AN INNOVATIVE VEHICLE SURVEILLANCE FRAMEWORK USING INTERNET OF THINGS

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Abstract- The Internet of Things (IoT) is highly prevalent in traffic control, medical and industrial applications. A massive amount of research efforts have been made with the ongoing growth of the IoT. Given a vast number of diverse "resources," it is an essential and significant question of how to include a single access method for IoT. This article provides an Innovative Vehicle Surveillance Framework using the Internet of Things (IVSF-IoT) framework for a range of low-speed and high-speed machines with related extensibility and flexibility. IEEE 1451.2 based design has been implemented, and the suggested vehicle surveillance system design has been proposed. The simulation outcomes such as Accuracy, Efficiency, Precision, and F score of the proposed system have been analyzed, and the results have been plotted. The proposed method has the highest performance in all situations.

Keywords – Internet of things, Vehicle Surveillance, Traffic Control, IEEE 1451.2

1 INTRODUCTION TO THE VEHICLE SURVEILLANCE SYSTEM

The internet requires various devices to interconnect automatically, mobile telephones, laptops, servers, cars, and home appliances. In 2009, IBM launched the idea of Smart Cities with this sharing of knowledge through thousands of internet-linked devices [1]. For communities to be intelligent, it is essential to process and evaluate data collected to make decisions and forecast events using data processing techniques or machine learning. Thus, increasing accessibility, energy efficiency, the nature of the atmosphere, and decreasing the number of incidents or circumstances may strike people living in cities [2, 3].

Vehicle Traffic is one of the issues of most concern in smart cities; this subject is split into two fields of focus: smart parking implementations and the concerns traffic path analyses for traffic lights optimization [4]. The two factors are studying traffic delays in city environments, which create environmental issues by raising air CO2 and financial woes by increasing energy and reducing people's lifestyle by expanding market distance driven [5].

Several types of research have been performed to handle the traffic of automobiles by way of mathematical modeling using mobiles [6]. To alleviate these challenges, utilizing which automobiles and pedestrian crossings are characterized by rules that enable the switch of speed in the traffic conditions. The number of individuals demonstrates a direct link between human and vehicle traffic [7].

On the other side, it proposes a methodology for estimating traffic congestion through diffusion logic methods, which provides information on the making decisions of the community and the laws of inference utilizing cabinets fitted with a Global Positioning System (GPS) [8]. It measures position, road length, and speed limit and allows a protocol for traffic congestion to be extracted.

In Chowdhary et al., a categorization is carried out using an adaptive neuro-fuzzy strategy of diffusion logic to achieve the status of traffic jams, which break them into three distinct states constant exchange and motion and highly jammed [9]. Another article evaluated the traffic jams by image analysis. Muthuramalingam et al. utilize optical flow to gather data from the traffic of vehicles across images, dividing each frame into four regions and manipulating traffic information using noise mitigation statistical methods in optical flow frames [10].

The "IoT" is an evolving technology that Alrifaie et al. suggested researching the Radio Frequency Identity (RFID) for the first time [11]. IoT supports the composition of operations for different applications. It allows things that affect to interact through the network. It comprises three layers: a layer of awareness, a network layer, and a device layer, and the IoT from the awareness layer is attached to sensors, electric motors, RFID tags, and other smart devices [12]. The contact between 'objects' and individuals is the responsibility of the network layer. The application layer is supplied with abundant technologies.

IoT primarily allows "objects" to connect in comparison to the conventional internet. Given the vast and diverse number of 'objects,' the basic and essential problem for IoT implementations is to have coherent exposure to the IoT for different 'objects.'

There are already a lot of configuration schemes and equipment commercially available. Most of them operate in a specialist field and may only provide very few devices with advanced interfaces. It designs and implements a new infrastructure for IoT connectivity to multiple IoT devices to solve this problem. On the one hand, IEEE 1451.2 supports many sensors, electric motors, and data capture sensors. It incorporates this configuration with technology from FPGA and SoC, which can quickly reconfigure the whole device and consume lesser energy.

The rest of the research as follows. Section 2 deals with the background and literature survey of the vehicle surveillance system. The proposed Vehicle Surveillance Framework using the Internet of Things (IVSF-IoT) framework is designed and implemented in section 3. The software analysis and performance evaluation are discussed in section 4. The conclusion and future scope of the proposed framework are illustrated in section 5.

