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Design and Implementation of an Integrated Vehicle Security System (IVSS)

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***Abstract*: -** Nowadays, technology is rapidly developing in all fields, which is very important and widely used in all applications. A security system is one of these applications to avoid car theft and decrease the possibility of accidents. Enhancement of security systems in the vehicle would be beneficial to the customer to ensure safety for the customers and their families. Also, Road accidents are increasing rapidly every day. In this paper, an Integrated Vehicle Security System (IVSS) is introduced to the vehicle using many applications integrated together to increase the safety factor. A fingerprint is used in front of the vehicle door to avoid theft and face recognition is applied indoors to ignite the vehicle motor; the driver alcohol detection system is used as one of the integrated system applications which are used to prevent the drivers from driving while they are drunk and avoid any accident. All applications are connected to a GSM module to send messages to the owner in case of recognition failure either from fingerprint or face recognition with certain information and to a GPS module to give a live location of the vehicle in case it is stolen.

***Keywords:* -** Security System, Fingerprint, RFID, Face Recognition, GPS&GSM**.**

I. INTRODUCTION

In recent years, vehicle thefts have increased around the world. People started to use theft control systems installed in their vehicles. The commercially available anti-theft vehicle systems are very expensive [1]. Here, we make a modest attempt to design and develop a simple, low-cost vehicle theft control system using built-in microcontroller, a camera module, alcohol, RFID sensor and fingerprint sensor and a GSM/GPRS+GPS module. The identification of individuals became crucial recently due to the high rates of property theft and especially vehicle theft, and to get a high level of security is a critical task so there are number of authentication techniques used on this project to ensure that [2]. This project deals with design and development of the theft control system for a vehicle, which is used to prevent or control the theft. This developed system makes use of an embedded system based on fingerprint sensor, face recognition camera and GSM technology, an interfacing mobile is also connected to the microcontroller.

First step will be through fingerprint sensor, the user needs to register a fingerprint ID to the fingerprint scanner. If the ID is matched with the stored ID in the memory that confirms that this person is an authorized user then the car door will open. Once an unauthorized person tries to open the door by giving number of times of a wrong ID, an alerting message is sent to the owner of the vehicle that someone is trying to open the car. After we enter the car, a second stage of security will be there which is done through face recognition. Once this individual enters the car, the camera is then set to stand-by to confirm his face ID. If the face matches the face ID stored in the database, this means that this person is an authorized user and the car engine will start.

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For any reason, if the security has been hacked and car is stolen, there is a GPS integrated with GSM module with help of SIM tracking chip to provide the location of the vehicle to the owner of the car by sending an SMS message to notify him of the location of the car.

II. FINGERPRINT APPLICATION

Fingerprint recognition is widely used to identify individuals by looking at the different features presents in the users with a template which most people are used to. It has become a feature of many devices that most people use now every day in their life [3]. Recently fingerprint sensor is integrated in more than application and more than system; in airport security, mmobile access and authentication, home assistance etc.
In our project, fingerprint recognition technology is used to provide more security to vehicles through using a fingerprint sensor to enter the car instead of the traditional car door lock, since the fingerprint of every person is unique. So, this helps in improving more security for the vehicle [4].

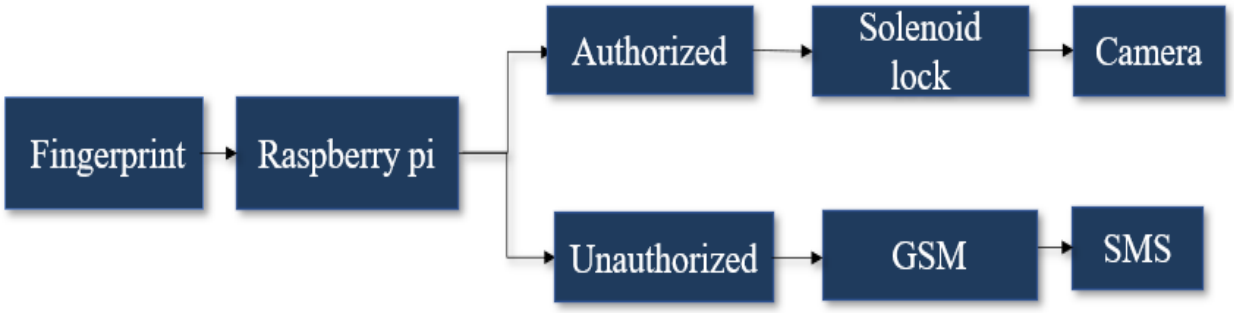

Fig 1: Block diagram of fingerprint operation

Fig 2: R305 fingerprint module

The process of this application is as follows, the user places his finger on the sensor to match his fingerprint with that stored in the database of the module, if the user's fingerprint matches this data the door lock will open and the user can easily enter his car. If the sensor detects an unauthorized fingerprint more than once, an SMS via GSM module will be sent to car owner notifying him that someone unauthorized is trying to enter the car.

