

# RFID and Camera-based Hybrid Approach to Track Vehicle within Campus

Dileep Kumar<sup>1</sup>, Pankaj Pratap Singh<sup>2</sup> and Shirshu varma<sup>3</sup>

Department of Information Technology  
Indian Institute of Information Technology, Allahabad, India

**Abstract:** License plate recognition system can play an important role to monitoring the vehicle, in Campus like parliament house or premises places in India. There could be some unidentified vehicle, because campus can't restrict them all. So, securities issues could occur. So the main targetable area in this vehicle tracking system is License plate recognition. For this purpose RFID Tag and cameras system could resolve the problem with the help of License Plate recognition system. Vehicle can be susceptible to their unidentified plate number. In addition, human resource is not possible to checkout every vehicle, so even a few susceptible persons can easily entered in building via vehicles and damages the building in sense of casuality to the people. Therefore, a Vehicle tracking system using RFID Tag base and Camera scheme is necessary to distinguish illegal vehicle from legal ones, and filter out unregistered vehicle in the building.

**Keywords:** Campus or premises Location, RFID Tag and Reader, Camera, Vehicle Detection system, License plate recognition, Vehicle tracking system.

## 1. Introduction

License Plate recognition (LPR) system is a key to many traffic related applications such as road traffic monitoring or parking lots access control. Terrorist in December 2001 attacked on Indian parliament, many people killed in that incident. The suspected terrorists dressed in commando fatigues entered Parliament in a car through the VIP gate of the building. Displaying Parliament and Home Ministry security stickers, the vehicle entered the Parliament premise. There is no security system that could recognise and authenticate the car.

Like parliament there are many premises in India that are not secure. Many vehicles go in and out but no system is there to keep watch on them. If it's a premier educational organisation definitely there will be thousands of student's vehicles. So how can be check out them all with human resources, so ultimately some tracking system should be required to fulfill this requirement. In this paper we acquaint a system that capitalized use of camera and Radio Frequency Identification (RFID) tag based approach to track vehicles and their activities within the campus.

The main Goal of the system is to identify all the vehicles that are visiting to the campus and to track vehicles and their activities within the campus. This paper is organized in various sections as, Section 2 describes about the Problem definition, and Section 3 describes some related work. In section 4 we have proposed plan of work with architecture and design of a proposed campus vehicle tracking system scheme finally in section 5 analyzes the Results, Section 6 remarks conclusion of this work.

## 2. Problem Definition

---

Corresponding author. Tel.: +09568265578  
E-mail address: iis2006007@iiita.ac.in.

The idea comes in mind after some essential incident, motivation behind this work arrived after the terrorist attack on Indian parliament where number of people were killed in this incident due to lack of security system that could recognise and authenticate the car. The basic problem is how to design an automated system that should be able to detect vehicle within few circumstances:

- a) Designing and implementing License Plate Recognition System.
- b) Designing of Wireless network with the help of wired network to track the vehicle in the campus.

Problem definition in details and possible solutions and sub systems of the project

- **Vehicle Detection System** (VDS) and **License Plate Recognition System** (LPR) for recognising all the vehicles visiting to the campus
- **Tracking system incorporated with a network of RFID and camera** to track the vehicles and their activities within the campus

## 2.1. Vehicle Detection System

Vehicle Detection System mainly captures a picture of vehicle running within the campus and detects while moving, captured images further used for various purposes as given below

- It will be used by License Recognition Plate subsystem for extraction of vehicle number.
- The number will be stored with the timestamp and will be used as proof in case of security breach against the vehicle owner.

## 2.2. License Plate Recognition System

The main purpose of License plate Recognition is to process the picture taken by the VDS system and extracts the registration number of vehicle on license plate. The registration number of the vehicle is unique identity of the vehicle.

## 2.3. Tracking System

Tracking system incorporated with a network of Radio Frequency Identification (RFID) and camera to track the vehicles and their activities within the campus. The RFID tag containing a unique authentication code is attached to the vehicle at entrance of the campus.

For tracking the vehicle, the entire campus is divided into small regions, where every region is enabled with RFID at some crucial locations camera is also installed for surveillance purpose.

On the other hand, of course, as the RFID reader operates maliciously or inconsistently, they will get lower trust values.

## 3. Related Work

There are many literatures on the object extraction and recognition. The Guidelines provided by the author Groft Eric, Andrews Kirby, Kuff Howard in their patent are really useful in getting the idea of the License plate recognition system and tracking system [1].

