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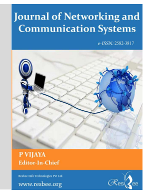

IoT Based Live Streaming and Object Detecting AI Robotic Car

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Abstract: The integration of IoT and AI in robotics has revolutionized the capabilities of robotic systems. IoT enables seamless connectivity and communication between devices, allowing for real-time data transmission and control. AI, on the other hand, empowers robots with advanced perception and decision-making abilities. The combination of these technologies in a robotic car facilitates real-time monitoring, autonomous navigation, and intelligent object detection, making it a powerful tool for various applications. In today's world, mechanical autonomy and fake insights (AI) are progressively utilized over different segments, including mechanical, therapeutic, and military areas. The rapid advancement of technology has paved the way for innovative solutions in various fields, including robotics. One such innovative solution is the development of an IoT-based live streaming and object-detecting AI robotic car. This research paper aims to explore the design, implementation, and potential applications of this robotic car, highlighting its significance in the modern technological landscape. The IoT-based live spilling and object-detecting AI robotic car, is outlined to function in situations that are perilous or blocked off to people. By leveraging the ESP32-CAM microcontroller coordinates with TensorFlow.js for question discovery, this robot proficiently adjusts picture preparation and engine control Inside its restricted memory limitations.

Keywords: IoT, Object Detection, AI, Robotic Car, Wireless Control, Surveillance.

Nomenclature

Abbreviation	Expansion
IoT	Internet of things
AI	Artificial intelligence
Wi-Fi	Wireless Fidelity
CSS	Cascading Style Sheets
HTML	Hypertext Markup Language
SLF	Structure of Life cycle
IoRT	Internet of Robotic Things
B2C	Business-to-consumer
JS	JavaScript
URL	Uniform Resource Locator

1. Introduction

The advent of the IoT and AI has brought forth a new era of technological innovation, particularly in the field of robotics. Robots are being utilized for different purposes in businesses, labs, Space, therapeutic segments, and front lines. Individuals are sending robots to places where a man can barely go like in space, submerged, bomb-encompassed zones. Innovation progressions are giving smaller and more cost-effective gadgets for joining computational preparation, remote communication, and a wave of other functionalities [1].

Manufactured insights are the reenactment of human insights forms by machines, particularly computer frameworks. Counterfeit insights (AI) innovation is progressively centered on protest location innovation. We are utilizing manufactured insights in our venture to recognize the question [3][5]. In our extend, we are going to identify the question utilizing ESP32-CAM with the Tensorflow.js JavaScript

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library. The microcontroller utilized on the robot encompasses a restricted memory that must be divided between picture handling for object discovery and controlling the engine to urge the correct course. This division must be done due to the constrained source. In this manner, a compelling and proficient strategy in picture handling is required [6]. Picture handling ought to be kept basic and effective to dodge pointless memory utilization. The association between the robot and the controlled framework has been set up through Wi-Fi innovation [7]. When we turn on the control of the robot and associate it with the current framework through Wi-Fi, one will work the robot by giving remote commands from the net browser using the capacities as of now modified within the ESP32-CAM [8].

The picture-preparing strategy is connected to identifying the question, and the processing is kept straightforward to decrease memory utilization. We'll use an ESP32-CAM microcontroller and compose the program code in C++ dialect. The ESP32-CAM may be a full-featured microcontroller that too has a coordinates video camera and microSD card attachment with a built-in streak-driven. It's reasonable and simple to utilize and is culminated for IoT gadgets requiring a camera with progressed capacities like picture following and acknowledgment.

1.2 Problem Statement

- ❖ On 24 April 2013, the Rana Square catastrophe was an auxiliary disappointment and 1134 individuals were dead. Around 2,500 harmed individuals were protected from the building lively. In such a put work a protection mission is exceptionally unsafe. The harmed man and the fire servicemen both were at chance in this circumstance.
- ❖ Within the current circumstances of the world, how do we keep up? In the case of serving patients with Covid-19.
- ❖ Most of the major companies center on creating high-end robots basically for mechanical purposes with tall taking a toll and upkeep and subsequently out of reach for common individuals.
- ❖ Moreover, most of the as of now sent robots within the advertise require specialized skills and an obliged environment with broad care and support.

