Vehicle Anti-Theft Face Recognition System Based on IoT using Raspberry Pi4

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***Abstract*— Security for automobiles provides the protection of living lifestyle in this era where the vehicle is an essential need to adopt in modern society around the whole world. The major problem these days is to secure the vehicles, because the owner always has fear about their vehicles would have stolen from parking areas either at home or office. In this paper, we present a system, vehicle anti-theft face recognition system (VATFRS) that can be detected access through Internet of things (IoT), allow authorized identification or unauthorized protection. The proposed VATFRS provides the security infrastructure on a low-cost extendable security system. This will work with a structure, with combination of three systems, i.e. face detection subsystem (FDS), a global positioning system (GPS), and an android management platform. Moreover, the system captures images of the driver and compares their face to the database to determine whether or not he is an accredited driver. We use a Raspberry Pi circuit to handle all of the events and construct a face detection module based on an advanced local binary pattern (LBPH) algorithm. Although different modules transmit necessary information to users to help and provide security. Therefore, our results show that the thief identification system and vehicle location system are much smarter and cost-effective than the traditional system.**

***Keywords*— Face Recognition and Detection, Vehicle Theft, Raspberry Pi4 MODEL B+.**

INTRODUCTION

Nowadays, automobile security has been a major concern around the world [1]. Security for automobiles has become a significant feature of all owners' regarding vehicle safety purposes, because the vehicle is a valuable asset that cannot be replaced if it is stolen. The vehicles can be sold or rebuilt by its spare parts in the market that usage as illegal activities include robbing, theft, dacoits, snatching and kidnapping. The stolen vehicles are the huge business and are difficult for the owner to recover/find the stolen vehicle as vehicle is progressively exposed to theft [2]. However, automobiles security is rapidly improving the features of security systems. The vehicle security system with Internet of Things (IoT) technology, software programs are consistently improving in the market [3].

IoT is a rapidly developing domain of work that consists a network connection, objects or things that are embedded with electronics, applications, detectors, and internet connections, allowing them to collect and share data [4, 24, 25]. Accordingly, IoT permits things to be sensed and controlled remotely using existing network infrastructures, allowing for more seamlessly integrating between the real world and computer-based platforms. IoT can allow for more efficient resource usage, reduced human labor, increased security, faster data collecting, lead to increased productivity, accuracy, and cost savings. Additionally, IoT can strengthen data gathering processes and security systems because everything is connected to embedded node for making the system safer and efficient [5-6].

In addition, automobile security is based on artificial intelligence (AI) where facial recognition and detection technique can be applied in IoT. Facial recognition can be used for a variety of purposes, including security and law enforcement by collecting pictures and comparing them to databases from local, state, and government resources as well as social media. Face detection is a method for identifying and locating human faces in digital photos or set photos and videos or set videos [7]. Face identification technique has advanced that it can detect faces by features and properties independently i.e. head attitude, lighting circumstances, or skin tone. These techniques can compute the individual's facial behaviors and store information as a face print using deep learning algorithms. It can match and support large number of digital image or store recorded face print.

The digital image is made up of a finite number of elements, each of which has a specific value at a certain position and components. In reality, other fields such as computer vision, computer graphics, and artificial intelligence overlapped with digital image processing. In digital image processing, the input is an image, and the output is depiction; in computer vision, the output is some sort of knowledge or specification; in computer animation, the input is some type of explanation or code, and the output is a picture. The input for artificial

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intelligence is an explanation, some buzzwords, or some program, and the output is an explanation or some key phrases. Fig.1 shows the feature extraction of the image technique to recognize a person [8].