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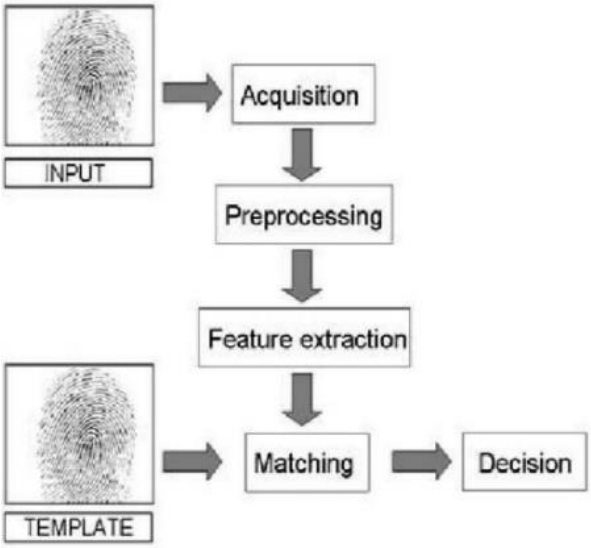

Fig 3: Fingerprint process

We used an optical fingerprint scanner module R305 connected to microcontroller raspberry pi 4 using a USB to Serial converter, a solenoid lock connected to a relay which is connected to the raspberry's pin

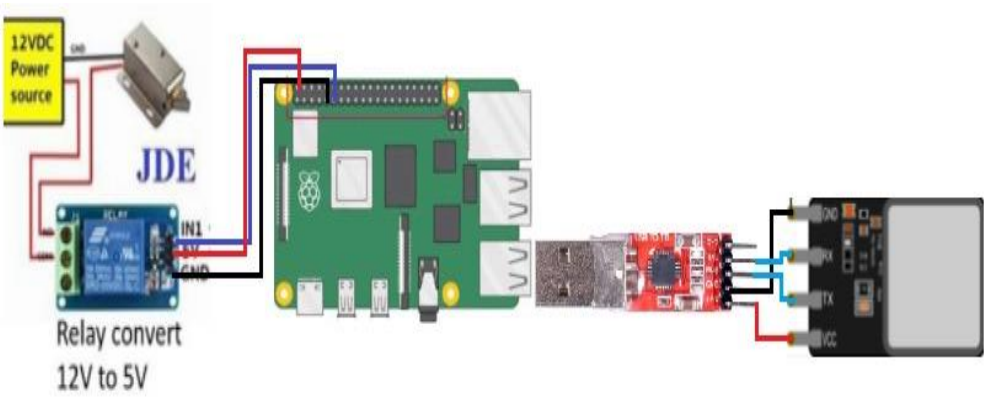

Fig 4: Fingerprint hardware connection

III. RFID-RC255 SENSOR

RFID system consists of two main components, a transponder (tag) has a microchip those stores and processes information, as well as an antenna to receive and broadcast a signal, and a transceiver (reader) that made up of a Radio Frequency module and an antenna that generates a high frequency electromagnetic field [5].

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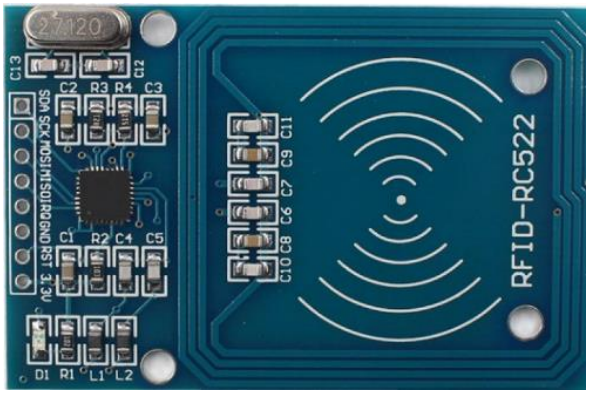

Fig 5: RFID-RC522 sensor

To read the information encoded on a tag, the tag must be placed near to the Reader in order for the information encoded on it to read. A reader produces an electromagnetic field that causes electrons to travel through the antenna of the tag and power the chip. When triggered by an electromagnetic interrogation pulse from a nearby RFID reader device, the tag transmits digital data, usually an identifying digital number, back to the reader [6].

