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Automated Parking and Security System

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Abstract: This paper focuses on implementing Raspberry Pi based " Automated Parking and Security System", using different technologies based on the developments in Smart Sensors, Image processing and Raspberry Pi- RPI model with their comparative analysis. The research survey includes the current scenario of the Parking Systems incorporating technologies such as Automatic Number Plate Recognition- ANPR, RPI, Wireless sensor network and Wi-Fi based automatic space booking system. The combination of above solutions is considered for designing and implementing an "Automated Parking and Security System", going to be considered as "One Time Investment". The prototype is established on grounds of RPI 3B model, Image Processing - blurring, dilating, eroding, contouring and segmenting of Number Plate and Face Recognition which would resolve the problems faced by existing systems and would satisfy the requirements of an accurate and secured parking system. As a whole, it is a confined user-friendly and easily modifiable for future requirements and applications.

Keywords: Image Processing- Blurring, Dilating, Eroding, Contouring, Segmenting, Face Recognition, Management, Parking, RPI 3b, Security.

I. INTRODUCTION

Current scenario highlights an increase in population leading to increasing in a number of vehicles, due to which, it has become very difficult to manage parking system, especially in offices, institutes and various public places. In India mostly the parking system are human controlled making it a tedious job to record the data of each vehicle. It also weakens the security of the institutes or any other public places. If we look at ways to apply technology to tackle some of the most pressing issues facing our cities today, parking is ripe for innovation. There are few interesting facts: first, 20 min is the average time spent looking for a parking space globally, second, 30% of city traffic consists of people looking for parking, third, and 60% of drivers have given on an activity recently due to the difficulty of finding parking. Therefore there is a need for an "intelligent automated parking system which will manage the record and the security of the system". Several parking systems exist which involve various techniques of automated parking system designed using technologies such as Automatic Number Plate Recognition-ANPR, RFID, RPI, Wireless sensor network and Wi-Fi based automatic space booking system but face certain issues in terms of power, cost, efficiency, speed and other external factors.

The main objective is to overcome the above problem so that these systems can work *faster, accurately with less manpower, user convenience and with less cost of maintenance required*. A system with less manpower costs less and also becomes more accurate as everything is handled by the system. "*Automated Parking and Security System*" is a concept going to be designed in order to provide security and enhance management of a parking system that could be implemented wherever and whenever required.

The automated behavior of any parking system could be achieved on grounds of processors or controller. Among various processors and controllers *"Raspberry Pi Module"* is used for automated control of all operations of the parking system. In addition to ANPR, face recognition techniques will also be used. This creates a complete database for every visitor automatically with user's vehicle number would also help in recognizing the person easily if any problem occurs.

II. LITERATURE SURVEY AND DESIGN ANALYSIS

A. Existing models

Automated vehicle parking system using RFID

"In this RFID is used to detect and match a vehicle's RFID tag already stored in a database. This system completely provides security to one's vehicle". [1]

Design and implementation of smart parking system (SCPS) using raspberry pi

"It refers to the use of computers and information technology to detect the exact parking space in the parking area without wasting any time in search of the vacant places through roaming in the area. It uses raspberry pi, Wi-Fi module, image processing and graphical user interface (GUI)". [2]

Smart parking system based on embedded system and sensor network

"It uses a prototype reservation-based smart parking system (RSPS) that permits drivers to effectively locate and withhold the vacant parking spaces. It uses wireless sensor networks (IR sensors), internet of things, embedded system, reservation, resource allocation, parking guidance and information". [3]

Intelligent parking space detection system based on image processing

"Camera is used as a sensor for video image detection due to its capability and realization cost. It uses edge detection with boundaries condition method for image detecting module". [4]

Raspberry-pi based intelligent vehicle parking system

"A digital system was constructed in this project which used raspberry-pi and onboard computer which will be interfaced with cameras to visualize the blind spots and proximity sensors for obstacle detection. The prototype of the system was implemented on a toy car. The main aim of this model was to solve the problems of parallel and reverse car parking for the beginners as well as intermediate due to the presence of blind spots".[5]