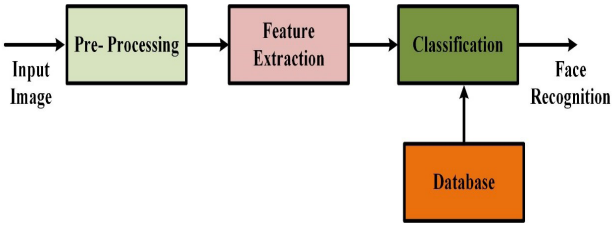


Fig.1. Feature extraction of image to recognized person

Face identification is a necessary module for presenting the automated vehicle theft system. This module requires to embed other module namely Raspberry-pi4 Model B+ module, Raspberry Pi (IR) camera module, and global positioning system (GPS) shield. The Raspberry-pi4 Model B+ board is used in the automation system and it is connected inside the Raspberry Pi 4 MODEL B+. It makes the connection between hardware or software that can be connected into a television or computer screen and operated using a conventional keyboard and/or mouse by using GPIO pins to interact with external I/O modules such as sensors or touch screens. So, Raspberry Pi 4 Model B+ module can reduce cost of single-vehicle using nano-system to perform the function as dynamic systems. Raspberry Pi (IR) camera is a nano-computer and low-cost dark sight module include flexible focusing and adjusting capabilities for capturing the image or recording the video [9]. GPS uses the Raspberry Pi (IR) camera to provide even a breakout board which is based on the RoyalTek REB-4216 GPS component. It's a GPS transceiver with the ability to save GPS data to a secondary device as storage medium. The electromechanical module that employs a buzzer to collect audio information in the form of signals [10].

Concerning the vehicle security issue, organizations are actually expanding their product offerings to include biometrics in multiple gadgets with the features of facial gestures and expressions for making it possible to recognize someone. While the face recognition, face data gathering, and facial expression recognition are the basic components for facial analyzation [11].

Existing vehicle security systems do not now provide sufficient outcomes for vehicle owners, because GPS and cellular carriers are not fast enough to prevent theft information, especially when the engine is starting, then the security strategy of employing an alert is still possible to break. So, it is vital clear to need an improvement of the vehicle's security in order to protect it against thefts. Facial recognition system is the finest approach for improving a vehicle's security mechanism when it comes to vehicle thievery. When a stranger is spotted in front of the vehicle's security system, the elector mechanical module can activate the buzzer and record an image that is sent to the owner's phone. The thief will be notified, and he will have no time to disable the vehicle safety system to enforce security [12-13].

The contribution of this research is to provide an effective vehicle anti-theft security system. This system based on improved face recognition algorithm that detects face when person want to drive the vehicle. Our proposed system detects the exact location of the automobile and also navigates the traveling of vehicle tracking on Google Maps. The main contribution of this paper as follows:

- We present the design architecture, and embedded system using Raspberry Pi 4 MODEL B+ using deep learning algorithms for implementing face recognition and identification.
- We used several programming tools such as Python, Java, and MySQL.
- This system implements a mobile application through which a user can trace the vehicle and get the user picture and information on his mobile.
- We present the real time location tracking system that can help the law enforcement agencies to stop the crime.
- Our system provides a low cost and efficient security system that can offer to control access to owner vehicle.

Further, this research is divided into five sections as section 2 present the security vehicle system's corresponding work. Section 3 present VATFRS and main requirements. Section 4 discusses the application and user interface, and results case testing, and section 5 is conclusion of the research.

RELATED WORK

Many researchers have been worked on the face recognition, and automobile security systems have been much focused study in the past years [13-14]. Automobile has incorporated innovative approaches as biometric identification, passwords, fingerprint scanners, and image processing algorithms. Face recognition systems have been investigated, and it is an essential computer vision challenge with implication for monitoring, multimedia analytics, and consumer things. To attain significantly faster detection capability, new face detection techniques are developed. The face detection mechanism used to recognize the person in this embedded intelligent security system. The GPS module parse received GPS signals to determine the vehicle's location. Vehicle thievery is mostly focused on various lock technologies or guiding and commanding the automobile from a distant location remotely. Because the system has many types of faults and the formalisms need to be improved these forms of car protection systems cannot be used in practice [15-16].

