left(\left|\left|x - y\right|\right|\right) G\sigma r(||\ Ix - Iy\ ||)$ is normalization factor, σ_s and σ_r used for the filtering amount, S: considered window, $G_{\sigma s}$ and $G_{\sigma r:}$ Gaussian function kernels, and I: Intensity value.

Grey scale convergence:

Formula used for grey scale convergence is, Z= (3.06R + 5.85G +1.09B)/10

Where, Z denote the value of greyscale pixels, R denote the red color, G denote the green color and B denote the blue color for every pixel.

Morphologic operation:

Dilation and erosion are the two operations which is performed in morphologic operation.

Operation of Dilation: After expanding the objects characters are divided.

Below are equations (3.2) and (3.3) for operation dilation and erosion:

$$S = X \oplus Y[k; l] = \max \{X[k - n; l - m] + Y [n; m];(k - n; l - m) \subset X; [n; m] \subset Y\} \quad (3.2)$$

Operation of Erosion: In this operation objects are reduced by value in size.

$$S = X \ominus Y [k; l] = \min \{X [k - n; j - m] - Y [n; m]; (k - n; j - m) \subset X; [n; m] Y\} \quad (3.3)$$

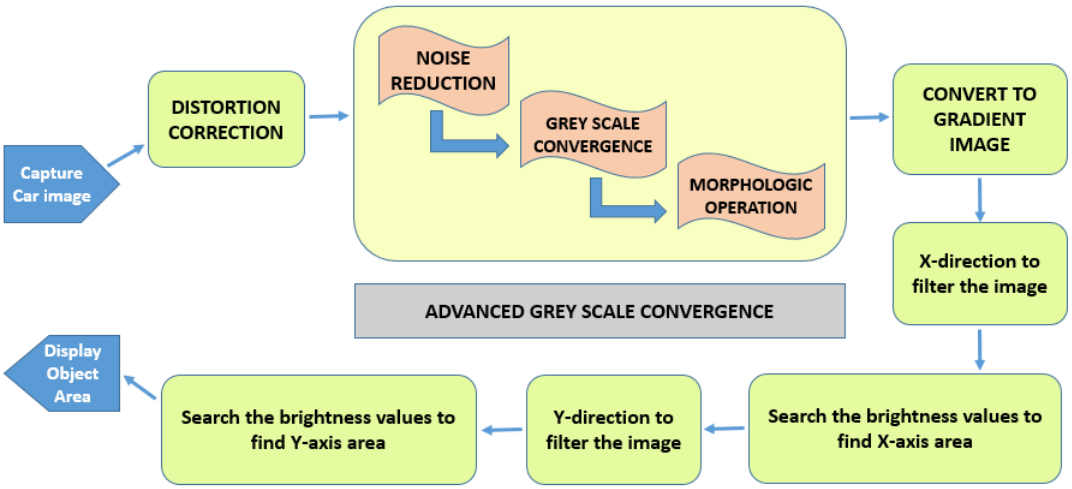


Figure 3.1: Automated detection of object using IOT

3.2 ADVANCED ALGORITHM FOR DETECTION OF LOAD IN TRAFFIC

We have come up with multiple algorithm as one [With the help of fuzzy system detection of traffic overload + sensor of motion using IOT]. Provided algorithm is best for detecting the traffic load in any side which will reduce the traffic load with the help of traffic light control.

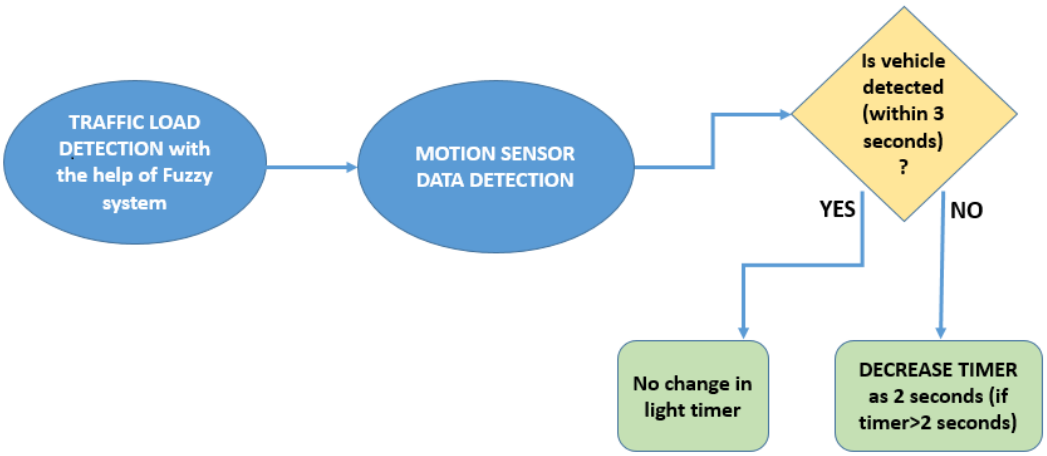


Figure 3.2: Advanced detection of load in traffic

3.3 AUTOMATIC DETECTION OF OBJECT USING IOT

We have added below proposals for finding the parking lot easily with the help of shortest path algorithm and provided navigation for better understanding of the route. License number plate detection algorithm also provided above to track the vehicles easily.

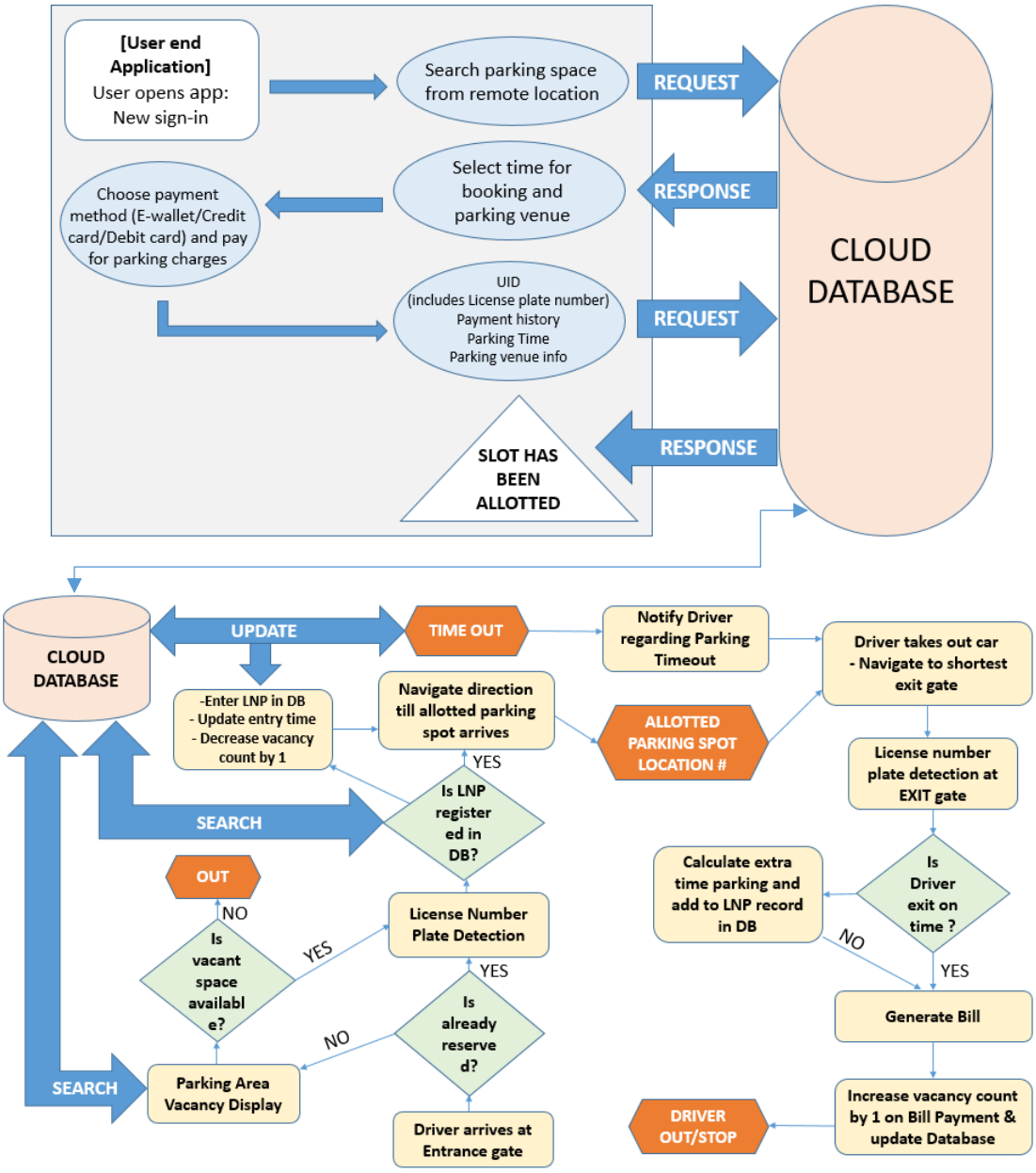


Figure 3.3: Flow diagram for Smart parking system based on IoT

CHAPTER 4: METHODOLOGY

4.1 ENHANCEMENT OF LICENSE NUMBER PLATE DETECTION

We have advanced the proposed solution of Hu & Ni [3] for automatic license number plate detection in this part of thesis.