2 BACKGROUND AND LITERATURE SURVEY OF THE VEHICLE SURVEILLANCE SYSTEM

2.1 Internet Connection with Objects

The internet of things is the latest generation of technologies to link devices for a shared purpose. IoT is a form of framework that addresses the problems that arise in real-time [13]. The term "objects" refers to physical systems that communicate with a specification with other systems and the internet. It has unique personalities, physical characteristics, and virtual accountability and uses smart frameworks.

Cloud computing is the data center service calculations. The cloud is a network of computers or servers [14]. The IoT apps provide intelligent traffic management services, smart homes, and biomedicine software in the database [15]. The device connects with the dedicated server. It also incorporated cloud computing techniques in the suggested method to view the real-time parts of a specific vehicle during its movement between the customs.

2.2 RFID

The classification of radio waves is the technique whereby users radio waves to relay the target's identity. This system is the popular equipment for object detection and target identification to detect objects using small electronic circuits called tags [16]. There's a reader and a label in the RFID technology. The tag comprises a computer chip and antennas, and the label has a limit of 2 KB of information to get the information. It must have a scanner, the unit that transmits radio signals, the tag that unlocks the computer chip will collect these radio signals and relay the information [17].

RFID tags are categorized into active and passive batteries tags. Passive RFID identifiers have no battery pack so that no data can be sent from their device. They need RFID scanner power activation and relay only a limited array of data called the card's ID. Active tags have a battery that can continuously transmit the data [18]. A Battery-Aided Passive tag (BAP), consisting of a battery but only passing messages in the absence of a reader, maybe known as combination Tags. The storage allows them to relay data longer than the reader antenna [19].

The online surveillance systems allow access to various vehicle state data, including diagnostic information, motor Rotations per Minute (RPM), pace, position, and measures of different engine detectors [20]. The provision of current knowledge on diagnosis allows automotive owners to maintain their protection and security utilizing a wireless automobile safety surveillance system [21]. A device like this will instantly diagnose problems and report them to specialists in automotive maintenance. This cloud-based technology allows wireless access to the information from a smartphone or Personal Computer (PC).

2.3 Survey

The technician can control the motor and transmitting system by this function while a car is powered elsewhere.

A microcontroller interface for engine specifications is an onboard diagnostic (OBD) device to obtain vehicle specifications from GPSs and transmit them with other microcontroller-based equipment (smart telephones), Bluetooth gadgets and computer systems, and Cloud service [22].

A cloud processor is a webpage for the transmission and online processing of data in pictorial and data sizes. In [23], the information is represented graphically. Raspberry Pi is a Linux-based micro-computer. The newest release, emitted by Raspberry Pi 4B in August 2019, is available for communicating onboard WiFi via the website. It can show superior to Raspberry Pi in comparison with other microprocessors.

The research in [24] suggests using a Raspberry Pi to map the car's location and control safety. GPS, stress, and gasoline detectors are proposed for this device. It just provides a machine diagram, but no specifics are given. An OBD method is not used.

In [25], and OBD instrument and a Raspberry Pi are used to provide a vehicle classification tool. A Bluetooth adapter for Wireless applications is used for this method. Information is not seen on a remote server.

In [26], work is done using an OBD-II scanner to incorporate a tracking system. An SYM32 UART is included in this framework to monitor a WiFi module, gather information from an OBD scanning tool, and transmit data remotely to computers. Information on Bluetooth low Energy devices is shown on this system. Scholars of [27] use OBD-II and GPS coordinates to forecast driving habits, but no information about the application of the outcome transmission is available through the web [28].

Raspberry Pi and digital data show do not have the effectiveness of the control. From the article's experiences as a final-year graduate, there seems to be a real need for execution knowledge [29]. Engineers may also learn from these data. A Vehicle Surveillance Framework using the Internet of Things (IVSF-IoT) framework is proposed to overcome these problems.

3 PROPOSED VEHICLE SURVEILLANCE FRAMEWORK USING INTERNET OF THINGS (IVSF-IOT) FRAMEWORK

A Vehicle Surveillance Framework using the Internet of Things (IVSF-IoT) is proposed. The software involves the sharing, encoding, preserving, and transmitting data for all types of IoT applications and computers. The architecture is commonly utilized for real-time tracking, procurement, and device management in various IoT environments.