B. Performance Analysis

Table 1: Comparative Performance Analysis of Existing and Proposed Models

Sr No.	Drawbacks in existing Models	Drawbacks overcame in existing models
1	In the first model, Radio Frequency Identification is used to grant entry, but the drawback is if RFID Tags are destroyed or lost, then the entry will not be granted.	In the Proposed model, a completely different approach is used that is instead of RFID, Face recognition is used. So even if the person comes with another car, the entry will be easily provided.
2	In the second model, Wi=Fi module along with GUI is used which is comparatively expensive and if the server goes down then the whole system will stop working.	This model dose does not require Wi-Fi, so there is a guarantee of smooth working and the system becomes cost efficient.
3	In the third and fourth model, reservation feature is available for the user and multilevel parking system is used but the system as a whole becomes complicated and expensive.	To reduce cost, an SSD is used in order to directly display the number of empty spaces.
4	The fifth model is completely based on image processing so the system lacks security.	The model is going to work purely on the grounds of image processing but security is improvised with the use of the concept of ANPR and Face Detection together. Thus, providing a two level security.

The above-given projects are using either RFID, image processing, ANPR, smart cards or raspberry-pi along with WI-FI module based on android and GUI. Going through all these projects, it was observed that any of these projects did not solve both the purposes of security and proper management system. Thus, an "Automated Parking and Security System" a model was proposed.

C. Proposed model

The model "Automated Parking and Security System" which is going to be designed and implemented would include 2 major factors. These factors altogether contribute in establishing desired objectives by enhancing systems performance. Brief descriptions of these factors are given below:

Image processing: It would be used to detect number plate of the vehicle as soon as it has been sensed by an ultrasonic sensor. It involves various functions such as Thus, adopting the principle based on automatic number plate recognition system (ANPR).

Raspberry Pi module: RPI 3B module is basically used for controlling and monitoring the prototype to be implemented, which acts as a master that gives commands to other devices considered as slaves.

D. Block Diagram

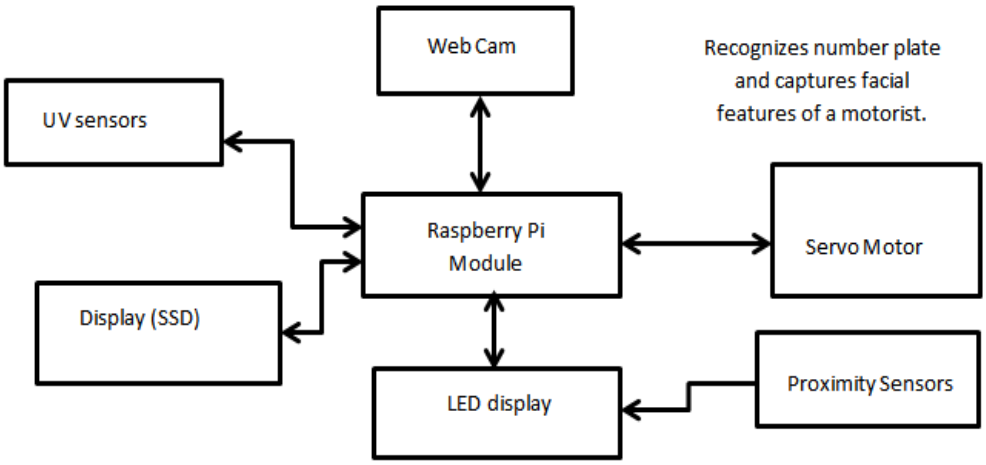

Fig1: Automated Parking and Security System

The block diagram above describes the prototype to be designed. The internal processing is as given below which indicates when and how number plate and Facial features would be detected and whether entry would be granted in comparison with the existing database.