S.Veerappa et.al [17] used the principal component to analyze the accomplished level of security. Face recognition and GSM

modules were used in the research to validate drivers. If the user was found to be a confirmation match, the engine started. The engine was not igniting if an unrecognized face spotted, and the system transmits an SMS to the owner. The vehicle anti-theft system uses sensors and includes functions such as detection of fire. Kanimozhi, K.et.al [18] presented the survey on IoT based vehicle theft that used detection technique. Vehicle were restrained using the password protection when the individual has been authorized then the automobile engine be turned on when an automobile's continuous observation of any target is performed.

B.Bhumi et.al [19] proposed the smart security using GSM. The surveillance device allowed supervision of the automobile for remotely basis. The event detection sensor and logics make up an event detection component. The position of the car is maintained in the pad when the engine is started. The vehicle's controller uses password protection with a distant ignition cut-off function. If the erroneous password was entered multiple times, the engine turned off and the vehicle no longer is accessible. The buzzer sound when this type of occurrence occurs. Whenever the engine turned on, then the face recognition or identification performed, and a photo taken and transmits to the vehicle's owner. Results showed that authorized user confirm whether or not the car was reported stolen. The robber's picture recorded at once the picture detected, and the car ignition turned on.

Past studies [17-19] compares and predicts probable matches between faces independent of expressions such as facial hair, or age. Quality assurance is an important factor to avoid incorrect detection.

According to Keshavan's et al. [23] protocol, only those who have been given the authority by the automobile's owner may drive it. Upon turning on the engine, the system scans the person's face, and if the pictures in the database identify the person's face, the vehicle will ignite. The very first time the gadget is turned on, it identifies the owner's facial features. After a registration process, the car can be activated. The program prohibits entry, the bell rings, and a sms notification goes out to the owner's cell phone if the face doesn't really match the photographs in the database. Unauthorized individuals' images will be taken and given to the owner of the car. A gadget created by Jain et al. has functions including accurate identification of the position of automobiles ahead of them when they arrive in close proximity, automatic braking system trigger component configuration, and alarm system. A continuous surveillance feature, Internet connectivity in cars, and surveillance cam_tracking are some more features. These components will make the car more secure and deter theft still the quality was not discussed. Many researchers developed and present the vehicle theft detection as it is a valuable tool for security authorities to improve security processing to their clients and provide a smoother service and experience. Table I. shows the relevant research in contrast to our planned study.

Table I. Comparison work

Features	[20]	[21]	[22]	VATFRS
Mobile Application	No	Yes	No	Yes
Tracking/Monitoring	Yes	Yes	Yes	Yes
Engine Power Control	No	No	No	Yes
Driver Authentication	Yes	Yes	No	Yes
Location Logging	No	Yes	No	Yes
User Friendly GUI	No	No	No	Yes
Intruder Clue	Yes	Yes	No	Yes
Camera Used	< 5MP	< 5MP	No	> 5MP
Cost Effective	Yes	No	Yes	Yes

Concerning the related work of research, we improve the system as compared to other features. We built hardware and software development using Raspberry Pi4 Model B+, power supply module for Raspberry Pi, rectifier, regulator, GSM, and LCD. The system designed is based on an integrated system, uses a facial recognition technique, and includes a new architecture. This system provides the cost effective and higher level of security.

Other researchers' work in the same area but there is no one system that incorporates all the features of Mobile Application, Tracking/Monitoring, Engine Power Control, Driver Authentication, Location Logging, User Friendly GUI, Intruder Clue, high quality Camera and a Cost Effective solution at the same time. This makes the proposed system novel.

PROPOSED VATFRS

We design vehicle anti-theft face recognition system (VATFRS) where vehicle owner pays attention to protect from vehicle theft that, because of security issues. Object tracking and detection are quite important in computer vision application including surveillance, vehicle safety and activity recognition. We built a system using an image processing technology that can be divided into three stages such as detecting a face to monitor, identifying a facial structure to record, and tracking the face. Face detection is an important case of object identification. The goal of object-class detection is to identify the size of all items in a given picture and their position.