It implemented IEEE1451.2 for access to various receptors, effectors, and converters in this design. The standard sets out several requirements from the description of the sensor framework to the collection. It implemented FPGA to integrate the entire system to minimize the use of device underlying hardware. This architecture contains and incorporates several complex IP cores. In the meantime, the primary system element is deployed on a standard FPGA chip through SoC technology management.

Fig. 1 shows the block diagram of the proposed Vehicle Surveillance Framework using the Internet of Things (IVSF-IoT). The critical components of the device are the Master Unit and the Module for analyzing information, and the two members interact through the serial peripheral UART interface. The Data gathering unit is essential for gathering information about the atmosphere and accessing various sensors. AC and DC signals can be assisted by employing analog to digital converter (ADC) and digital to analog converter (DAC). An operating system performs the IP central controls and signal processing of the whole unit.

The transducer electronic data sheet (TEDS), designed and placed in Blocks of RAM (BRAM), has been used in IEEE 1451.2 to define the form, function, and characteristics of detectors, effectors, and converters. The Master Unit performs other vital roles as the most significant unit for the whole scheme: network connectivity, storage device, etc. The Master Unit also offers high-speed applications such as the video camera with interfaces. The critical controller with superior efficiency, high reliability is an ARM Cortex machine.

This architecture enables the machine to access different types of IoT detectors, actuators, and other high-speed instruments. The specified data capture module performs data capture tasks that allow the Master Unit to concentrate on complicated functions, including network connectivity and storage device.

3.1 Application in-vehicle monitoring

"Intelligent traffic" is now an essential part of people's lives with the advancement of technology. While many related elements are present on the market, generalization, expansion, and renewability are typically lacking. It develops and deploys a new and smart vehicle surveillance system obtained from the proposed framework in this article.

Fig. 2 shows the application scenario of the proposed Vehicle Surveillance Framework using the Internet of Things (IVSF-IoT). The transportation management terminal is the central unit of the entire system, gathering diverse natural details, including video data, geological events, and positioning data in real-time. Users can easily access various information through the network interface.

3.2 Hardware Architecture

A Xilinx-7000 SoC chip combines a valuable ARM double-core Cortex-A9 MP-Core derived and Xilinx generated by smart for the entire design of the hardware device. It also includes the on-chip storage, external connectors, and a rich range of I/O peripheral devices in addition to the Embedded system. It comprises a wealth of FPGA analytical tools that are available for various devices and frameworks.

It follows the MicroBlaze IP core as the controller is entirely produced with low-powered and quality FPGA tools in this program. For connectivity between the ARM controller and the processor, a UART protocol is introduced. The panel also supports the power source and DDR. The hardware architecture of the proposed Vehicle Surveillance Framework using the Internet of Things (IVSF-IoT) is shown in Fig. 3.

It accesses available 17 analog external input cables using 12-bit ADC on board. The ADC framework can be accessed from analog signal output detectors. It operates personalized FPGA IP centers to incorporate various digital signal implementations, such as Serial port, Arduino UNO, IIC, etc., for these Electronic Detectors. In this implementation, two Arduino frameworks have been developed and introduced for heat, humidity indicators, and a Gsm modem UART controller. FPGA tools for TEDS memory are used to enforce a 64KB BRAM.

Using rich ARM I/O devices, it collects a range of high-speed adapters directly from the USB and LAN. An Ethernet connection attaches the panel to digital webcams in this research. The device can reach the internet via air with the 4G unit or Wireless via a USB port.

3.3 Software Design

The automobile surveillance system primarily acquires, processes, and transmits atmospheric data in this article. Considering that the device consists of 2 components: the data processing module and the central system, both for the acquiring and high-performance Linux operating systems for the master unit, it accepts lightweight. The entire system will run with high efficiency and low electricity usage with this design.

It also developed an autonomous software framework for acquiring, analyzing, and transmitting sensor information as per IEEE1451.2 for the data acquisition framework.

Fig. 4 shows the flowchart of the proposed Vehicle Surveillance Framework using the Internet of Things (IVSF-IoT). The machine will start and then join the waiting period for the main module submission. When the demand signal is detected, the unit decides the requested signal type. The module answers the object detection request to a particular sensor, performs data, interprets read operations, and transfers the findings to the master unit. The framework answers the TEDS data query to the specific TEDS system and transmits the list to the master unit. In addition, the self-test feature is implemented to monitor the state of the whole module.