Previous solution was not more efficient as compare to our solution, we have provide solution which will save memory storage in cloud. It will take the image of the license number plate instead of the other images like whole car.

For converting image to gradient below four methods are applied:

4.1.1. Correction of Distortion [5]:

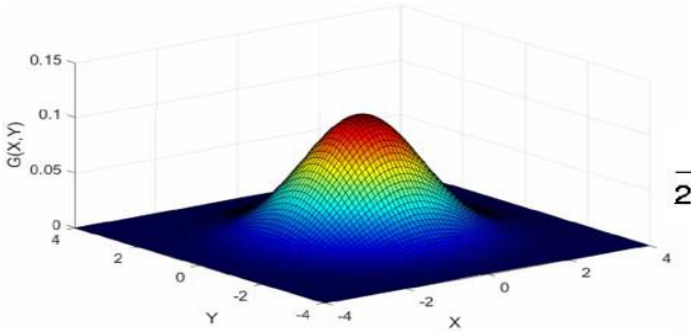
As we know images are distorted due to the lenses of camera of any device so for detecting the license number plate accurately, correction of distortion should be the first step. Generally we observed more distortion when we take image of license number plate and this is happened because of the lances category. If we use wide lens then distortion will be maximum.

Figure 4.1: Example of distortion with different-2 lenses

When we take an image then generally images becomes curved due to the properties of the lenses so in this case radial distortion used for making picture more visible. In our thesis we also used the radial distortion and corrected it after reducing the ratio of intersection point of straight line and coordinates. We applied distortion in reverse manner so that we can reduce more distortion after comparing images of distorted and non-distorted.

4.1.2. Minimization of Noise [4, 5]:

Noise in an image can be occur due to the scanner circuit or sensor or digital camera. This is basically the unwanted fluctuation in signal which is received by the AM radio. Detection of noise from license number plate was very important. We used Gaussian method for minimizing the noise.



$$\frac{1}{273}$$

1	4	7	4	1
4	16	26	16	4
7	26	41	26	7
4	16	26	16	4
1	4	7	4	1

Figure 4.2: Gaussian method for minimization of noise

Gaussian provide the equation and with the help of that equation image blur was reduced. With the help of this method image transformation in pixel we applied.

Equation 4.1 shows the Gaussian method:

$$G(x, y, \sigma) = \frac{1}{2\pi\sigma^2} e^{\frac{x^2+y^2}{2\sigma^2}} \quad (4.1)$$

Where, x denotes the distance in X-direction and y denotes the distance in Y-direction, σ denotes the standard deviation in Gaussian noise.

Average weighted values are entered in the figure 4.2 which are the values of each neighbor pixel. If distance is increasing between original pixel and neighbor pixel then provide weight will be minimum and similarly if distance is decreasing between original pixel and neighbor pixel then provide weight will be maximum. Gaussian methods reduced random noise with this approach.

4.1.3 Provided Formula for convergence of Grey scale:

Below, we have provided one formula for convergence of Grey scale which is used in paper [4].

Formula used by Hu & Ni [3], Z = (3R +6G +B)/10

Our formula in thesis [4], **Z= (3.06R + 5.85G +1.09B)/10** [Better than proposed]

Where, Z denote the value of greyscale pixels

R denote the red color, G denote the green color and B denote the blue color for every pixel.

4.1.4 Operation of Morphologic [4]:

It is basically useful for dividing the every elements and for combining the scattered elements.

For Operation of Dilation: After expanding the objects characters are divided.

Below are equations (4.1) and (4.2) for operation dilation and erosion:

$$S = X \oplus Y[k; l] = \max \{X[k - n; l - m] + Y [n; m];(k - n; l - m) \subset X; [n; m] \subset Y\} \quad (4.1)$$

Operation of Erosion: In this operation objects are reduced by value in size.

$$S = X \ominus Y [k; l] = \min \{X [k - n; j - m] - Y [n; m]; (k - n; j - m) \subset X; [n; m] Y\} \quad (4.2)$$

Table 4.1: Algorithms compression of all object detection

Technology	Background	Environment	Light's Condition	Picture quality	Color's Model	Accuracy
Based on color feature	More depend on proper location of number plate	Illumination should not be skewed	Good in day & night images but bad in fornon-uniform light's images	Binary images	RGB > HIS	80.00%
Based on Geometry	Uniform	Illumination should uniform	More contrast	Both binary and digital images	Greyscale	82.00%
Histogram	Uniform	Better in varied weather	Best for poor illumination & different light condition	Grey scale 640*480 pixels digital and binary image	HIS	82.50%
Based on Edge	For high quality result sharp edges require	NA	More sensetive for noise and light intensity	352*288 Images 30f/sec Video	Greyscale	91.00%
Neural Network	Good for uniform background and bad for non-uniform	Good for uniform illumination	Additional light in day time and refelecting material in night time	Digital image : 320*240 Optimized resolution image : 1600*1200 aspect ratio	RGB to Greyscale	94.00%
Morphology	Better for multiple backgroud	Good work for almost every	Good for low light conditions	Static Image	Greyscale	96.00%

4.2 ADVANCED ALGORITHM FOR TRAFFIC LOAD DETECTION

In this advance algorithm for traffic load, we used artificial intelligence and IoT. On the basis of this algorithm traffic light can be decided for reducing the load ,result:

We are taking four way path, if we are taking any one path and signal is green for this path so for other three side's vehicle have to wait20 sec till light become green for them. If, for taken path there is no more vehicle then we will make signal as yellow for 3 sec and at that time we will check load on remaining three sides and will make green signal for those side which have more load. With this approach we can save 17 sec time.

Fuzzy logic applied for checking the load for each side and with this technique we can check load easily. In fuzzy system if we denote 1 as a true absolute and 0 as a false absolute then tentative value can be 0.9,0.8..etc for 1 and 0.1,0.2 ..etc for 0.

Membership function used in the Fuzzy logic for determining the green light signal termination and increment. We are basically reducing the traffic load for each side of the road by maximum pass of the vehicles. We used sensors on the zebra crossings.