Our proposed system focuses on human faces from the front to match and detect the image process. The person's image is matched bit by bit that can correspond to the photographs from the database. We use efficient face detection techniques that are genetic algorithm base on the eigen-faces algorithm. The face detection algorithm performs the recognition works into 6 steps such as detection the face, alignment, measurement,

representation, matching and verification. The design of VATFRS model is shown in the Fig.2.

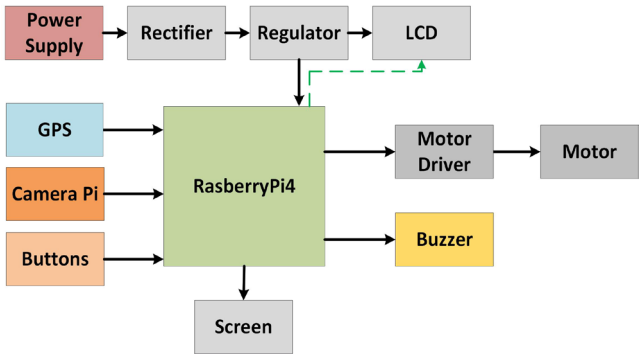


Fig.2. VATFRS Model

Further, we present the data flow diagram graphically that can be represented the process and functions which can manipulate, distribute, store and capture data between the system and the components of the system as shown in Fig.3.

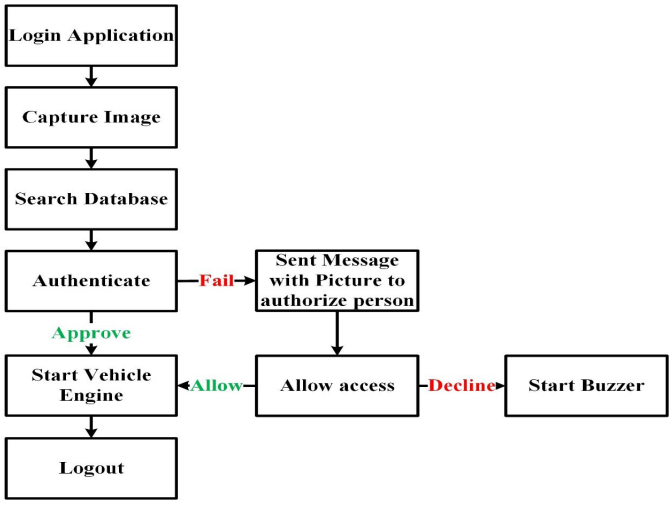


Fig. 3. Implementation of Model design system

A. Sequence diagram of VATFRS

The systems integration is needed to present the work flow of the framework. We design the sequence diagram which is method of establishing the required characteristics of a framework. During the system design, it integrates subsystem and module to ensure the data flow of the system.

Fig.4 shows sequence diagram and the entire architecture of a framework.