The Master Unit primarily manages the device, processes, and transfers various files. The beta-Linux runtime framework is compiled to execute the functionality mentioned above and implemented, allowing multiple software drivers and dependencies.

It created and established data processing agents that collect sensor data to manage digital cameras for information acquisition systems and video recording agents. In addition, a wireless connection building, system servicing, and data exchange processing and control unit have been created. Fig. 5 is shown the device architecture of the proposed Vehicle Surveillance Framework using the Internet of Things (IVSF-IoT).

3.4 Video Analysis Framework

Footage with a camera mounted to the roadside is filmed. The built-in camera has a framing rate of 30 images per second, where each image is 460 to 680 pixels in size. It should be remembered that a higher framing rate and the more good quality camera provides extensive detail about time and automobile.

It calculates the image data with the picture of the street frame. This stage aims to clear all fixed items, such as trees, bars, and panels. This move both facilitates the mission and determines the path of the passing car. The new position of the vehicle is denoted in Equation (1)

$$N(p) = F(e) \times V(p) \quad (1)$$

F(e) is a position value of the picture, N(p) a new position of the vehicle, V(p) mask p-point value. As an optimum value, a limit of 50 has been found. The statistical cutoff calculation is shown in Equation (2)

$$a(x, y) = \begin{cases} 0 & f(x, y) < 40 \\ 1 & else \end{cases} \quad (2)$$

The statistical cutoff value is denoted as$a(x, y)$, the two-dimensional position of the vehicle is denoted as$f(x, y)$. The next step is to identify the automobile path in frames after detection. The observed vehicle's structural centers are represented in Equations (3) and (4)

$$X_c = \frac{\sum_{j=0}^{n} x_j}{n} \quad (3)$$

$$Y_c = \frac{\sum_{j=0}^{n} y_j}{n} \quad (4)$$

The vehicle center location is denoted as X_c, Y_c. The respective vehicle position at each second is denoted as x_j and y_j. The number of vehicles is denoted as n. All ranges between objects must be calculated to trace a car between all the photos of the automobile from view n to view n+1 using coordinates (x_k, y_k). The energy can be measured using Equation (5)

$$d_k = \sqrt{(x_k - x_c)^2 + (y_k - y_c)^2} \quad (5)$$

The two-dimensional coordinates of the vehicle are denoted as (x_k, y_k). The center location of the vehicle is denoted as (x_c, y_c). The last step is to measure the velocity of the automobile after monitoring the picture, using the velocity formula given in Equation (6)

$$s = v \times t \quad (6)$$

s is denoted the speed corresponds to length d measured in the last step. The time is denoted as t, and velocity of the vehicle is denoted v. And t are based on k, which can be determined in Equation (7):

$$t = \frac{1}{k} \quad (7)$$

k is denoted the temporary constant concerning the time t. The necessary velocity of the vehicle is represented in Equation (8);

$$v = ks \times v_0 \quad (8)$$

Where v_0 is denoted the apportionment constant, the length between the car and the camera can differ. In this way, the vehicle's speed is identified and used to indicate the high-speed users on the road.