1.3 Solution

- ❖ Based on the over circumstance on the off chance that we need to induce freed of those issues, we suggest our possess robot. Able to diminish the chance and spare human lives.
- ❖ Able to convey medicine to COVID-19 patients with our robot.
- ❖ The center of this venture is to create a low-cost and low-maintenance robot that's user-centric and requires no extra specialized information.
- ❖ This venture has been developed keeping in intellect the potential client. Each arrangement of improvement has centered on expanding the ease of client interaction. We will unravel such issues within the genuine world.

1.4 Objectives

- ❖ To provide the pharmaceutical to the COVID-19 understanding from a distance separate through IoT.
- ❖ To realize more exactness than human creatures.
- ❖ To assist in tracking individuals stuck beneath a building or any kind of contract put.
- ❖ To check the foes, show them on the spot are there and follow which kind of weapons are utilizing on the front line.
- ❖ To carry things inside is a constraint.
- ❖ To screen and control things.

1.7 Project Scope

- ❖ Within the therapeutic division and mechanical segment, this mechanical arm can be supportive for numerous assignments.
- ❖ It can be valuable to do unsafe errands and diminish human fiascos.
- ❖ It too can be utilized on the battlefield.
- ❖ This will be utilized for the space investigations.

The rest of the paper is arranged as follows: Section 2 represents the theoretical background, Section 3 explains the methodology, section 4 executes the result, Section 5 mentions the advantages and disadvantages of the proposed method and Section 6 concludes the paper.

2. Theoretical Background

A robot is for the most part an electromechanical machine that can perform errands whether naturally or physically or in both temperaments. It is additionally characterized as the mechanical machine that replaces the human being to work in such conditions, which is hazardous. Front-line assistive Robot can be characterized as a machine that expels the mines in war all by itself and can be utilized to spy on adversaries [1]. These days with the enhancement of innovation, robots are utilized in military operations, which are not programmed. Those were controlled remotely. Their operations can be from arranging bombs to looking over for regions. The physical and computerized world form an unused framework which is known by the term:

"Cyberphysical systems". This framework has more significance for developing IoT to deliver the more progressed rule within the meaning of mechanical autonomy which is driven to finding a term known as "internet of mechanical things or (IoRT)" [4]. Before long, the web of things (IoT) with other zones such as fake insights, and cloud computing can make a modern future for robots by presenting the following contract of savvy robots known as the "Internet of mechanical things (IoRT)". Inserted framework and Mechanical technology are the foremost successful fields for present-day innovation, we know that inserted framework may be a programmed controlling and working framework with devoted work [1]. A combination of implanted framework and mechanical technology creates a genuine life workable engine or gadget. That motor or gadget can be worked naturally or physically or by command.

Arduino-based Front line Assistive Robot's fundamental usefulness is to bargain with extreme circumstances where human creatures cannot handle circumstances like obscurity, entering contracts and little places, and recognizing covered-up bombs, etc. This framework works utilizing an RF flag through which full control of the framework reaction is done [1]. Utilizing a night vision camera connected to robot circumstances around the framework is observed according to which the robot is educated to move or do other functionalities. Other than with the mechanical arm anything can be picked and carried inside its limit and with the assistance of a metal finder, a GPS framework, and a cell phone, a flag will be gotten if there's a subterranean insect short of the bomb or metallic weapons around the robot.

North American Military's, "TISON, overwhelming EOD robot" This unmanned multi-mission robot contains a solid grasping instrument. Additionally, it contains an energetic wheel framework against any harsh surface. Despite such savvy highlights, it cannot work properly at night [9].

S. Naskar *et. al.* attempted to explore how a radio frequency-controlled robot can be utilized in defense and genuine war fields. The robot is radio-operated, self-powered, and has a backtracking office, in case of misfortune of association from the base station. Remote cameras will send back genuine time video and sound inputs that can be seen on an inaccessible screen within the base station from where the robot is being controlled and action can be taken in like manner [10]. Resistance-based flex sensor's exactness is destitute and hence controlling is troublesome [12]. In addition, utilizing accelerometers isn't a financially reasonable alternative.