The techniques explained by the K.B.M.R. Batuwita, G.E.M.D.C. Bandara in their technical paper Fuzzy Recognition of offline Handwritten Numeric are really useful in extracting the essential feature of the number and character both in order to recognize them [3]. Every character has some features that make it unique but identifying such features is really tedious for recognition of the character in the number plate because character recognition is NP hard computational problem due to variability of someone's calligraphy over time, the similarity among the characters, infinite variety of shapes and infinite variety of writing styles produced by different writers.

The characters contain many redundant information and makes learning slow, it is computationally expensive so researchers proposed a new method in which only essential features of the characters were extracted and used to recognize it, it made the learning faster[3]. Some of the features of character are horizontal line, vertical line, left oblique line, right oblique line, curve shapes and the hole from the image (Euler number) [3]. many literatures suggest that these features are not sufficient to recognize a character as mapping between feature space and pattern space is difficult to establish.

It further can be generalized as the merely presence of lines, curves and intersection can themselves can not recognize a character but the temporal information as shown in table 1, i.e. the sequence in which they appeared make them uniquely recognizable [7].

One the other hand few other techniques like Statistical approaches, structural approaches, neural network approaches, and recently support vector machine (SVM) have all been well studied on this problem. Each method has its pros and cons. Statistical approaches are simple but not very accurate. Neural network approach is good in learning, capturing features and their generalization. The neural network is also good at handling inaccurate, incomplete and imprecise information [6].

TABLE 1 MEANINGFUL FEATURES IN CHARACTERS

Meaningful Straight Lines		Meaningful Arcs	
Horizontal Line		C like	
Vertical Line		D like	
Positive Slanted		U like	
Negative Slanted		A like	
		O like	

So keeping all these things in mind new algorithm will be designed that not only consider static as well as temporal information. Besides these, the tutorial provided on socket programming was really useful in order to understand the socket programming that will be used in designing tracking system[10][11].

#### 4. Plan of Work

Initially the attention will be focused on the development of the vehicle detection system and the license plate recognition system and then tracking system.

##### 4.1. VDS and License Plate Recognition System

The VDS and LPR systems are installed at the Campus entry Gate as shown in figure (1). VDS and LPR system at the Gate are used to grant access to the vehicle in the campus. The central system will have list of all allowed vehicle in the campus like the college Bus, Faculty and student vehicle etc. It will allow access to them. Whenever any external vehicle comes at the Gate of the campus, the system will help security person to notify about the same. Then a RFID tag containing unique number is issued to the vehicle, now that vehicle is tracked with the help of unique number in tag and vehicle number using tracking system as shown below.

##### 4.2 Architecture of the Tracking System

As shown in figure (2), the system consists of multiple nodes, for every node there is a RFID reader. This network of RFID reader will be useful to track the vehicle within the campus.

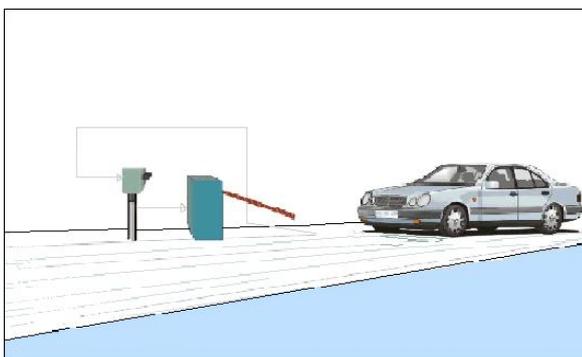


Figure 1: VDS and License Plate Recognition system

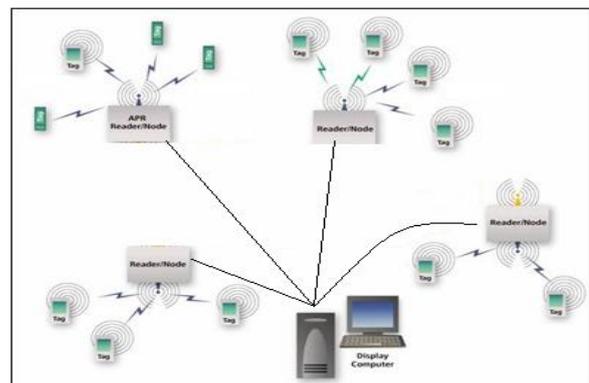


Figure 2: Architecture of the tracking system

### 4.3 Detailed Design of License Plate Recognition System

The main aim of the License plate recognition system is to extract the region containing the license plate in the captured image. This extracted region is processed by the number recognition system to recognize the license plate registration unique number of the vehicle. The original image initially processed in the RGB color space. On the original image initially white color filter is used and all the objects white in color are extracted. All these objects are then tested against the features of the license plate in order to extract only the region of the image containing only license plate.