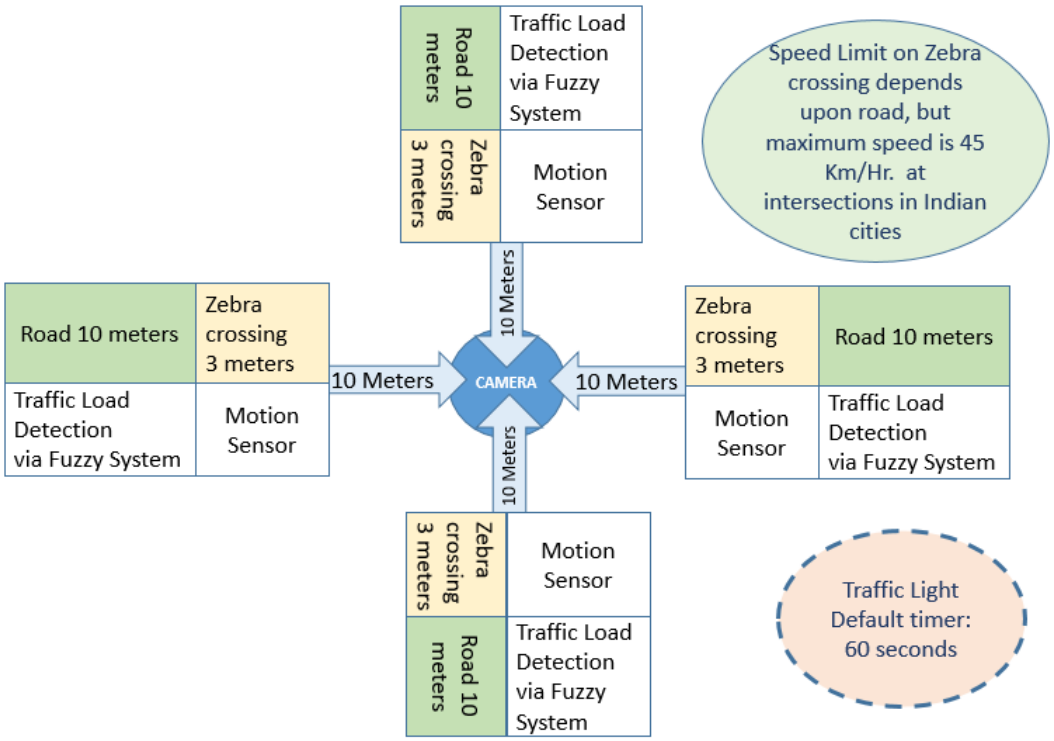


Figure 4.3: IoT and Fuzzy logic for traffic load reduction

We provided one example: From above diagram 4.3: We taken maximum speed during crossing as 35 km/h and for crossing the zebra crossing which have size 3mt ,time taken will be 0.31 sec. If we take a very worst condition for zebra crossing speed as 4 km/h so time taken will be 2.88 sec for crossing the zebra.

In our proposed work we have taken 4 sec a waiting time means if sensor does not detect any motion then traffic light will wait for maximum 3 sec and for addition time of traffic light we have taken 5 sec means this 5sec will be transferred to the traffic which have maximum load compare to the others.

MATLAB used for simulating the result as compare to the other provided solution from different-2 research papers.

4.3 SMART SYSTEM OF PARKING USING IOT

We have added License number plate detection technique in every exit and entry and enhance system of parking provided with more accurate tracking system of the vehicles .

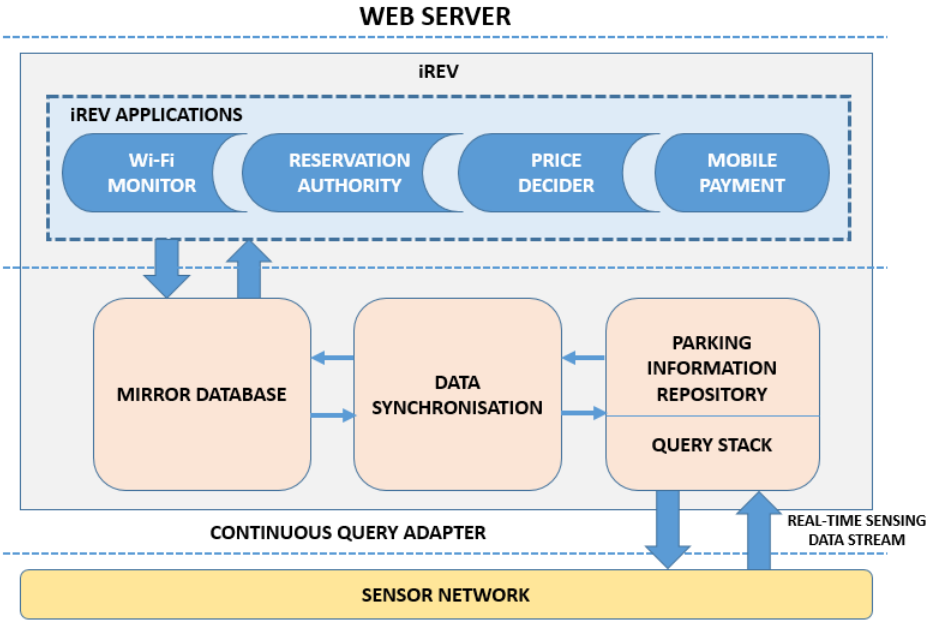


Figure 4.4: Smart parking system architechture

For reserving the parking lot we have suggested our approach here:

License number plate detection – we have already discussed it above and we are using this

Tracking system for vehicles – We have used Dijkstra's algorithm for shortest path in parking system and for navigation.

As we know, we have used LED lights each side of the road for better navigation of the shortest path so that driver can exit easily.

CHAPTER 5: EXPERIMENT AND RESULTS

5.1 TOOL USED

Smart parking and traffic system is simulated as per the user experience of the users. We just took some data as per the different-2 behaviors of the users and presented with different-2 methods.

In our project we used visual studio and java (JDK vr.1.8) for finding the shortest path and MYSQL used for accessing the data base.MS Excel used for just storing data related to sensor. MAT Lab used for simulating smart parking system. All used tools are very interactive and user friendly.

5.2 ANALYSIS USING DATA SET

5.2.1 Using data set for traffic management

Vehicle detectors used on the road and on zebra crossing also. It is very useful on intersection of 4-way road.

With the help of detectors we can estimate our time interval for crossing.

Let Variable F denote the fuzzy variable and variable W denote the number of vehicle which will be waiting in queue and T denoted as an extra waiting time for more vehicles.

Table 5.1: Membership function for input data

Membership function for input data					
Membership Function	**Phase**	**Few**	**Small**	**Medium**	**Many**
F	Green	-4 to 4	0 to 6	4 to 12	8 to 10
W	Red	-4 to 4	0 to 6	4 to 12	8 to 10

Now we can determine T with the help of the above input.

Table 5.2: Membership function for output data

Membership function for output data				
Membership Function	**Zero**	**Short**	**Medium**	**Long**
T	0 to 5	5 to 10	10 to 15	15 to 20

In our fuzzy system controlling we extended time till 5 sec for green light.

F: Fuzzy rule:

After a minimum green (5 s)

If (F== few && W == few|| small|| medium|| many)

T = zero;

Else if (F==small && W ==few||small)

T = short;

Else if (F==small && W ==medium||many)

T = zero;

Else if (F==medium && W ==few||small)

T = medium;

Else if (F==medium && W ==medium||many)

T = short;

Else if (F==many && W ==few)

T = long;

Else if (F==many && W ==medium||small)

T = medium;

Else if (F==few && W ==many)

T = short;

Doing first T. (increase green light 5 second)

If (F== few && W == few|| small|| medium|| many)
T = zero;
Else if (F==small && W ==few||small)
T = zero;
Else if (F==small && W ==medium||many)
T = zero;
Else if (F==medium && W ==few||small)
T = short;
Else if (F==medium && W ==medium||many)
T = zero;
Else if (F==many && W ==few)
T = medium;
Else if (F==many && W ==medium||small)
T = short;
Else if (F==few && W ==many)
T = zero;

As we can see in second extension of green light now there is no need of extension and we can apply motion sensor which is bases on IoT.

For example:

Max. Speed limit during intersection is 35 km/h and Zebra crossing length is 3 mt, then time taken to cross zebra crossing is: 0.31 Second

Let an example of very rough case, suppose a person cross this Zebra crossing @ 4 km/ h, then taken time to cross it: 2.88 Second. In our thesis, we have taken a waiting time of 3 second. If motion sensor was not detecting any motion till 3 second then, it provided suitable direction for next green signals. Our aim was that maximum numbers of vehicle passing in a given time.

Weight, M (X): generated from the number of queuing vehicles wait for Green

Producing labels – M (X) : Zero (Z) = -5 ~ 5;
Low (L) = 0 ~ 7;
Medium (M) = 5 ~ 14;
High (H) = 9 ~ 18.

This rule used for deciding priority for the high demand at the time of green signals. Suppose for 'right of the way' is 4 is taken.