Table 2: List of Components

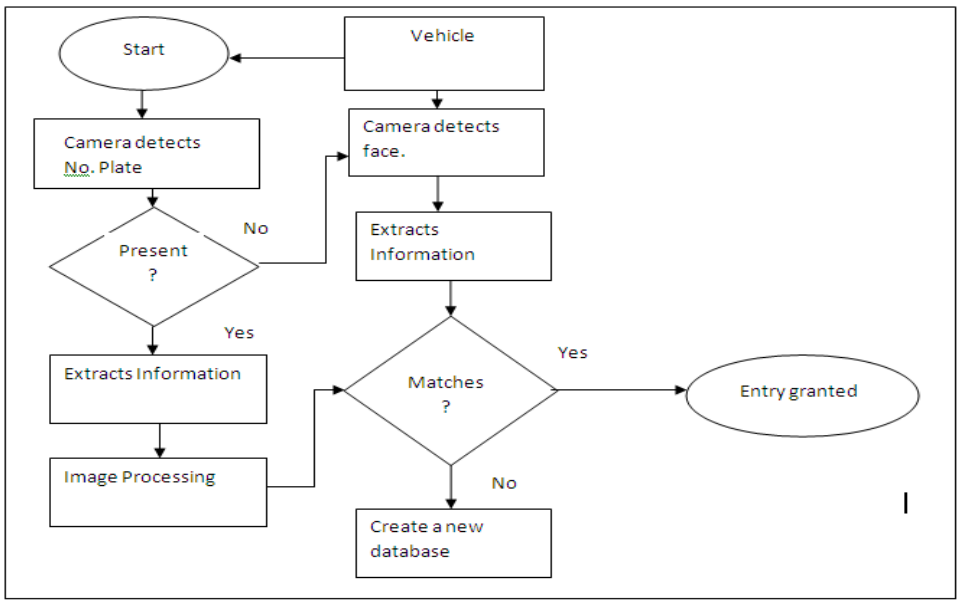

Fig2. Entity Relationship Flow

E. Components

III. DISCUSSION AND PRELIMINARY RESULTS

The system is designed in two phases, starting with phase-I: Image processing where initially, a single number plate was considered for performing various image processing operations, segmenting and storing all characters separately as shown below.

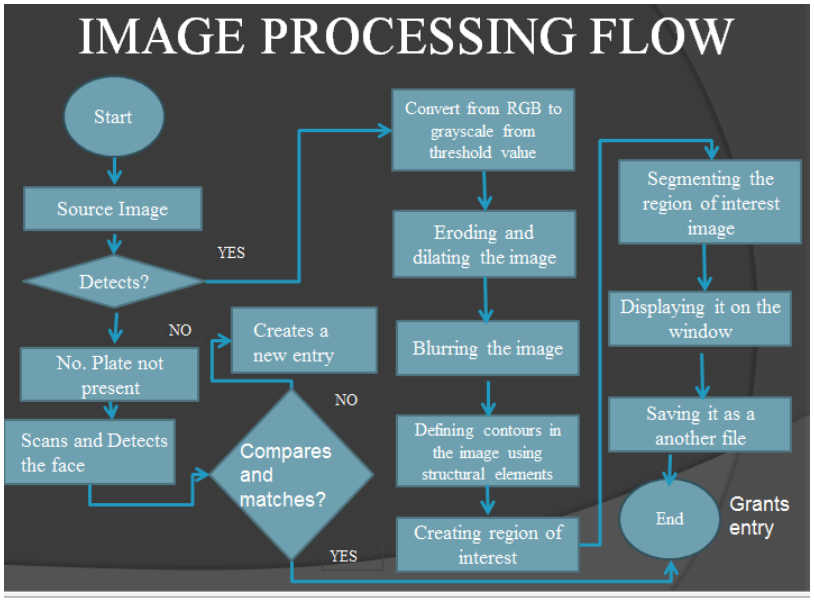

Fig 3: Image Processing Flow Chart

Segmenting and displaying of characters is carried out in steps as follows:
1. Converting RGB image to Grayscale using a threshold value: Here the image is converted from RGB to Grayscale using

$$\mathrm{dst}(x,y) = \max_{(x',y'):\,\mathrm{element}(x',y')\neq 0} \mathrm{src}(x+x', y+y')$$