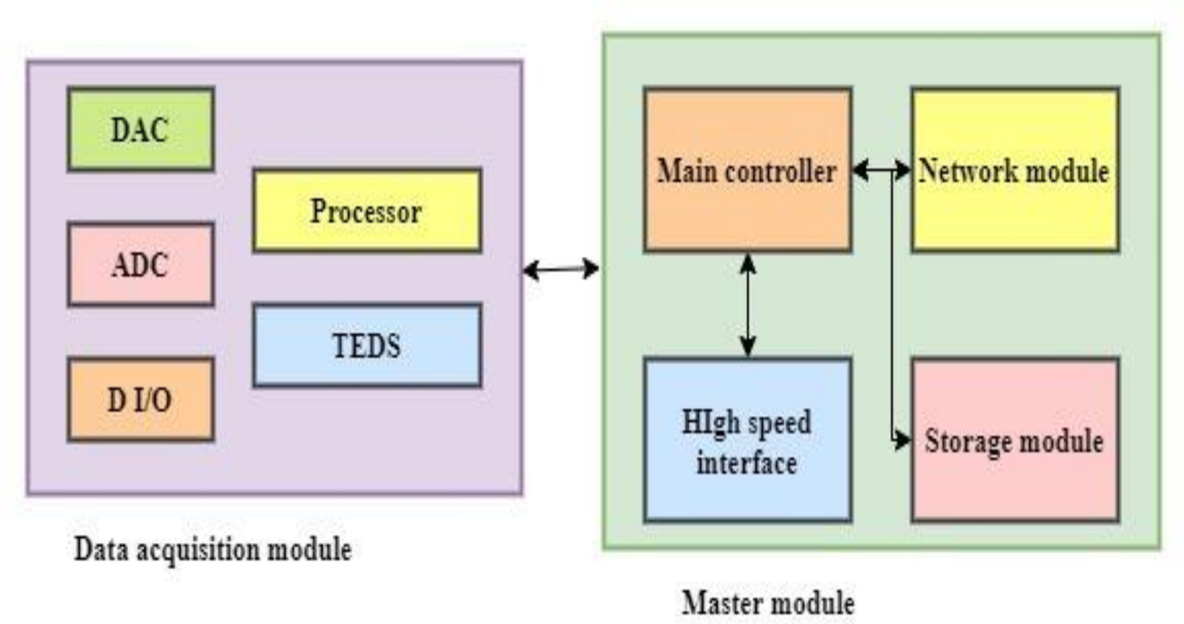

Figure 1 Block diagram of the proposed Vehicle Surveillance Framework using Internet of Things (IVSF-IoT)

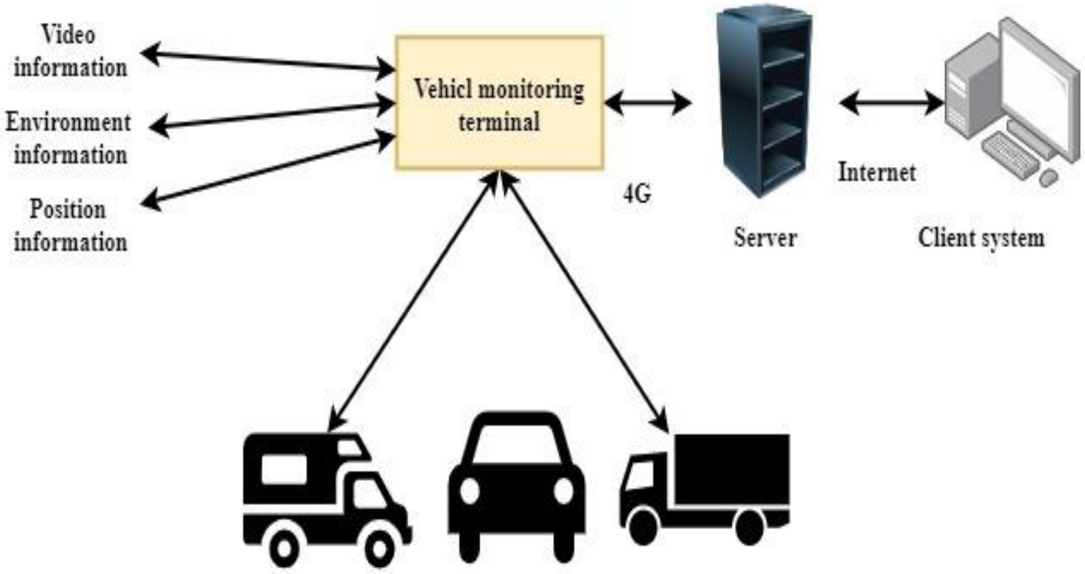

Figure 2 Application scenario of the proposed Vehicle Surveillance Framework using Internet of Things (IVSF-IoT)