M(1): East,
M(2): West;
M(3): South;
M(4): North;

Rule are following below:

If (M(2) == high)
Next Green phase = 2;
Else if (M(2) == medium && M(3) && M(1) == low)
Next Green phase = 2;
Else if (M(2) && M(3) && M(1) == low)
Next Green phase = 2;
Else if (M(2) < high && M(3) == high && M(1) == low||high||medium)
Next Green phase = 3;
Else if (M(2) ==low && M(3) == medium && M(1) < high)
Next Green phase = 3;
Else if (M(2) < high && M(3)< high && M(1) == high)
Next Green phase = 1;
Else if (M(2) && M(3) == low && M(1) == medium)
Next Green phase = E;

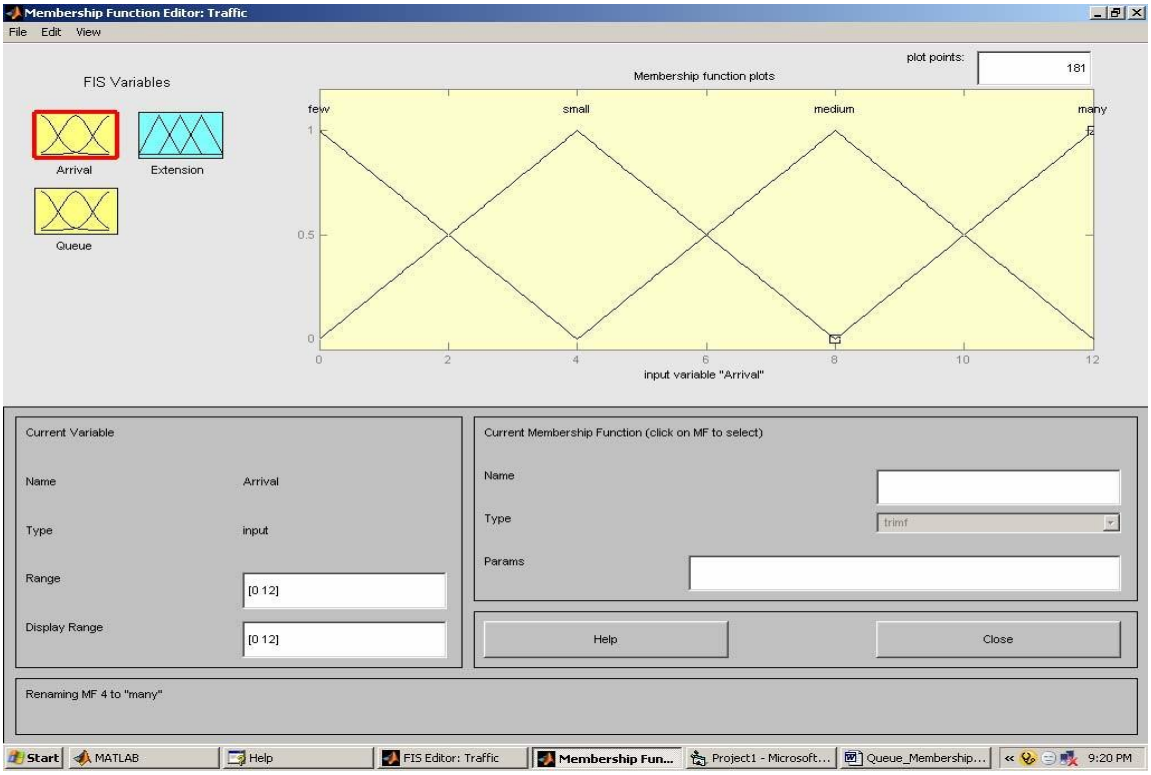


Figure 5.1: Fuzzy logic on input variable

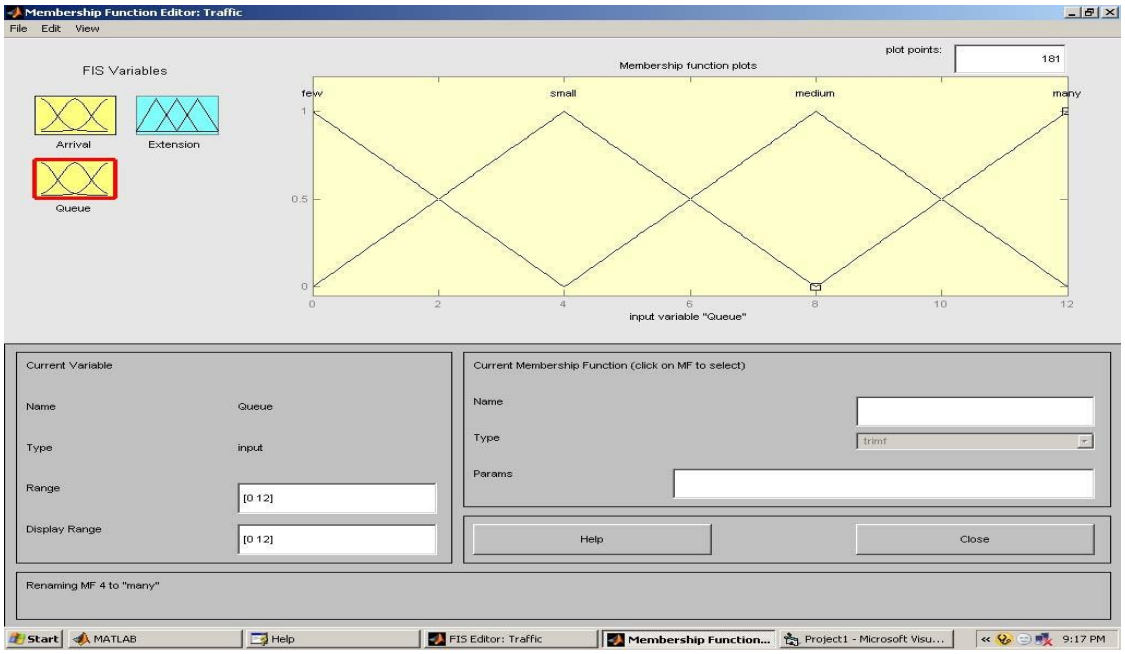


Figure 5.2: Fuzzy logic on queue variable

5.2.2 Using data set for IoT based smart parking system

1. All nearest available parking system:

There is some parameters related to our advance parking system with which proposed solution will work perfectly, please refer below:

Reachable by Walk: Walking distance is distance which can be calculated from start point (initial driver location) to the parking area location (destination), we used walking distance for customer's satisfactions as everyone wants to park their vehicle nearby their location.

Find out the traffic load: Pre-reservation for parking lot already provided after putting many constraints in mind like delay in traffic. We make our proposed solution as advance as possible and performance wise result is also good. Our proposed solution of parking has been simulated and related data is shown in the next section.

Blindly Searching: With the help of our proposed solution free parking lot will be notify to the driver firstly to avoid any kind of delay in last moment. Driver can pre-reserve their available parking lot otherwise driver have to again start searching of the parking and there was a chance of risk for availability.

Shared Parking Information (SPI): As we know drivers also share the vacant parking lot to others so for solving this kind of problem, provided solution with method for Current availability of parking so that everyone can save their crucial time on main time.

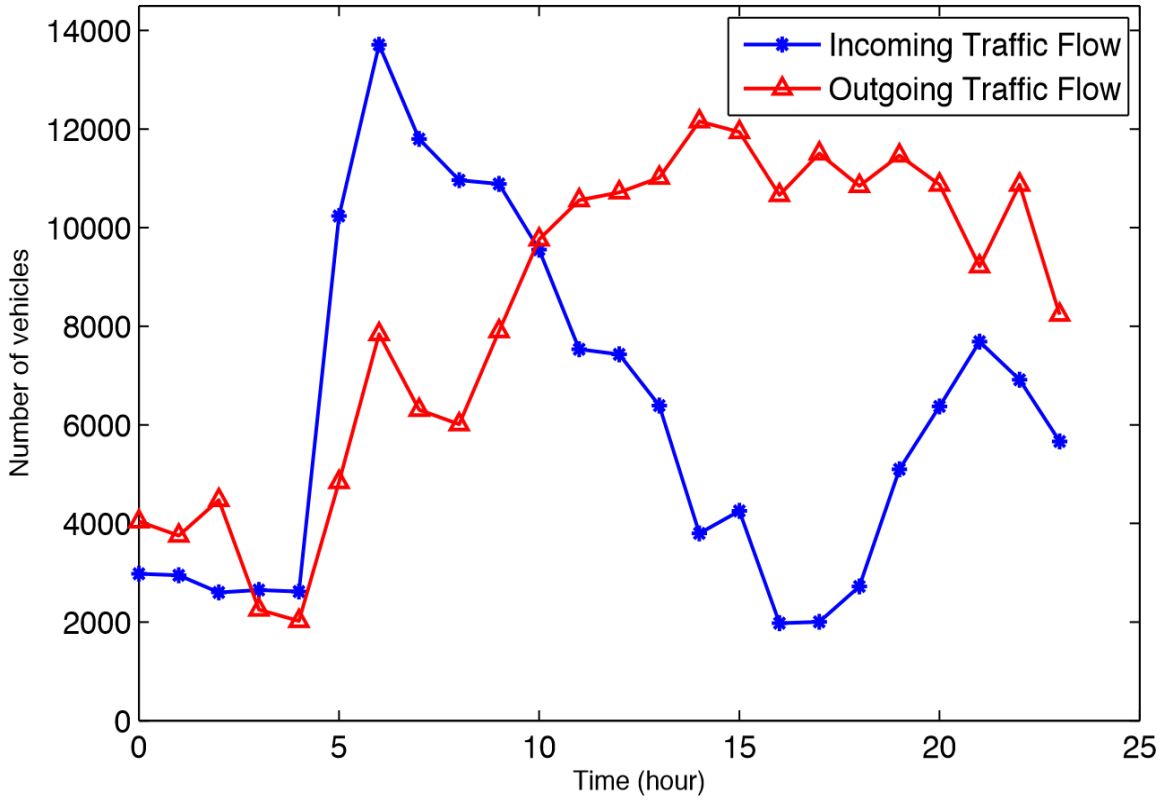
Buffered SPI (BSPI): As we know at the peak time, parking load increasing so for solving this type of problem or we can say for solving SPI problem this method came to the picture. In this approach some parking saved in backup for peak hours but parking will show it's full with this solution we can reduce the traffic load as well.