The properties of the license plate under consideration with some limitations are as follows

- The license plate should be rectangular in shape.
- The expected area in the image containing vehicle and license plate (upper bound and lower bound etc. for area).
- The license plate must be white in color.
- The license plate contains black letters only.

The extracted number is then recognized using recognition system whose details are given below.

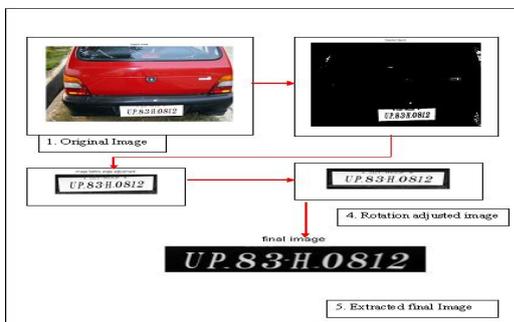


Figure 3: process showing extraction of the number

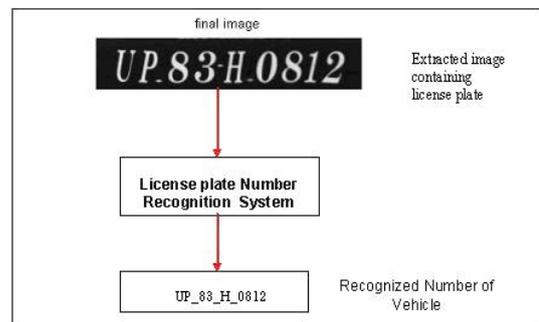


Figure 4: Recognition of the License Plate number

### 4.4 Detailed design of the Recognition System

The sub components of the proposed system are as follows

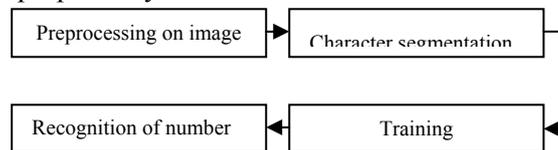


Figure 5: Sub Components of proposed system

#### 4.4.1 Preprocessing of the Image

The first phase in our character recognition system is Thresholding i.e. to convert the text image to Binary. Binary images are images whose pixels have only two possible intensity values. They are normally displayed as Black and White. The converted Character image has pixel value zero for Black and one for white. Thus the color of the character is White and the background is black.

Once this is done the image is further processed with image dilation operator in order to fill redundant gaps. The third Phase is getting the Skeleton image from the dilated image by using the Thinning Algorithms.

#### 4.4.2 Character Segmentation

The character segmentation is done using standard character segmentation algorithm.

#### 4.4.3 Feature Extraction

The feature extraction process involves extracting features like Horizontal line, vertical line, Right slant line, Left slant line, curve and Hole from the thinned image.

Generally the compass operators are used to find out the horizontal, vertical and slant edges in the letter. The problem with this technique is that lines should exactly horizontal (0 degree), vertical (90 degree) and inclined to -45 and 45 degrees. In real scenario such conditions can not be met. So getting exactly horizontal lines, vertical lines and slant lines is difficult.

#### 4.4.4 Enhanced Feature Extraction Method

The enhanced feature extraction algorithm will traverse through the characters to find the hidden features listed in table 1. The feature will be weighted as per their order of appearance so as to consider the temporal information and all the weights are normalized within the range  $[-1 \ 1]$ . The  $-1$  represents the absence of feature while  $0$  and  $1$  represents the “don’t know situation” and “presence of the feature” respectively. For example the enhanced feature extraction algorithm will extract the features like almost vertical line followed by almost round shaped object for character ‘b’ in the figure. The character ‘b’ and ‘d’ have same features but the order they appear make them unique so the order should be considered while extracting feature. The feature that will appear first should have more weight to the features that appear afterwards and that’s the principle on which the enhanced feature extraction algorithm works. The features extracted by an enhanced feature extraction technique are then used to train the Recognition System and finally when the system is trained it can be used to recognize the number plate.