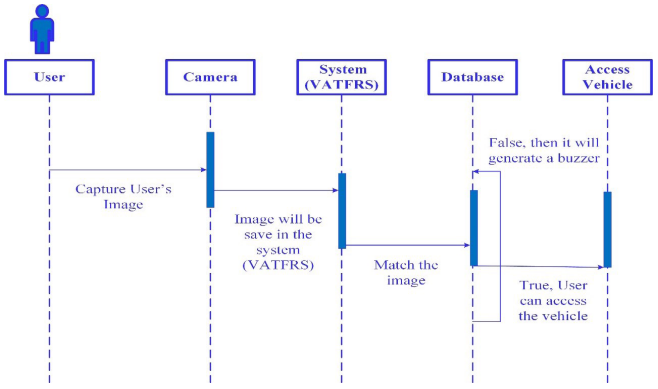


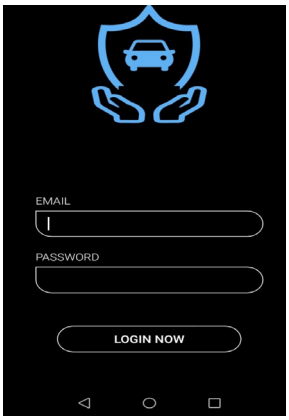
Fig.4. Sequence diagram of VATFRS

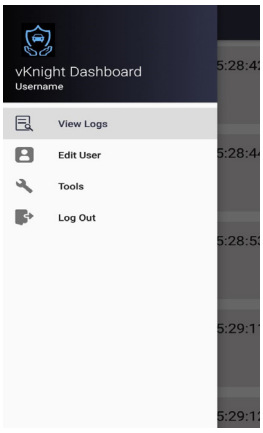
B. VATFRS Requirements

Raspberry Pi, buzzer, camera, and LCD are among the system requirements. Our system utilizes a face recognition technology and a Raspberry Pi circuitry that includes a digicam for taking digital images, 24 x 4 LCD display, a motor, and a buzzer warning alarm for the security system and authorization. The system must fulfil functional requirements as features or services of the framework while system development process. We use Python, MySQL, and Java for Android. During research work, we construct six key building blocks to establish the functional requirements such as managing users, monitor vehicles, track automobiles, and secure automobiles. Each of block is required the list to make connectivity. Mobile application involves the user interface requirements that display the information layout. Information layout consists the linear layout, relative layout, constraint layout and navigation layout.

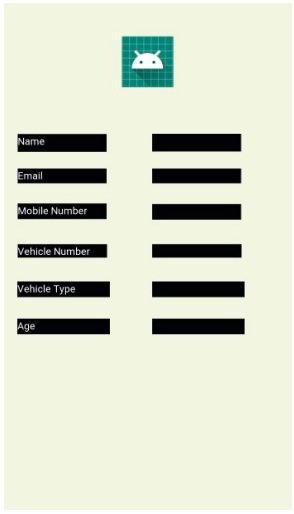
MOBILE APPLICATION INTERFACE

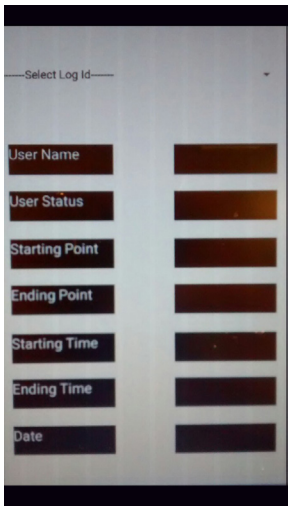
In this section, we present the result and discussion. We developed the mobile application, where user must have login to enter his/her correct email and password to gain access. The login page of the mobile application and view login are shown in Fig.5.