Sr no.	Component name	Specifications	Quantity
1	Raspberry Pi 3 model B	1.2 Ghz 64-bit quad core atmv8 CPU, 802.11n Wireless LAN, Bluetooth 4.1, Bluetooth Low Energy (BLE), 1GB RAM, 4 USB ports, 40 GPIO pins, Full HDMI ports, Ethernet port, Camera Interface(CSI), Display Interface(DSI), video core IV 3D graphics core, micro SD card slot, combined 3.5 mm audio jack and composite video.	1
2	24 IR night vision camera	CCTV Dome 24 IR Night Vision USB Camera DVR. ARM 9 32-bit microprocessor. Input AC 220/110V. Output 5v/1A. VGA: 640*480. CIF: 352*288 30000 pixel high resolution.	1
3	Servo motors (MG996R)	Operating Speed: 0.17sec or 60 degrees (4.8V no load) 0.13sec or 60 degrees (6.0V no load). Stall Torque: .13 kg-cm (180.5 oz.-in) at 4.8V 15 kg-cm (208.3 oz.-in) at 6V. Operation Voltage: 4.8 - 7.2Volts. Gear Type: All Metal Gears. Bearings: Dual	2
4	Ultrasonic sensors (HC SR04)	Working Voltage: 5V(DC). Static current: Less than 2ma. Output signal: Electric frequency signal, high level 5V, low level 0V. Sensor angle: Not more than 15 degrees. Detection distance : 2cm-450cm. High precision : Up to 2mm. Input trigger signal : 10us TTL impulse. Echo signal : output TTL PWL signal.	2
5	Seven segment display	Common Cathode	3
6	Proximity sensors	Adjustable Range using preset (Using Potentiometer On board). Operating Voltage: 5V DC. Digital Output: logic one (+3.5V DC) logic zero (0V DC). Mounting Hole of 2.5mm diameter for Easy Mounting.	5
7	LEDS	Size 3mm. 1.8-2.2VDC forward drop. Max current: 20ma. Suggested using current: 16-18ma. Luminous Intensity: 150-200mcd	10
8	Resistors	330ohms	10

3. Erosion: As the kernel is scanned over an image, we compute the minimal pixel value overlapped by and replace the image pixel under the anchor point with that minimal value.

$$\mathrm{dst}(x,y) = \min_{(x',y'):\,\mathrm{element}(x',y')\neq 0} \mathrm{src}(x+x',y+y')$$

4. Blurring of Image: Blurs an image using the normalized box filter.

$$K = \frac{1}{\mathrm{ksize.width}*\mathrm{ksize.height}} \begin{bmatrix} 1 & 1 & 1 & \cdots & 1 & 1 \\ 1 & 1 & 1 & \cdots & 1 & 1 \\ & & \cdots\cdots\cdots & & & \\ 1 & 1 & 1 & \cdots & 1 & 1 \end{bmatrix}$$

5. Defining Contours using Structural Elements: The function retrieves contours from the binary image using the algorithm. The contours are a useful tool for shape analysis and object detection and recognition. In mathematical morphology, a structuring element is a shape, used to probe or interact with a given image, with the purpose of drawing conclusions on how this shape fits or misses the shapes in the image. Bounding Rect: Calculates the upright bounding rectangle of a point set.
6. Creating Region of Interest [ROI], Segmenting the ROI Image then Displaying and Saving Separately.

Preliminary Results:

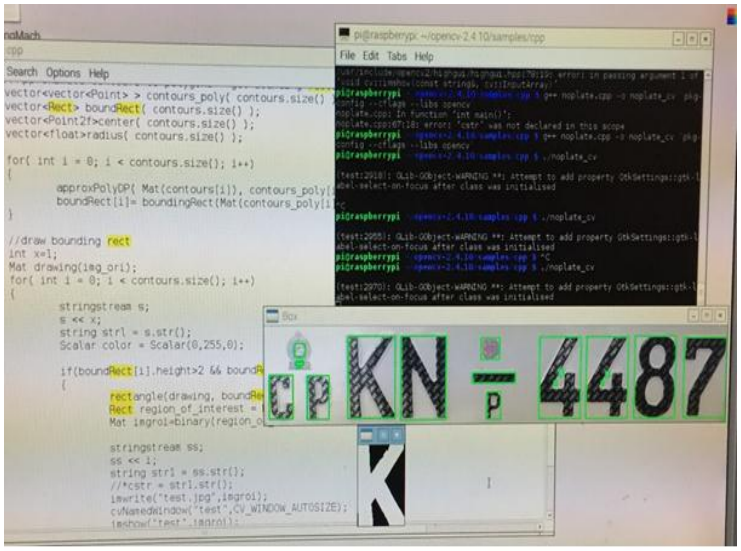

Fig 4: Segmenting of number plate.