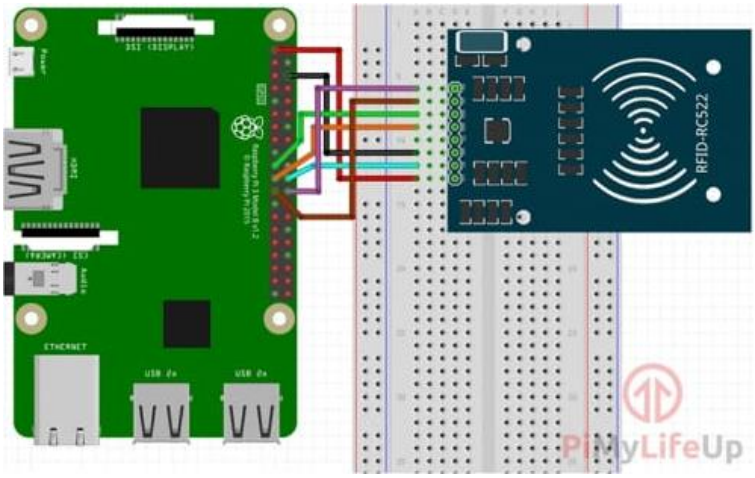

Fig 6: RC522 RFID sensor hardware connections

RC522 sensor has 8 pins, VCC which is connected to the 3.3V of the raspberry's pin1, RST connected to pin22, GND connected to pin6, MISO connected to pin21, MOSI connected to pin19, SCK connected to pin23, SDA connected to pin24. Since it is possible that the fingerprint sensor might be broken or damaged over time depending on its lifetime, RFID will be an alternative security system in this case. It is hidden in the car body in a secret place except for the car owner. It is an alternative way to enter the car in case of an emergency, the user/driver has the identifying card that the sensor already has the same ID of this card in its memory, if the fingerprint is not working then the RFID sensor will automatically be turned on and wait for the identifying ID from the user's card. After that, the user will be able to access the system and enter the car.

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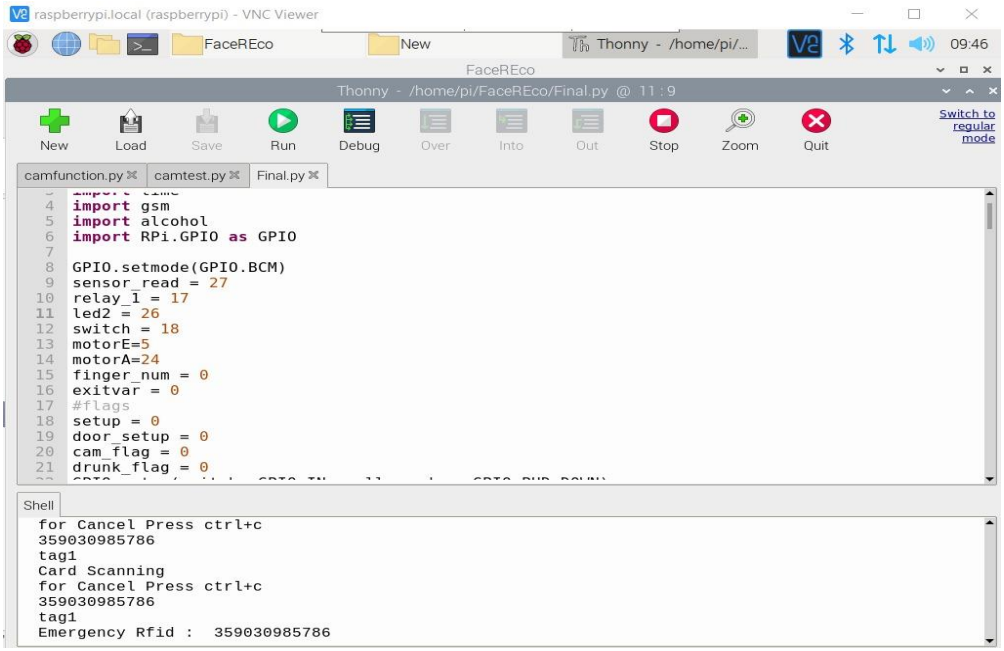