Randomly we checked some data related to peak hours and observe in morning from 7~10 and in evening from 4~6 more traffic occurs. In some cases like any festival, games etc also increase the traffic in this case BSPI is very useful.

Table 5.3: Data of traffic on different-2 roads for some days

Dated	Road Name	6 ~10 AM	10 ~2 PM	2 ~5 PM	5~9 PM	9~6AM
01-May-18	X	High	Mediam	Low	High	Low
02-May-18	X	High	Mediam	Low	High	Low
03-May-18	X	High	Mediam	Mediam	High	Low
04-May-18	X	High	Mediam	Low	High	Low
05-May-18	Y	Mediam	Low	Low	Low	Low
06-May-18	Z	Low	Low	Low	Low	Low
07-May-18	Y	High	Mediam	Low	High	Low
08-May-18	Y	High	High	Low	High	Low
09-May-18	Y	High	Mediam	Low	High	Low
10-May-18	X	High	Mediam	Low	High	Low
11-May-18	X	High	Mediam	Low	High	Low
12-May-18	X	Mediam	Low	Low	Mediam	Low
13-May-18	X	Low	Low	Low	Low	Low
14-May-18	Y	High	Mediam	Low	High	Low
15-May-18	Y	High	Mediam	Low	High	Low
Average		**High**	Mediam	Low	**High**	Low

Traffic on date 1st May 18



Traffic on date 15th May 18

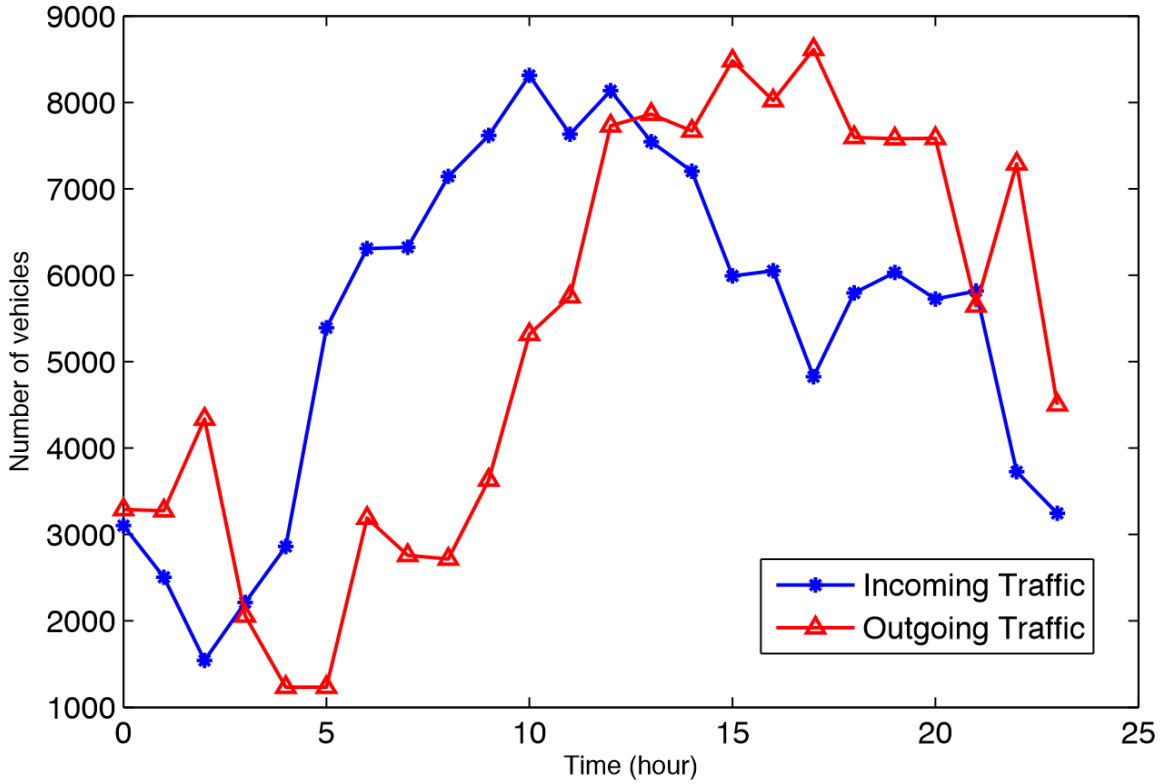


Figure 5.3: In & Out traffic for city

2. For inside parking system:

We simulated a program in C++. We provided LNP number as input (Vehicles number after detection). After detection of number plate, this program checked in DB that if an already reserve slot X, then it provided direction to reach X. If in case of new entry, provided new available slot Y & direction.

In case of exits, it navigated via shortest path to exits gate and again detect LNP & generated bill according to time.

Table 5.4: Data storage for entry and exit

Entry DB					
LNP Number	Is reservered	Slot number	current time	Booking entry time	Entry time (G)
Exits DB					
LNP Number	Is reserverd	Current exits time	Booking exits time	Exist Time (S)	Billing time = G-S

5.3. RESULT

5.3.1 Result for License number plate: Here we checked till before gradient convergence (As per our algorithm changes). Below are some samples of images.