(a) login form (b) Dashboard login views

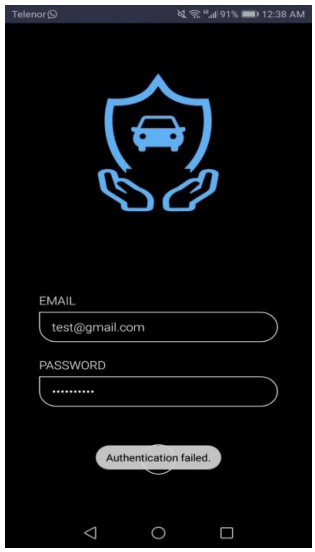


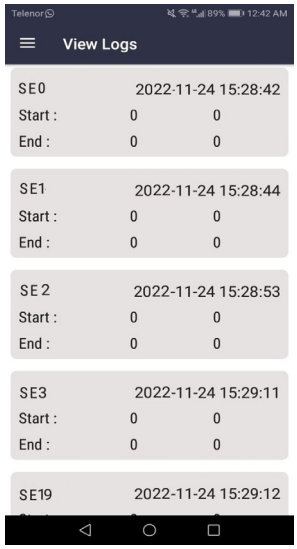


(c) User registration form (d) User logs form

Fig.5. (a), (b), (c), and (d) mobile application user interface

We performed 20 case tests with user name SE0 to SE19 that user requires to login the application first to authenticate the user information. The engine is turned on; the user must verify face through the registration process. Before the engine start, if an unauthorized user is trying to use the vehicle, then the system will start to detect the individual face to check from the database. The system checks three conditions. One is face matches the authorized profile i.e. registered face, then system will send the notification to owner and start engine; second is if it doesn't match face, the system will capture the intruder's photo, then theft photo automatically sent to the owner's personal phone, and initiates the buzzing sounds. Other is if the automobile is stolen, the owner has a picture of the attacker, and then the stolen vehicle can be reclaimed by the police because the authorized person has a photograph of unauthorized person which has sent to owners. This system detects the user login account and view logs information as shown in Fig.6.





(a) User authentication (b) User login information

Fig. 6 (a) and (b), results of user case testing

Table II shows the summarize result of different testing and description of the mobile application working properly from all aspects. The results show that when an unauthorized user was detected by the system and the owner having the mobile application denies the permission to access the system. The generated logs travelled by the user drawn up on the Google map generating in the cloud database that is firebase for the current mobile. User details registered in the database along with the users that created or edited in firebase. Authenticate button on the screen automatically starts to detect the user's face and message will pass user is recognized or unrecognized by the system. System responds when an unauthorized user was given temporarily access to the system and not granted permission to access the system. Add User function which will make the user get recognized by the system and then ask details for the newly added user.

Table II Case Test Description and Priority

User	ID	Priority	Test Case Description
SE 0	**TC001**	High	Testing of mobile application login authentication
SE 1	**TC002**	High	Testing of all the buttons and the functions
SE 2	**TC003**	High	Testing of generating logs and verifying the accuracy of the result
SE 3	**TC004**	High	Testing of Edit User button on the mobile application
SE 4	**TC005**	High	Testing of Delete User button on the mobile application
SE 5	**TC006**	Medium	Testing of Logout button on the mobile application

SE 6	**TC007**	High	Testing of notification when the system do not recognize the face
SE 7	**TC008**	High	Testing of notification when the system recognizes the authentic face
SE 8	**TC009**	High	Testing of mobile application when temporary access is granted
SE 9	**TC010**	High	Testing of mobile application when access was denied by user for unauthorized person
SE 10	**TC011**	High	Testing of clickable logs showing the path on which the system was travelled
SE 11	**TC012**	High	Testing of logs generated in cloud(firebase)
SE 12	**TC013**	High	Testing of Users being registered on cloud(firebase)
SE 13	**TC014**	Medium	Testing of screen being able to detect the touch of a person
SE 14	**TC015**	High	Testing of authenticate button when touched on the screen
SE 15	**TC016**	Medium	Testing the touch screen system when the user is not recognized
SE 16	**TC017**	High	Testing of touch screen system when the user is recognized
SE 17	**TC018**	High	Testing of touch screen when unauthorized user was given access
SE 18	**TC019**	High	Testing of touch screen when unauthorized user was not given access
SE 19	**TC020**	High	Testing of touch screen's function of Add User

CONCLUSION

In this research, we present IoT based vehicle anti-theft face recognition system (VATFRS) using Raspberry Pi circuit. During experimental work, the hardware and software components of the system were designed and implemented separately. We developed mobile application using face recognition approach as a prominent intelligent security system that can prevent vehicle theft and secure the automobile from unwanted users with easy identification. VATFRS must enable the owner to observe the vehicles at any time or to update the location on a regular basis. This system will help to reduce the complexities and achieve high security level as well. We believe this research is being significantly less expensive and more intelligent than existing systems available in today's market.

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