Fig 7: Software results of identifying user's RFID

IV. FACE ID

Facial recognition is basically software that maps, analyzes, and confirms the identity of a person's face in a picture or a video is one of the most powerful surveillance tools ever made. Face recognition is a way of confirming an individual's identity by first detecting their face then recognizing it [7]. In our project, we will use facial recognition technology to provide more security to car owners through using facial recognition to start the engine instead of the traditional engine start button. This will be the second security application in our system, The facial IDs of the car owner is stored on a database, when an owner enters the car, the camera will be turned on and it will detect his face, if it matches the one stored in the database the car will be ready to start.

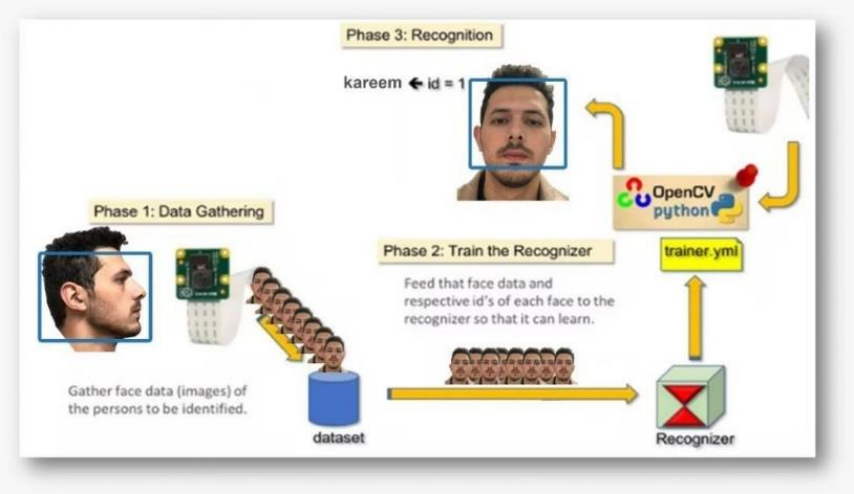

Fig 8: Face recognition process

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However, if someone other than the owner somehow managed to enter the car enter the car, when he tries to start the engine, he will have to go through the facial recognition test, after a certain time if the face ID is not recognized; a message is sent to the car owner notifying him that someone suspicious is trying to start the engine of the car.

Fig 9: Raspberry pi 4 connection with camera

V. ALCOHOL SENSOR

According to the National Highway Traffic Safety Administration (NHTSA) about 28 people per day die in America in drunk-driving car crashes [8]. Considering this problem, we used an alcohol sensor as a driver alcohol detection system for safety. It is an add-on application to the Face ID application to start the car's engine.

Fig 10: MQ3 alcohol sensor

M3Q alcohol sensor has 4 pins. VCC and GND are connected to the raspberrypi's 5V, GND pins, respectively, while A0 pin is not used as we work with digital which is D0 pin that connected to pin number 37 (GPIO 26) to the raspberry. We work on the digital pin according to the sensor topology which in digital it can indicate the presence of the alcohol and in analog it can represent the concentration of the alcohol in the air. So, we used what is compatible to our system.

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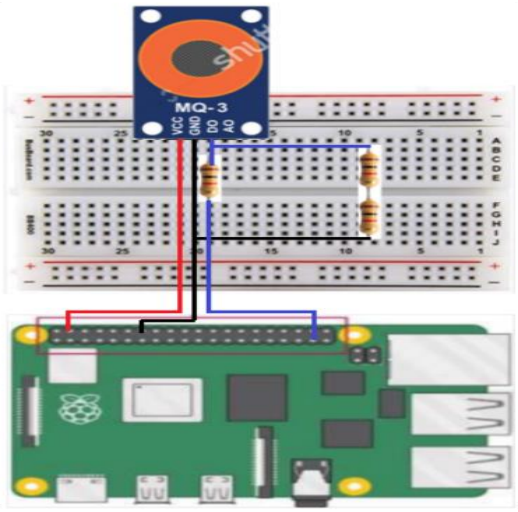