Image 1: Checked for taken image in day time

Image 2: Checked for taken image in night time

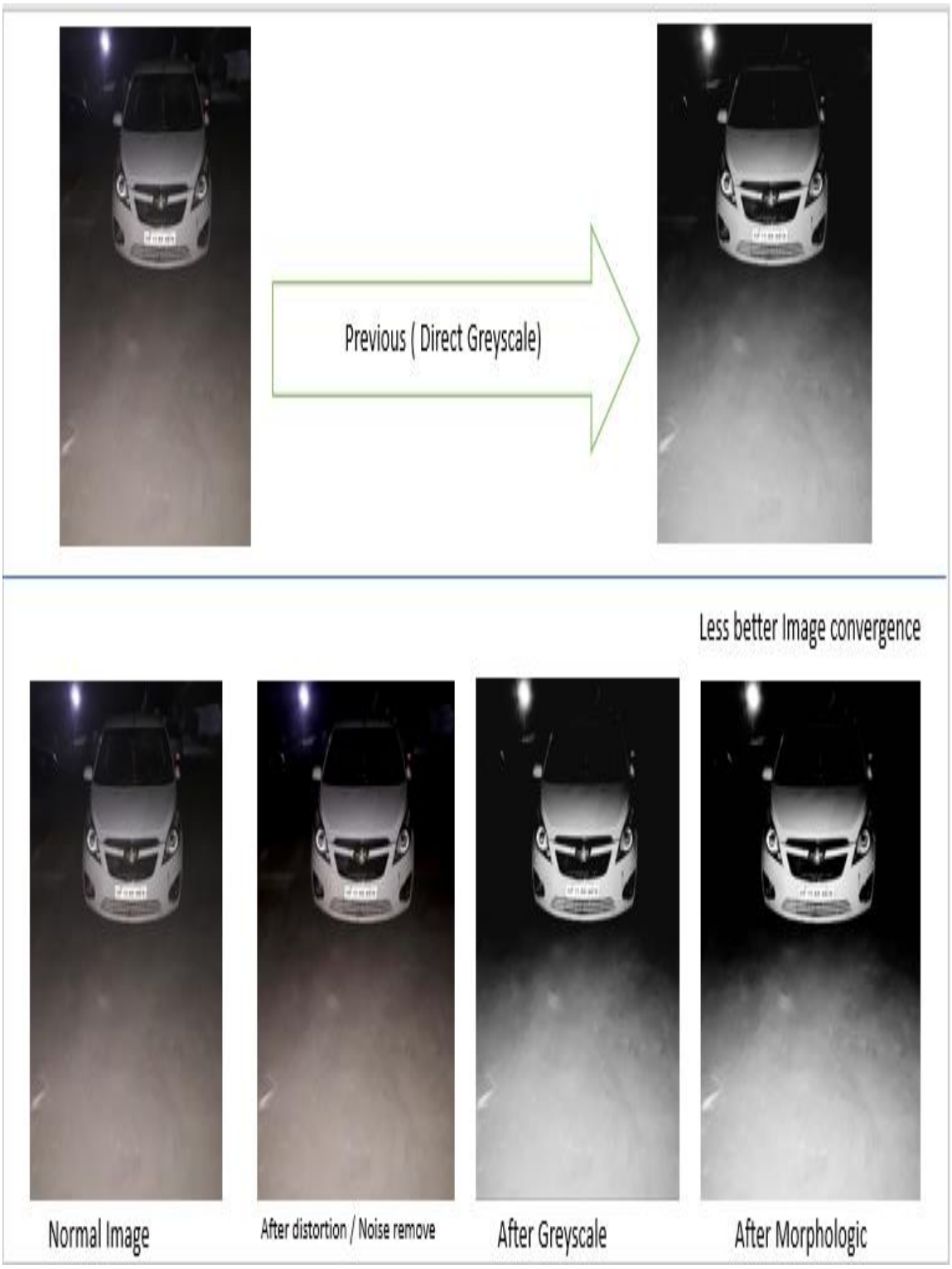


Image 3: Checked for taken image from heights

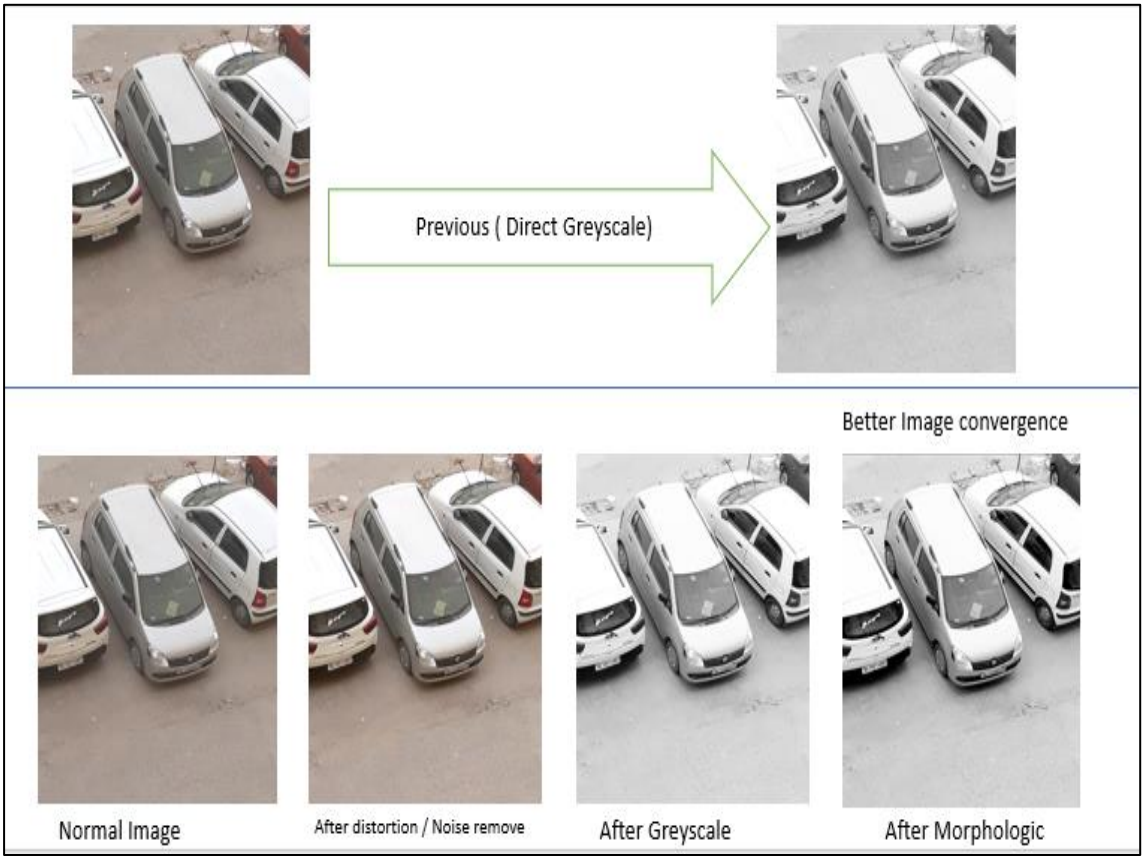


Figure 5.4: Applying proposed algorithm in different images

Result analysis:

Table 5.5: Comparison between proposed and existing detection techniques

Comparision		Image Quality		Image Size	
Image Name	**Type**	**Proposed**	**Already exits**	**Proposed**	**Already exits**
Image1	Daylight	Good	Poor	554 KB	656 KB
Image2	Night Light	Average	Poor	740 KB	4.46 MB
Image3	Height	Good	Average	1711 KB	3320 KB

As per result analysis, our proposed enhancement in algorithm given better Image quality in less size. It provided best result after implementation this change in existence algorithm. Also, this enhancement was already proved in other research paper [4][5][6][7] with separate operation. We have merged all and implement in paper [3] and found that result was good.

5.3.2 Result set for traffic management for intersection

Displaying a traffic intersection simulation in MATLAB environment. As below:

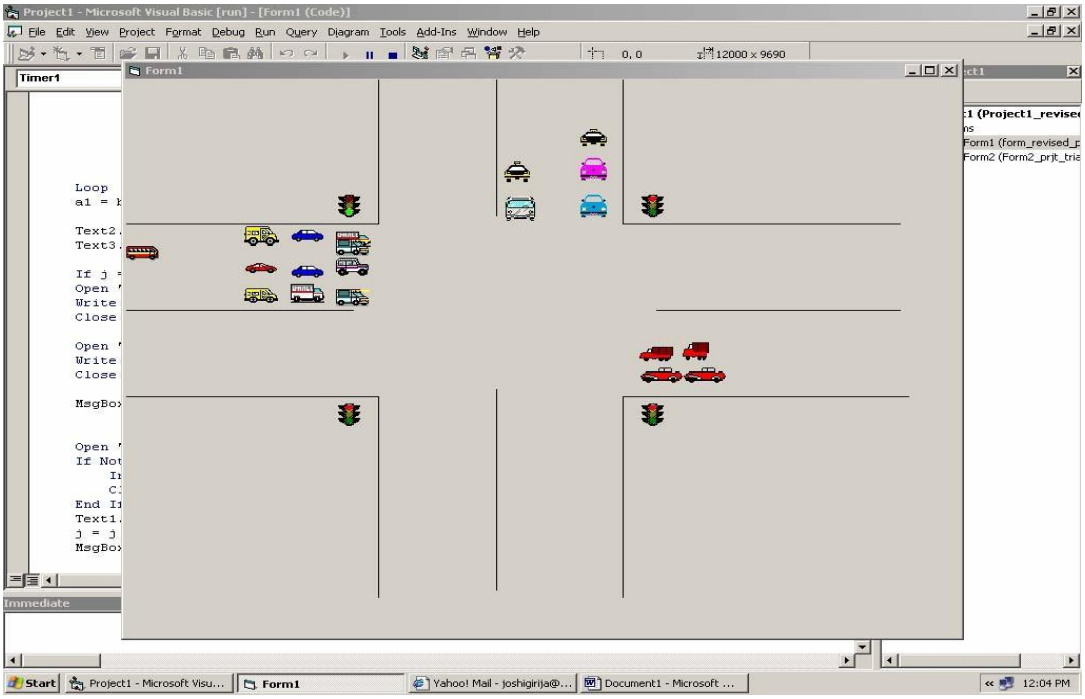


Figure 5.5: Simulation of traffic intersection

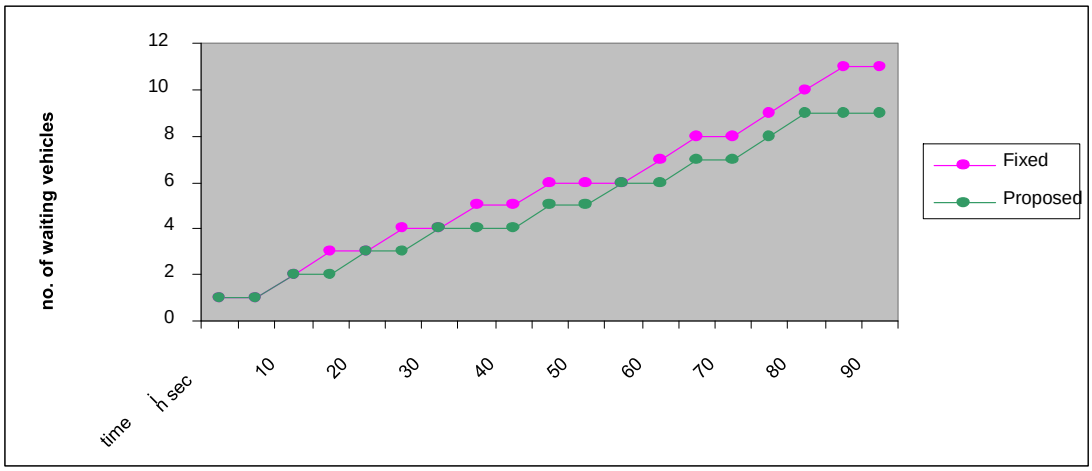


Figure 5.6: Graph showing compression between Fixed and Proposed system

As per graph, as per result the proposed system was more effective than normal fixed system. It provided help to reducing the number of vehicles waiting time. Hence it was a time saving algorithm than fixed normal system.

5.3.3 Result for proposed parking system

1. For parking system in city:

Traffic Searching for parking with used of proposed technique:

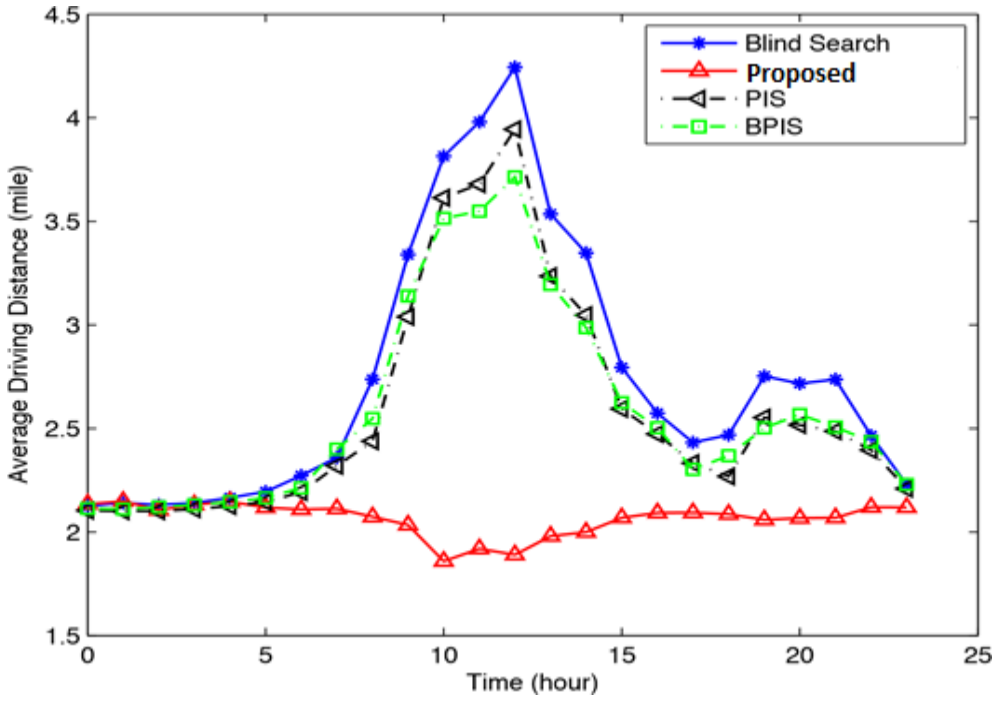


Figure 5.7: Comparison among different traffic searching strategies

Table 5.6: Result comparison between Proposed system and other systems

Average Distance (In Mile)	6AM to 10 AM	10 AM to 5 PM	5 PM to 9 PM
Blind Search	Worst	Average	Worst
PIS	Worst	Average	Average
BPIS	Average	Average	Average
Proposed	Best	Best	Best

Here, result was best for proposed system during the peak hours also. This approach is more better than PIS and BPIS also.

2. From Parking Lot to Exit:

Input: We used C++ for simulation and after finding the shortest path to parking lot below algorithm used for shortest path to exit.

TC: 1

Dimension of parking space (K*L): 10 10

Parking area: R- Road & P-Parking, Entry (1, 1) & Exit (K, 1) & (K, L), Entry denoted by -1, Exit denote by -2

R P P P P P P P P R
R R R R R R R R R R
R P P P P P P P P R
R P P P P P P P P R
R R R R R R R R R R
R P P P P P P P P R
R R R R R R R R R R
R P P P P P P P P R

Number of trails: 5

1 45878 (LNP Number)

1 23564

1 4781

2 23564

1 7894

Output:

After simulation of this system inside parking, we have found Navigation of car inside parking and time difference (in second) for bill generation.