In our venture, the automated car is controlled through an online real-time Wi-Fi connection, which can resolve network issues. To imagine the motion of the car for simple get-to and protest identification we utilized the ESP32-CAM module. The ESP32-CAM could be an exceptionally small camera module with the ESP32-S chip. ESP32-CAM is utilized in different IoT applications. This could be done by sending the commands wirelessly utilizing HTML planned web page through the Wi-Fi. Utilizing the camera with a built-in streak Driven was able to detect the protest in dull. The robot in conjunction with the camera can wirelessly transmit real-time video with camera controlling capabilities and utilizing the car anything can be picked up or dropped inside its constrain. This kind of robot can be exceptionally valuable for making a difference purposes within the war areas, industry, and therapeutic divisions. It is additionally a cost-effective and effectively controllable robot anybody can control it without proficient expertise.

2.1 Compare with Existing Work

Table 1 represent the comparision of six existing manuscript with the proposed system. The proposed method overcome the existing method in object detection, Image processing, Built-in flash LED, Support SD card, Support WI-FI, Support Bluetooth, Camera Module, and Digital voltmeter and solar panel.

Table 1. *Compare with Existing work*

Features	Arduino-based battlefield robot [1]	Stage-wise development of a remote-controlled robotic arm [2]	Pick and place robot [3]	Robot and autonomous controlled Robotic cars [7]	Robotic car using Arduino with Bluetooth controller [9]	AIGER An Intelligent vehicle for Military purposes [12]	Proposed project
Object detection	✓					✓	✓
Obstacle Detection				✓			
Image processing			✓				✓
Built-in flash LED							✓
Support SD card							✓
Support WI-FI			✓				✓
Support Bluetooth		✓		✓		✓	✓
Camera Module	✓		✓				✓
Digital voltmeter and solar panel							✓
Temperature sensor					✓		

3. Methodology

Robots work well in the delivery of goods, monitoring, and identification of objects. In our proposed model we used Tensorflow.js for object detection. The ESP32-CAM has the power to run an ML model directly. ESP32-CAM can detect faces but it doesn't have the power to run a complex model. Therefore, Tensorflow.JS is used to mix it with the video coming from the ESP32-CAM to detect objects. The Tensorflow.JS runs in the computer browser and the ML model runs in the browser. COCO-SSD is an ML to detects objects in a video streaming from the ESP32-CAM and to localize and identify objects in an image. TensorFlow has several pre-trained models that can be used to start easily with ML. TensorFlow is used initially and it is modified to adapt the ESP32-CAM. To use the Tensorflow.JS JavaScript library on a web page, the first step to use ESP32-CAM with Tensorflow.js to detect objects is building the web page where the inference will happen. To use the TensorFlow JavaScript library we have to follow these steps:

- ❖ Importing the TensorFlow JavaScript libraries.
- ❖ The ML model is pre-trained by COCO-SSD.
- ❖ Apply the COCO-SSD model to the incoming video and draw rectangles around identified objects.

Then integrate ESP32-CAM with Tensorflow.JS using the webpage we created.

3.1 Block Diagram

The camera captures images of the surroundings and the sensor detects fire, water, objects, etc., from the surroundings and sends them to the microcontroller. The microcontroller processes these images using TensorFlow.js to identify objects. Based on the analysis, the microcontroller sends commands to the motors to navigate the robotic car safely. The energy from the solar is obtained and stored in the battery that helps the motor to navigate. This entire process happens in real time, allowing the robotic car to respond quickly to its environment. The flow process is explained in the Fig.1.