Fig 11: Hardware connections

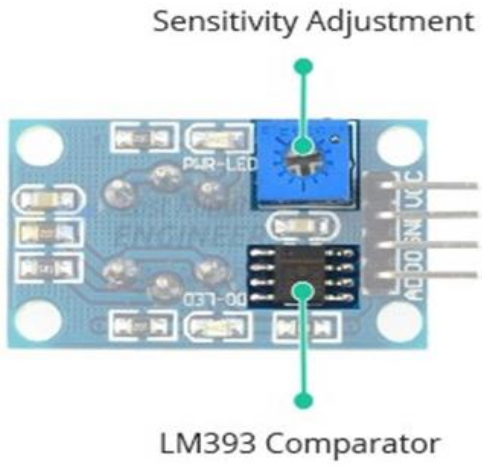

Fig 12: 1LM393 comparator and sensitivity adjustment

The analog signal is fed to a LM393 High Precision Comparator to digitize it and is made available at the Digital Output (DO) pin. The sensor detects the concentration of the alcohol in the air. When the driver blows into the sensor it can test the amount of alcohol in his body. The sensitivity of the sensor can be controlled to our need to make it more accurate when it is working and detect the actual results of the driver breath (alcohol amount). To adjust the sensitivity of the digital output (DO), there is a built-in potentiometer in the module. It can set a threshold; as the module will output LOW, when the alcohol concentration exceeds the value of the threshold, and as the module will output HIGH, when the alcohol concentration below the value of the threshold. For summary, when the alcohol concentration in the breath exceeds the threshold, then the user is drunk and the car will not be activated.

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VI. GPS-GSM MODULE

It is the second generation of long-range communication systems that added the ability to send voice over long distances wirelessly for the first time[9].The GSM and GPS module used as a security system to enhance the project and to make it more secure by send a message or make a call to the user's phone number if there is any attempt of theft occurred to the car.

Fig 13: A9G GSM/GPRS+GPS

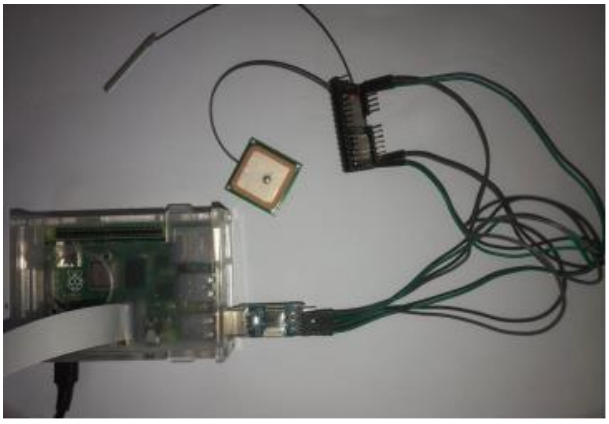

Fig 14: GSM/GPS connections

Table 1: A9G-TTL Pins connection

TTL	→	A9G
5V	→	V USB
GND	→	GND
RX	→	TX1
TX	→	RX1

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If the sensor on the car door detects an unauthorized fingerprint, an SMS will be sent by the GSM modem which used to establish phone connection between receiver (user's phone number) and transmitter (microcontroller) including a warning message as an alert to the car owner to notify him is that there is an unauthorized person tries to enter the car and the same process will occurs if the camera detects an unauthorized face ID.

Fig 15: Result for the GSM Module Send SMS to the Owner

The GPS modem will be activated once the car's engine is started, to make the car more secure in case if the thief succeeded to break into it. Once the owner sends a message (LOCATION) to the GSM/GPS unit, the GPS modem will start to communicate with Global Positioning system and send the current location, latitude, longitude to the registered number of the owner that will be send as SMS to open Google maps and find the current location of his car.