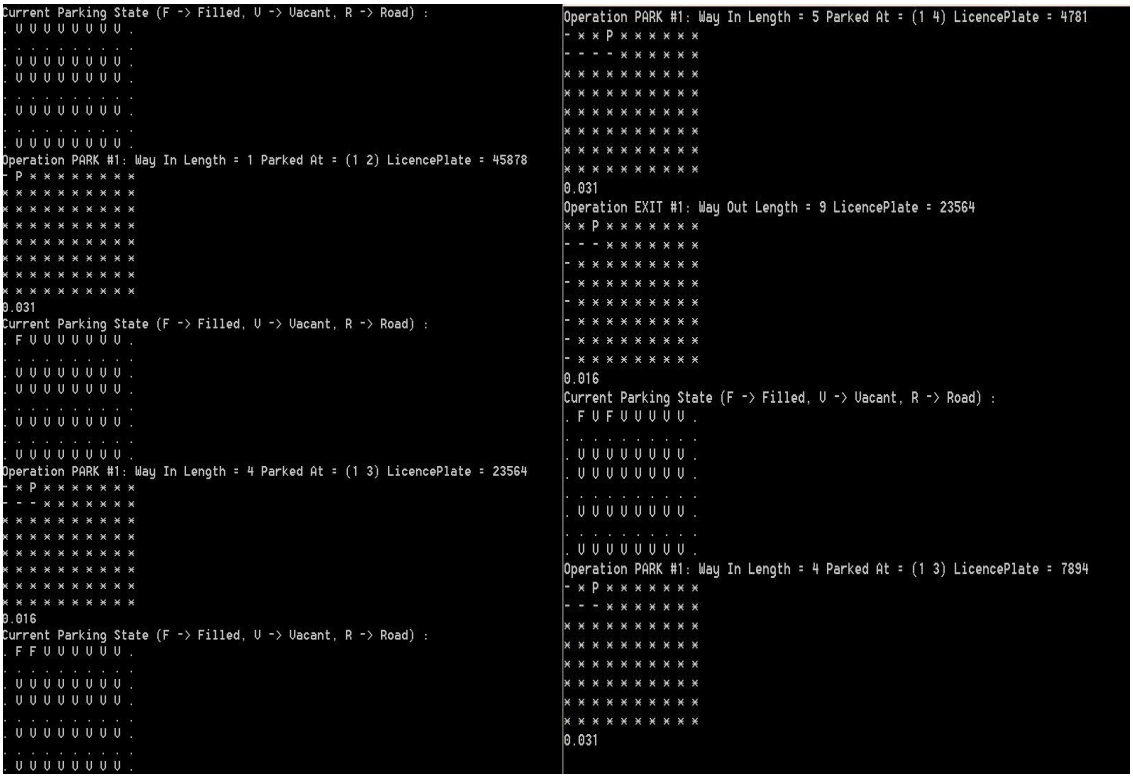


Figure 5.8: Simulation result of inside parking system

Source Code for Parking System (Inside Parking system)

```
// Due to few time difference beginning and start time will be the same. This is not a case in real time scenario.

#include<iostream>

#include<queue>

#include<ctime>

#include <functional>


using namespace std;

#define MAXN 1005


// 1. 1 Entry (1, 1)

// 2. 2 Exits (N, 1) (N, M)
```

```
char parkingLot[MAXN][MAXN];
bool visited[MAXN][MAXN];
int pathTraverse[MAXN][MAXN][2];
char displayPath[MAXN][MAXN];
char currentParkingState[MAXN][MAXN];

int N, M;
int dx[] = {0, 1, 0, -1};
int dy[] = {1, 0, -1, 0};

bool isSafe(int x, int y)
{
	if (x >= 1 && x <= N && y >= 1 && y <= M && parkingLot[x][y] == 'R' && !visited[x][y])
		return true;
	return false;
}

// Dijkstra
int Dijkstra(int x, int y, int exitCnt, int exit_X[], int exit_Y[])
{
	priority_queue<pair<int, pair<int, int> >, vector<pair<int, pair<int, int> > >, greater<pair<int, pair<int, int> > > > pq;
	pq.push(make_pair(0, make_pair(x, y)));
	pathTraverse[x][y][0] = x;
	pathTraverse[x][y][1] = y;
```

```
visited[x][y] = true;
int cnt, exit_x, exit_y;
bool flag = false;
while (!pq.empty())
{
	pair<int, pair<int, int> > presentAt = pq.top();
	pq.pop();
	int p = presentAt.second.first;
	int q = presentAt.second.second;
	flag = false;
	for (int i = 0; i < exitCnt; i++)
	{
		if ((p == exit_X[i] && q == exit_Y[i]))
		{
			//cout << "P = " << p << " exit_X[i] = " << exit_X[i] << " q = " << q << " exit_Y[i] = " << exit_Y[i] << endl;
			cnt = presentAt.first;
			exit_x = p;
			exit_y = q;
			flag = true;
			break;
		}
	}
	if (flag)
		break;
	for (int i = 0; i < 4; i++)
	{
```

```
                int _x = p + dx[i];
                int _y = q + dy[i];

                if (isSafe(_x, _y))
                {
                        visited[_x][_y] = true;
                        pathTraverse[_x][_y][0] = p;
                        pathTraverse[_x][_y][1] = q;
                        pq.push(make_pair(presentAt.first + 1,
make_pair(_x, _y)));
                }
        }

        while (!pq.empty())
                pq.pop();

        while (!(exit_x == pathTraverse[exit_x][exit_y][0] && exit_y ==
pathTraverse[exit_x][exit_y][1]))
        {
                displayPath[exit_x][exit_y] = '-';
                int tmp_x = exit_x;
                exit_x = pathTraverse[exit_x][exit_y][0];
                exit_y = pathTraverse[tmp_x][exit_y][1];
        }

        return cnt;
```

```
}

enum CMD
{
	PARK = 1,
	EXIT
};
#define MAXN 100005

int hshCarToGrid[MAXN][2];

int main()
{
	int T;
	freopen("input.txt", "r", stdin);
	freopen("output.txt", "w", stdout);
	cin >> T;
	for (int t = 1; t <= T; t++)
	{
		cin >> N >> M;
		for (int i = 1; i <= N; i++)
		{
			for (int j = 1; j <= M; j++)
			{
				cin >> parkingLot[i][j];
				if (parkingLot[i][j] == 'P')
```

```
                    currentParkingState[i][j] = 'V';
                else
                    currentParkingState[i][j] = '.';
                visited[i][j] = false;
                pathTraverse[i][j][0] = -1;
                pathTraverse[i][j][1] = -1;
                displayPath[i][j] = '*';
            }
    }
    int operation;
    cin >> operation;
    for (int z = 1; z <= operation; z++)
    {
        int car_x, car_y;
        int wayOutLen, wayInLen;
        int cmd;
        cin >> cmd;
        int exit_X[2], exit_Y[2], exitCnt, licencePlate;
        // licencePlate No should be less than 10^5
        bool flag;
        clock_t begin_time, end_time;
        time_t b_time, e_time;
        char *buffer;
        switch (cmd)
        {
        case EXIT:
```

```
                    begin_time = clock();
                    b_time = time(0);
                    buffer = ctime(&b_time);

                    cin >> licencePlate;
                    car_x = hshCarToGrid[licencePlate][0];
                    car_y = hshCarToGrid[licencePlate][1];

                    exit_X[0] = N; exit_Y[0] = 1;
                    exit_X[1] = N; exit_Y[1] = M;
                    exitCnt = 2;
                    wayOutLen = Dijkstra(car_x, car_y, exitCnt,
exit_X, exit_Y);
                    cout << "Operation EXIT #" << t << ": Way Out
Length = " << wayOutLen << " LicencePlate = " << licencePlate <<endl;
                    displayPath[car_x][car_y] = 'P';
                    currentParkingState[car_x][car_y] = 'V';
                    // Trace the output path
                    for (int i = 1; i <= N; i++)
                    {
                        for (int j = 1; j <= M; j++)
                        {
                            cout << displayPath[i][j] << " ";
                            visited[i][j] = false;
                            displayPath[i][j] = '*';
                        }
                        cout << endl;
```

```
                }
                end_time = clock();
                e_time = time(0);
                buffer = ctime(&e_time);

                cout << float(clock() - begin_time) /
CLOCKS_PER_SEC << endl;;
                break;
            case PARK:
                begin_time = clock();
                b_time = time(0);
                buffer = ctime(&b_time);
                cin >> licencePlate;

                cout << "Current Parking State (F -> Filled, V ->
Vacant, R -> Road) :" << endl;
                flag = true;
                for (int i = 1; i <= N; i++)
                {
                    for (int j = 1; j <= M; j++)
                    {
                        cout << currentParkingState[i][j]
<< " ";
                        if (flag &&
currentParkingState[i][j] == 'V')
                        {
                            car_x = i;
                            car_y = j;
```

```
                                        flag = false;
                                    }
                                }
                                cout << endl;
                            }
                            hshCarToGrid[licencePlate][0] = car_x;
                            hshCarToGrid[licencePlate][1] = car_y;

                            exit_X[0] = 1; exit_Y[0] = 1;
                            exitCnt = 1;
                            wayInLen = Dijkstra(car_x, car_y, exitCnt,
exit_X, exit_Y);
                            cout << "Operation PARK #" << t << ": Way In
Length = " << wayInLen << " Parked At = (" << car_x << " " << car_y << ")"
<< " LicencePlate = " << licencePlate<<endl;
                            currentParkingState[car_x][car_y] = 'F';
                            displayPath[car_x][car_y] = 'P';

                            for (int i = 1; i <= N; i++)
                            {
                                for (int j = 1; j <= M; j++)
                                {
                                    cout << displayPath[i][j] << " ";
                                    visited[i][j] = false;
                                    displayPath[i][j] = '*';
                                }
                                cout << endl;
                            }
```

```
                    end_time = clock();
                    e_time = time(0);
                    buffer = ctime(&e_time);

                    cout << float(clock() - begin_time) /
CLOCKS_PER_SEC << endl;;
                    break;
                default:
                    break;
                }
            }
        }
        return 0;
}
```

CHAPTER 6: CONCLUSION & FUTURE WORK

In our busy life the smart city idea will always be helpful. Now, everyone is looking for the smart things and many research is also ongoing on how to make things smarter. Artificial intelligence, cloud computing and internet of things provided the solution for smart things.

For making our city as smart we have to first resolve our problems related to traffic and parking so in our research we mainly focus on the traffic system and parking system. We provided solution for both parking and traffic system with the help of the internet of things, artificial intelligence and cloud computing. Provided solution for parking is very unique and efficient as we can book available parking lot from our home using website or mobile application. Provided solution will be more efficient which will be save time as well as fuel of the customer. Technique used for detecting license plate is also more efficient and it will work in any kind of environment.

In the field of traffic management, our proposed technique (AI – Fuzzy and IoT – sensors system), provided more real traffic data and help to save time in intersection in a smart way.

Scope in Future

As we know we are saving all the data related to customer's identification on cloud so we can also use that cloud data for customer's identification on different-2 parking systems. Below are the some points of future enhancement:

Security: we can encrypt data in symmetric manner for hiding the information of the users. We can apply security algorithm between the users and service provider.

Privacy: We can use a technique virtual identifier for maintain the privacy of the users.

License Plate No: We can also make license plate no smart with the help of the sensors so that we can provide the information of the users at any kind of emergency. IoT can also be use.

References

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