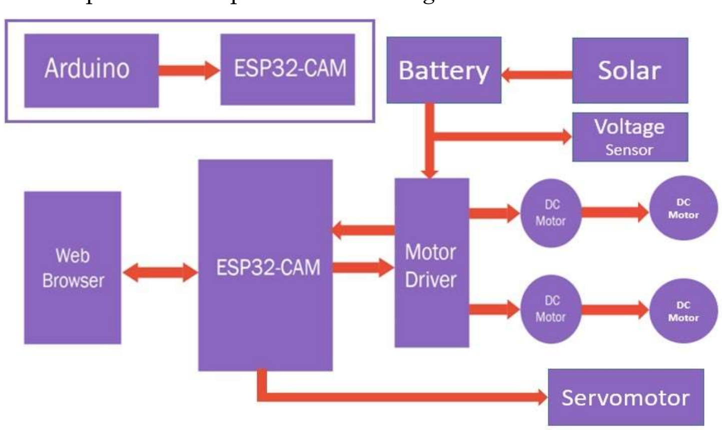

Fig. 1. *Project Block Diagram*

3.2 Hardware Requirement

3.2.1 Smart Robot Car Kit

The 4 Wheel Shrewd Robot Car Chassis Pack is an instructive learning unit (Fig.2) to urge hands-on encounters around Mechanical technology and can expand gadgets frameworks like Raspberry Pi, Arduino, etc. With frameworks and other gadgets, the car chassis can perform capacities of impediment evasion, separate testing, speed testing, or remote farther control.

It is simple to use with code disk. It is utilized to remove estimation and speed. This car is the tachometer encoder.

Fig. 2. *Smart Robot Car Kit*

3.2.2 Arduino MEGA 2560

The Arduino Mega 2560 (Fig 3) is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains a microcontroller that makes it simple to connect the computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila [17].

Fig. 3. *Arduino MEGA 2560*

The Specifications of the Arduino Mega 2560 are

- Operating voltage: 5V
- Input voltage (recommended): 7-12V
- Input voltage (limits): 6-20V
- Digital I/O pins: 54 (of which 14 provide PWM output)
- Analog input pins: 16
- DC current per I/O pin: 40mA
- DC current for 3.3V pin: 50mA
- Flash Memory: 256 KB, 8KB used by bootloader
- SRAM: 8 KB
- EEPROM: 4 KB
- Clock Speed: 16 MHz

The Pinout Diagram for the Arduino Mega 2560 is represented in Fig 4.

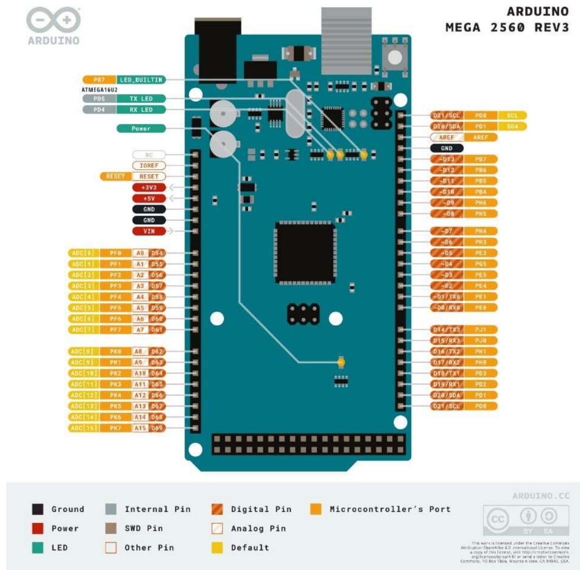

Fig. 4. *Arduino MEGA 2560 Pinout Diagram*

3.2.3 ESP-32 CAM

The ESP32-CAM is a full-featured microcontroller that also has an integrated video camera and microSD card socket. It's inexpensive and easy to use and is perfect for IoT devices requiring a camera with advanced functions like image tracking and recognition. The ESP32-CAM has a very competitive small-size camera module that can operate independently as a minimum system with a footprint of only 27*40.5*4.5mm and a deep sleep current of up to 6mA. ESP-32CAM adopts a DIP package and can be directly inserted into the backplane to realize rapid production of products, providing customers with a high-reliability connection mode, which is convenient for application in various IoT hardware terminals.

Fig. 5. *ESP-32 CAM*

The Pinout Diagram for ESP-32CAM is diagrammatically represented in Fig 6.