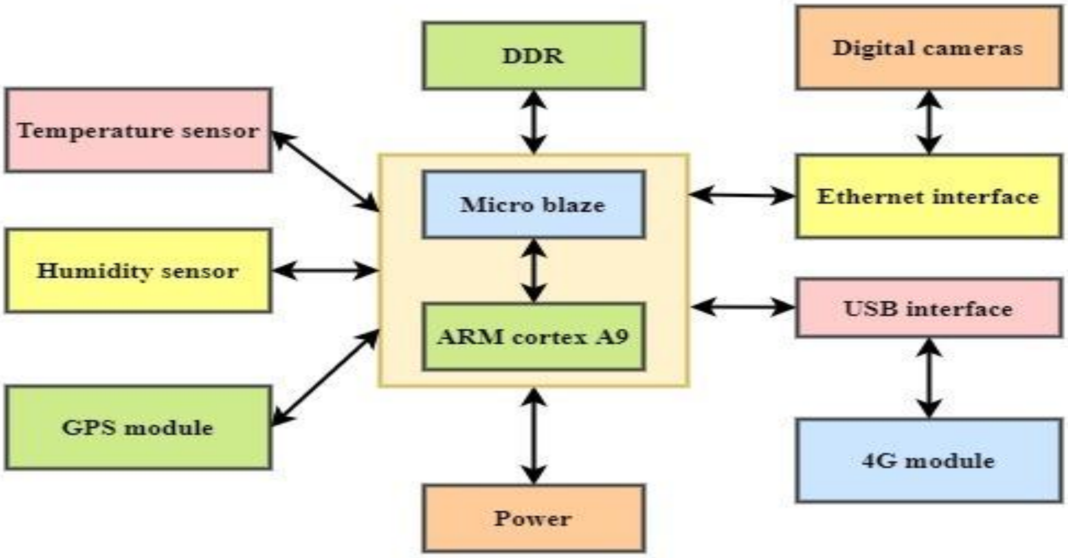

Figure 3 Hardware architecture of the proposed Vehicle Surveillance Framework using Internet of Things (IVSF-IoT)

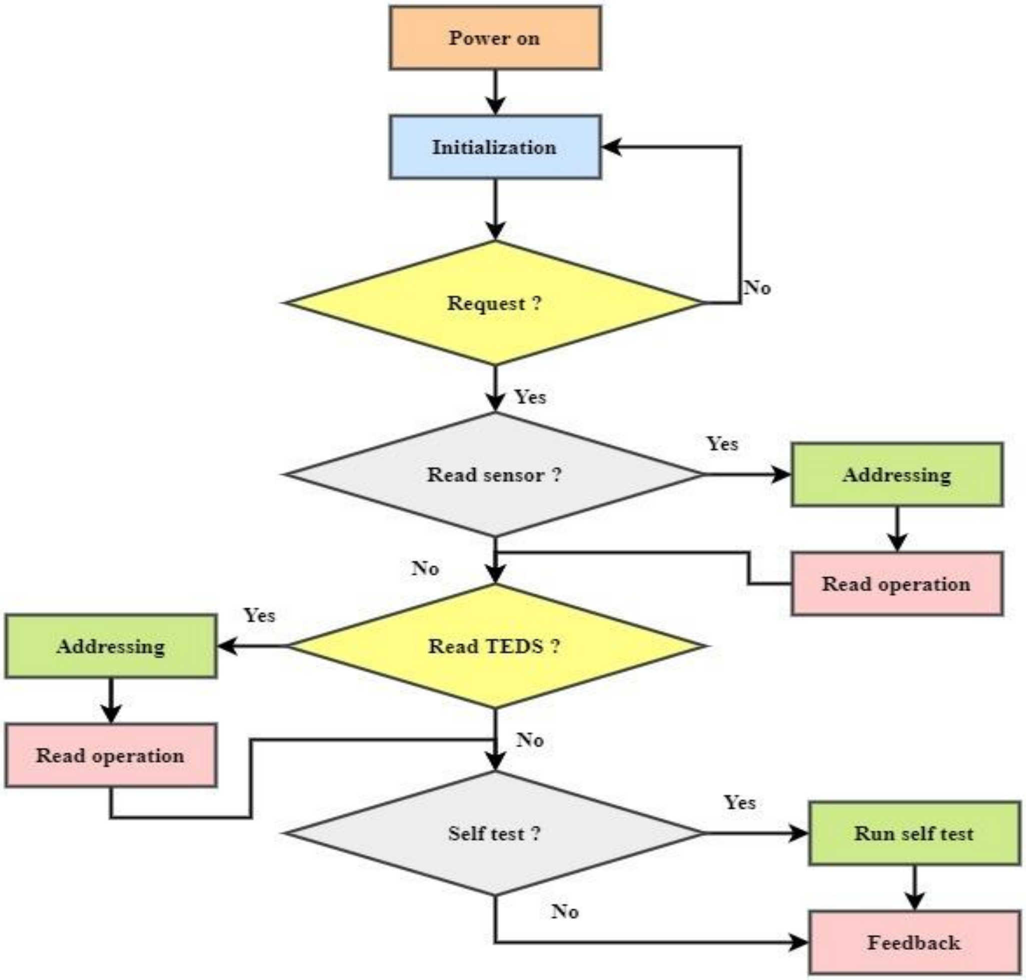

Figure 4 Flowchart of the proposed Vehicle Surveillance Framework using Internet of Things (IVSF-IoT)