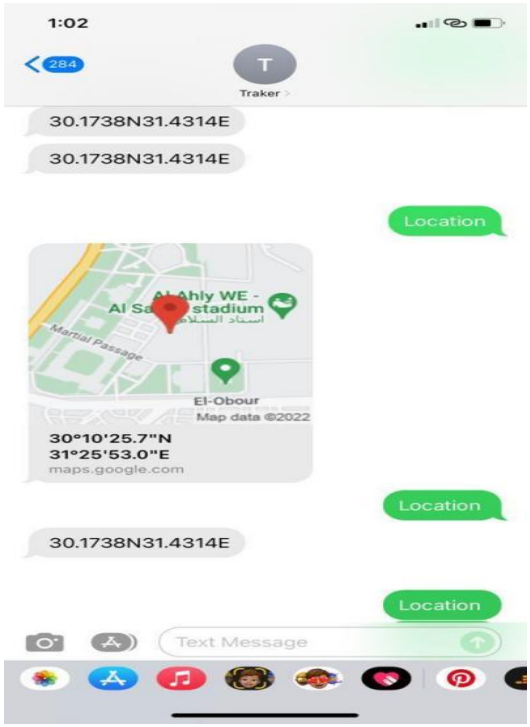

Fig 16: SMS to a track vehicle request

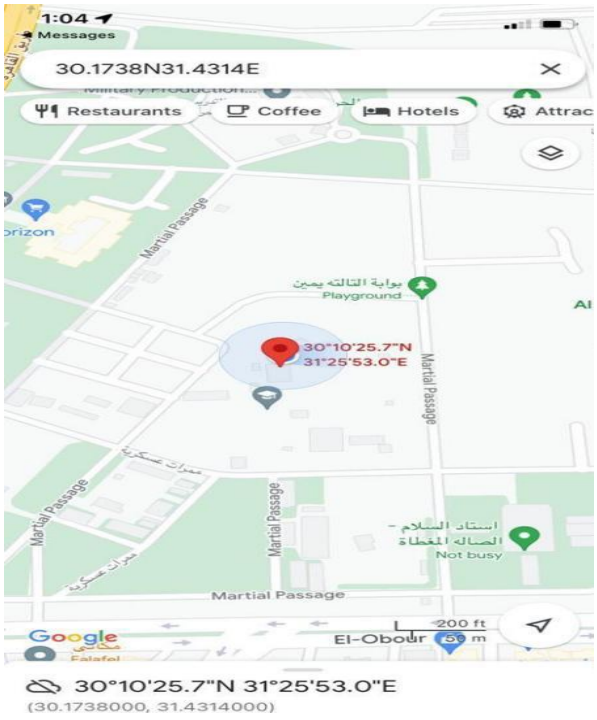

Fig 17: Result for the vehicle location on Google Map

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VII. HARDWARE

The overall system is shown in figures 18-21.

Fig 18: Hardware implementation of the proposed integrated system on a car model

Fig 19: Real Fingerprint sensor

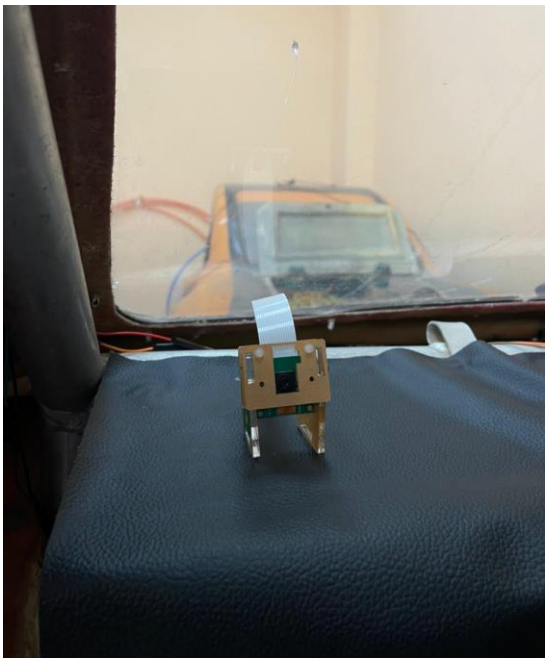

Fig 20: Real Face ID camera

Fig 21: Real alcohol sensor detection

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VIII. CONCLUSION

After we discussed those problems we are proud to present number of integrated solutions to number of arising concerns about cars safety ,we managed to provide reliable recognition features that can be integrated in all kinds of mobile vehicles and to provide simple tracking system that can track the car's real-time location by owner when needed another feature is to detect alcohol presence in driver's body and if needed the car won't start in case of severe amounts of alcohol exists in his body that would lead to danger when driving the car, thus we managed to prevent accidents that happen in such cases.

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