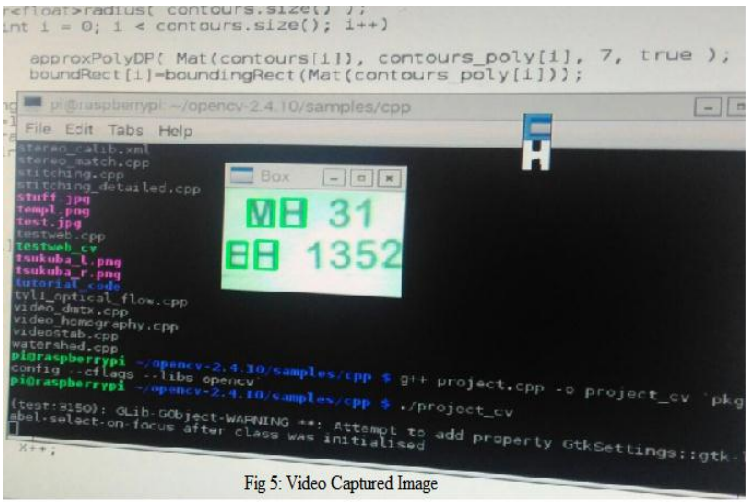

Fig 5: Video Captured Image

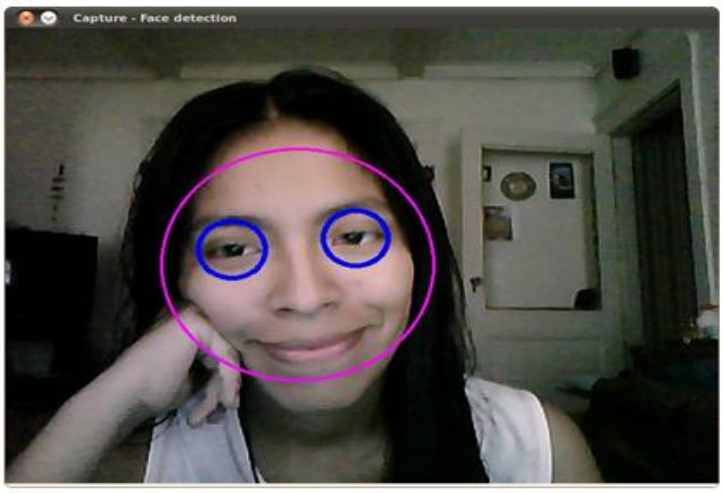

Fig6. Face Detection and Recognition using an Image

Further implementations will involve
1. Creation of databases which will contain data of number plates along with facial features of a motorist.
2. Comparison of visitor's data with the existing database.
3. Based on comparison entry is granted or database is modified with new visitor's data.

CONCLUSION

A **"One-time investment"** – **"An Automated Parking and Security System"**, a concept is a prototype having wide range of present deliverables and a great future scope which guarantees certain highlights below:

1. Applicable to commercial premises and complexes.
2. Guaranteed managed and secure environment.
3. Zero maintenance and cost efficient.
4. Accurate, convenient and fast operating.
5. Model compatible with any application.

This model being robust will solve numerous problems related to parking system. For proper functioning of the model certain points are to be considered
1. Environmental conditions: Conditions such as improper illumination and various environmental factors can hamper the processing of image
2. Power breakdown: It may stop the system.
3. Human errors: Absence of number plate and operational errors.
4. Wear and tear of components.

Proper precautions such as encasing of the camera to overcome environmental hazards, an alternate backup system for solving problem caused due to power breakdown, an alternate driver database could be configured in future and easy replacement of malfunctioning components. These precautions will not only minimize the above-mentioned problems but will also ensure smooth working of the model.

The above measures will enhance the future prospects, where the system could be used as an application serving different purposes in hospitals, industries, banks and in various commercial premises.

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