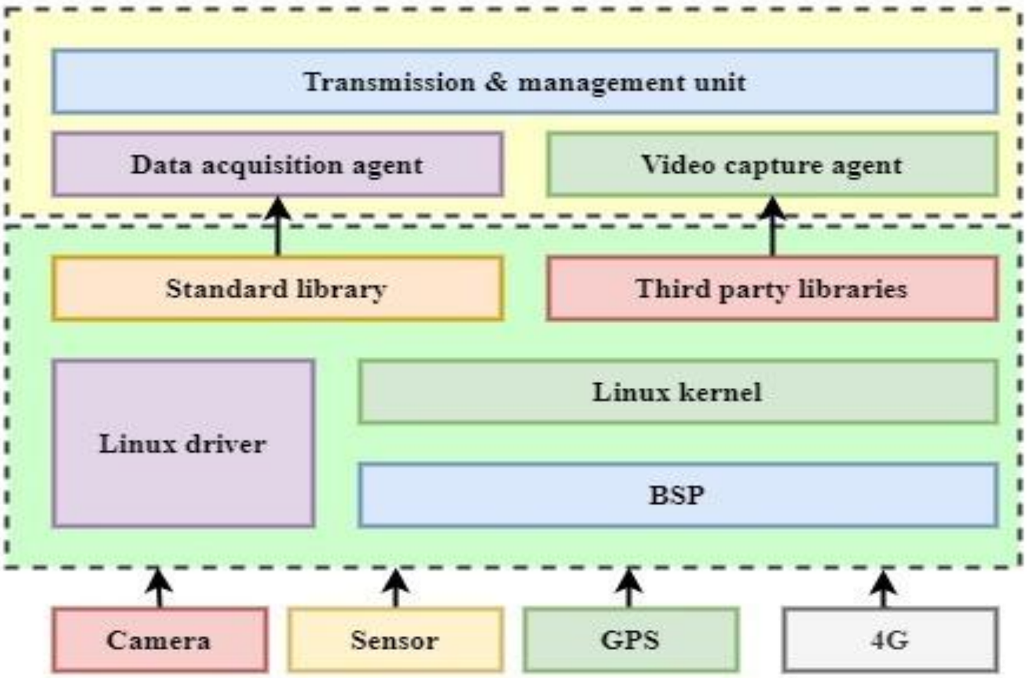

Figure 5 Device architecture of the proposed Vehicle Surveillance Framework using Internet of Things (IVSF-IoT)

4 SOFTWARE ANALYSIS

Table 1 shows the simulation parameters of the proposed Vehicle Surveillance Framework using the Internet of Things (IVSF-IoT). The parameters such as number of cameras, protocols used, number of sensors are shown in the table for the simulation analysis.

Table 1 Simulation parameters

Parameter	Value
Number of cameras	4
Antenna	Omnidirectional antenna
Network	LTE
Protocol	TCP/IP
Video transmission	RTSP
IP	IPv4
Programming language	C
Number of sensors	10

Fig. 6 shows the vehicle identification of the proposed Vehicle Surveillance Framework using the Internet of Things (IVSF-IoT). The identified vehicle is marked with a red box, and their respective speed is noted based on the vehicle number. The dataset is used for the simulation analysis is taken from [30].

Figure 6 Vehicle identification of the proposed Vehicle Surveillance Framework using Internet of Things (IVSF-IoT)

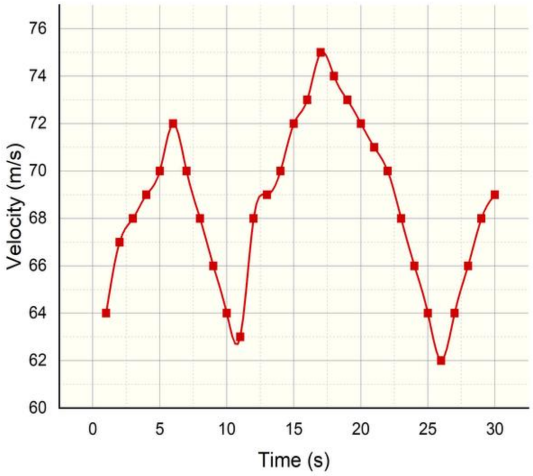

Figure 7 Velocity analysis of the vehicle

Fig. 7 shows the velocity analysis of the vehicle. The vehicle's velocity is continuously monitored, and the individual variations are plotted in the above figure. The car's high speed is identified, and a fine is sent to the respective user from the results.