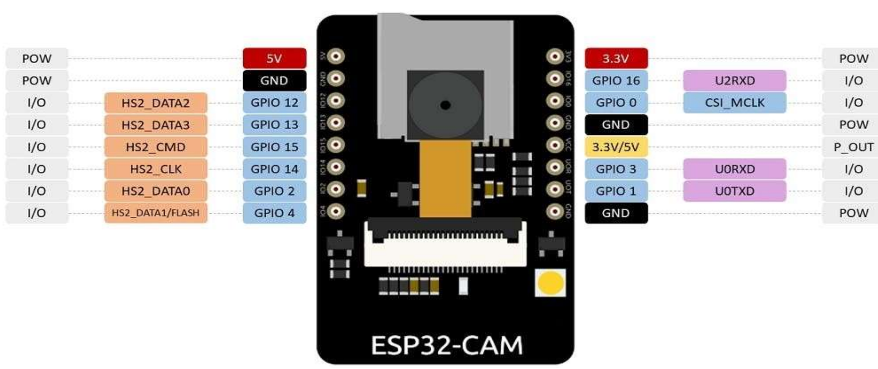

Fig. 6. *ESP-32 CAM Pinout Diagram*

3.2.4 Motor Driver

This L298N Motor Driver Module is a high-power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control. 78M05 Voltage regulator will be enabled only when the jumper is placed. When the power supply is less than or equal to 12V, then the internal circuitry will be powered by the voltage regulator, and the 5V pin can be used as an output pin to power the microcontroller. The jumper should not be placed when the power supply is greater than 12V and separate 5V should be given through a 5V terminal to power the internal circuitry. ENA & ENB pins are speed control pins for Motor A and Motor B while IN1& IN2 and IN3 & IN4 are direction control pins for Motor A and Motor B.

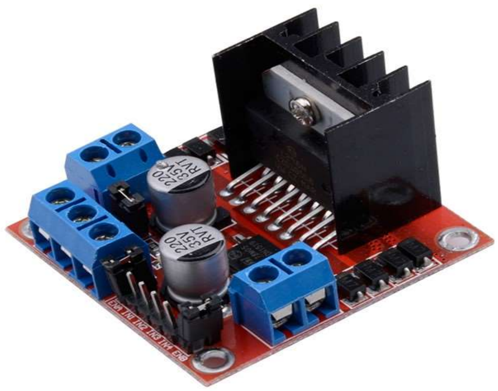

Fig. 7. *Motor Driver*

The Pinout Diagram for Motor Driver is diagrammatically represented in Fig 8.

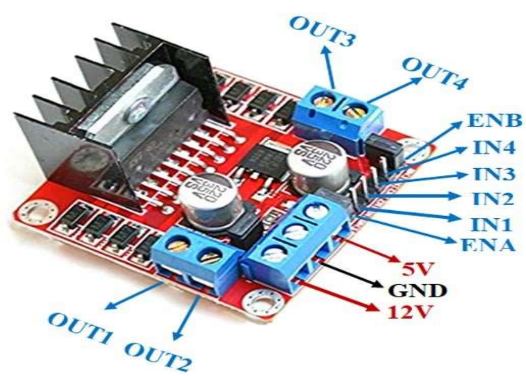

Fig. 8. *Motor Driver Pinout Diagram*

3.2.5 Micro Servo Motor SG90

Micro Servo Motor SG90 is a tiny and lightweight server motor with high output power. The servo can rotate approximately 180 degrees (90 in each direction) and works just like the standard kinds but smaller. We can use any servo code, hardware, or library to control these servos. Good to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. It has 3 horns (arms) and hardware.

Fig. 9. *Micro Servo Motor SG90*

The Pinout Diagram for the Micro servo motor SG90 is represented in Fig 10.

Fig. 10. *Micro Servo Motor SG90 Pinout Diagram*

3.2.6 Mini Solar Panel

Sun-oriented boards collect clean renewable vitality within the frame of daylight and change that light into power which can then be utilized to supply control for electrical loads. Sun-oriented boards retain the photons and in doing so start an electric current. The coming vitality produced from photons striking the surface of the sun-powered board permits electrons to be thumped out of their nuclear circles and discharged into the electric field produced by the sun-oriented cells which at that point drag these free electrons into a directional current. This whole handle is known as the Photovoltaic Impact.

Fig. 11. *Mini Solar panel*

3.2.7 Digital Voltmeter

The DSN-DVM-368 is a little module of only 32 mm x 12 mm x 9 mm. The small PCB is no larger than the three-digit segment display. On both sides, a little of the PCB material protrudes, so we can screw it behind a front panel.