#### 4.4.5 Tracking of Vehicle Using RFID Tag

- With the help of network of RFID reader, the car with RFID tag can be tracked.
- External vehicles will be rigorously tracked from the security point of view.
- RFID tag will also help in surveillance scheduling.

### 5. Result

For recognition system all methods are implemented in MATLAB. Once all vehicles are tracked with the help of RFID Tag, so it’s easy to recognize the license plate from vehicle via methods.

Project work completed in three domains

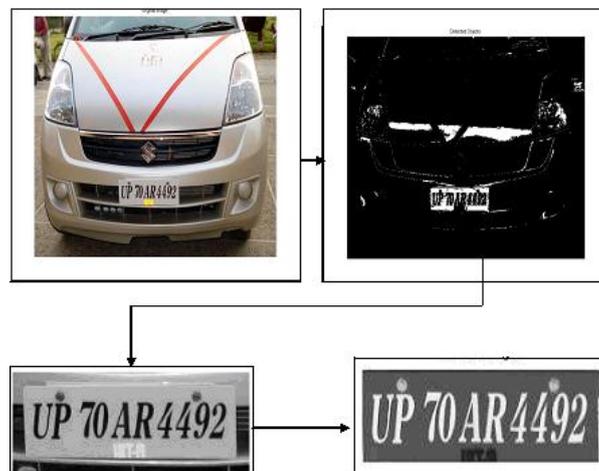
- Development of LPR system in RGB color space.
- Development of Number plate recognition system using neuro fuzzy system.
- Architectural design and implementation of sample back end system for tracking system.

#### 5.1 Results of License Plate Recognition System

Every color in RGB color space is represented by some pixel value like

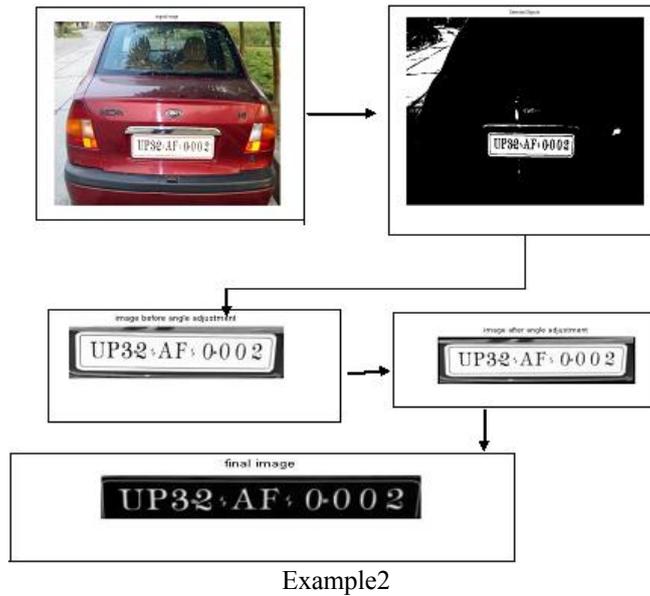
- white has RGB value  $[255 \ 255 \ 255]$
- red has RGB value  $[255 \ 0 \ 0]$
- black has  $[0 \ 0 \ 0]$

Initially reference color is specified with some RGB value and with some deviation. All the objects within this range are extracted. These objects are then tested against region properties in order to extract license plate. The input to the LPR system is RGB image and output is number plate:



Example 1

#### 5.2 Results of Number Recognition System



### 5.3 The Trained Network Is as Follows:

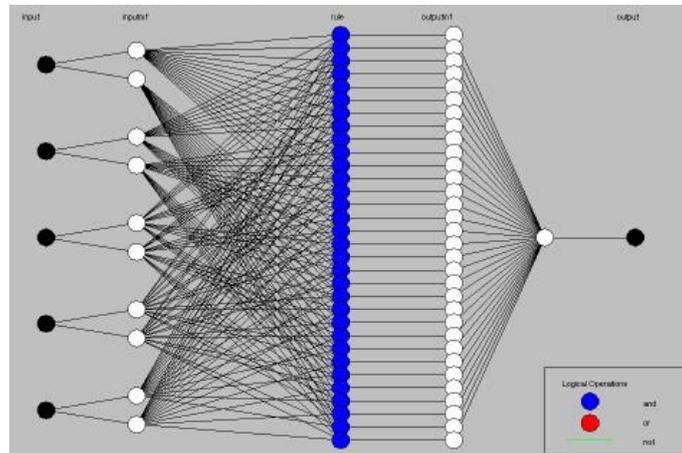
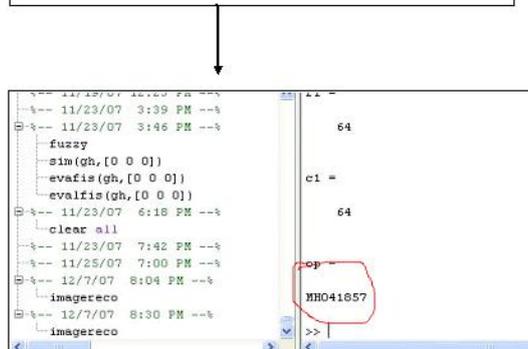
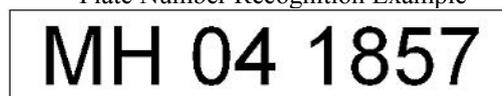


Figure (6) Trained Network

This network is used to recognize the number plate.

Plate Number Recognition Example



## 6. Conclusion

We proposed a campus vehicle tracking system using RFID Tag. As we referred, the security for campus is still in its infancy and there are not clear tracking models which can be applied to campus properly. Our tracking scheme does not employ certification mechanisms, so it is light enough to fit well with campus environment without great overheads. To the best of our knowledge, our approach is one of the incipient

researches on a Vehicle tracking scheme based on RFID Tag, which can detect, all the vehicles in Campus and filter out the unauthorized vehicle of them. We expect that our RFID-based scheme can help to make resilient Security system of Campus like premises places.

## 7. References

- [1] Groft, Eric et al, “Smart meter parking system”; United States Patent 20070016539.
- [2] Timar, G et al, “Analogic preprocessing and segmentation algorithms for off-line handwriting recognition” - Proceedings of the 2002 7th IEEE conference on Cellular Neural Networks and Their Applications, 2002. (CNNA 2002).
- [3] Kamlakannam et. al, “Fast character recognition using expert system”-in proceedings of the Thirty-Seventh Southeastern IEEE Symposium on system theory (ssst-05).
- [4] Batuwita et al, “Fuzzy Recognition of Offline Handwritten Numeric Characters”- IEEE Conference on Cybernetics and Intelligent Systems. 7-9 June 2006.
- [5] Sanparith et al, “A generic approach for on-line handwriting recognition” Ninth International Workshop on Frontiers in Handwriting Recognition, 2004. IWFHR-9 2004
- [6] Hailong Liu and Xiaoqing Ding “Handwritten Character Recognition Using Gradient Feature and Quadratic Classifier with Multiple Discrimination Schemes” in proceedings of Eighth International Conference on Document Analysis and Recognition, 2005.
- [7] Jameel, A. “Experiments with various recurrent neural network architectures for handwritten character recognition” - Sixth International Conference on Tools with Artificial Intelligence, 1994.
- [8] Suen, et, al “Handwriting recognition - the last frontiers”, Proceedings of 15th International Conference on Pattern Recognition (ICPR-2000).
- [9] Zhao, P.; Yasuda, T.; Sato, Y. “Cursivewriter: On-line cursive writing recognition system, 1993., Proceedings of the Second International Conference on Document Analysis and Recognition(ICDAR 1993) Volume, Issue, 20-22 Oct 1993 Page(s):703 - 706
- [10] Hiromichi Fujisawa and Cheng-Lin Liu “Directional pattern matching for character recognition revisited”. Proceedings of Seventh International Conference on document analysis and recognition(ICDAR 2003)
- [11] Ahmed, Sarfraz, Zidouri A.and Alkhatib, W. G. (2003), License plate Recognition System” The Proceedings of The 10th IEEE International Conference n Electronics, Circuits And Systems (ICECS2003), Sharjah, United Arab Emirates (UAE).
- [12] Tsang-Hong Wang, Feng-Chou Ni, Keh-Tsong Li, Yon-Ping Chen, “Robust License Plate Recognition based on Dynamic Projection Warping”, In Proceedings of IEEE International Conference on Networking Sensing & Control,Taiwan, March 21-23, 2004.