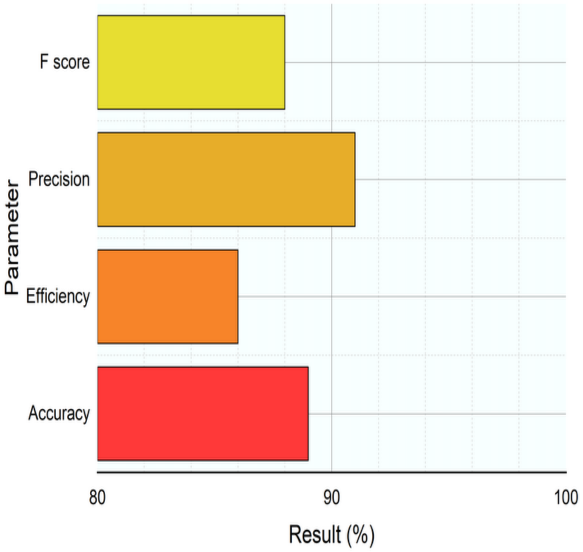

Figure 8 Performance analysis of the proposed Vehicle Surveillance Framework using Internet of Things (IVSF-IoT)

Fig 8 shows the performance of the proposed Vehicle Surveillance Framework using the Internet of Things (IVSF-IoT). The simulation outcomes such as Accuracy, Efficiency, Precision, and F score of the proposed system are analyzed, and the result is plotted in the above figure. The proposed method has the highest performance in all situations.

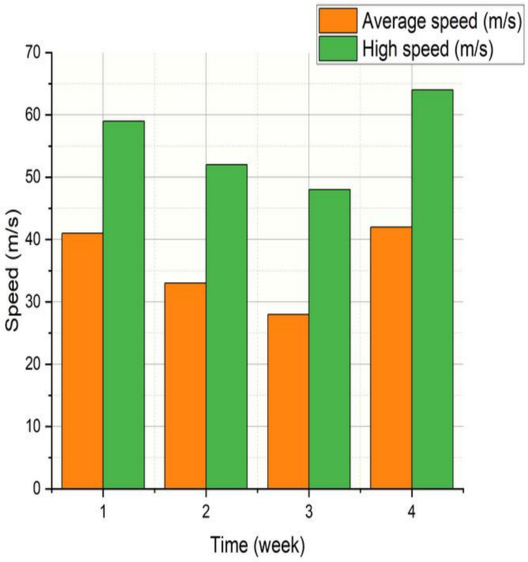

Figure 8 Speed analysis of the vehicle

Fig. 8 shows the speed analysis of the vehicle. A particular car is analyzed over one month, and the average speed and the high per week are calculated and plotted in the above figures. From the analysis, the user driving experience can be identified.

The proposed Vehicle Surveillance Framework using the Internet of Things (IVSF-IoT) is designed and implemented. The software analysis, such as accuracy, precision, efficiency, F score, speed, and velocity, is analyzed. The results show that the proposed method has the highest performance.

5 CONCLUSION AND FUTURE SCOPE

This article introduces a Vehicle Surveillance Framework using the Internet of Things (IVSF-IoT), taking the IEEE1451.2 model for multiple types of equipment in the IoT area. It is possible to unify access to different detectors and effectors, and high-speed systems that fulfill the specifications for real-time IoT applications. Taking full advantage of FPGA and SoC technology, the device offers robust processing, providing significant expansion while having less equipment and less energy consumption.

It tested the device achieved satisfactory accuracy during a realistic operation by considering the vehicle surveillance system as a standard example. The simulation outcomes such as Accuracy, Efficiency, Precision, and F score of the proposed system are analyzed, and the result is plotted in the above figure. The proposed method has the highest performance in all situations.

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