Fig. 12. *Digital Voltmeter (DSN-DVM-368)*

When we disassembled the module, there were two chips hidden in the internal. Next to the processor is a 5V stabilizer, five resistors, two capacitors, and a diode. The power supply goes via the diode D1 to the voltage stabilizer IC1, which provides the +5 Vdc power supply for the microcontroller and the display. The diode D1 probably provides a better distribution of the heat power dissipated on the PCB, which is now divided between the diode and IC1.

The DSN-DVM-368 has two modes of operation

- Mode 1, three-wire

The jumper J1 is open. The input is then disconnected from +Ub and can use the module to measure DC voltages from 0 V to +30 V with a fixed supply voltage +Ub of at least +5 Vdc.

- Mode 2, two-wire

When the jumper J1 is closed. To connect the module with only two wires to the voltage to be measured, which is called the supply voltage. In this mode, the lowest measurable voltage is about +4.5 V. At a lower voltage, the circuit fails.

The input voltage is significantly reduced via the voltage divider R1/R2. The extra resistors R3, R4, and R5, which can be connected in parallel with R2 using the jumpers J2, J3, and J4 is unclear. We can use this to adjust the voltage divider so that the module has maximum accuracy. The seven segments of the display, the two decimal points, and the three digits are controlled from only ten lines. However, thirteen lines are needed. The segments and the decimal points are merged into a 5 x 5 matrix, as shown in Fig 13. A soldering iron with a fine tip and a steady hand is necessary when soldering the jumpers or replacing the wires.

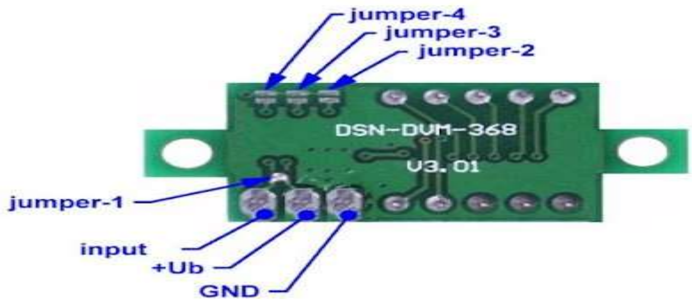

Fig. 13. *Digital Voltmeter back of the module*

3.2.8 Li-ion Battery-3.7V/6800mAH-18650 Model-Ultra fire

It is a rechargeable battery with re/discharging protection circuit. UltraFire produces different models with various capacities of 18650 batteries. There is a series of 18650 rechargeable lithium batteries from UltraFire. Battery capacity varies from 2200mAh to 7800mAh.

Fig. 14. *Battery*

3.2.9 DC Geared Motor 6V – Yellow

This gear motor is ideal for robotic cars or line-tracing robots. With plastic construction and colored in bright yellow, the DC gear motor measures approx. 2.5 inches long, 0.85 inches wide, and 0.7 inch thick. The wheel can be mounted on either side and the gearmotor works well between 4V to 7V (recommended 6 Volts). At a ratio of 1:48, we can get some good torque at 5 Volts.

Fig. 15. *DC Motor*

3.3 Software Requirement

- Arduino IDE
- Web Browsers
- Visual Studio Code or any other code editor

3.4 Use Case Diagram

The robotic car is mainly used for image processing and object detection, sending data and objects to the desired location, controlled wirelessly, results are live streamed and connected through multiple devices through WI-FI. The complete use case diagram is represented in Fig.16.

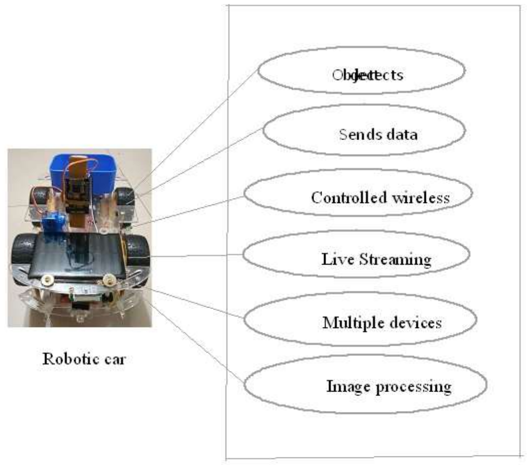

Fig. 16. *Use Case Diagram*

3.5 Circuit Diagram

The circuit diagram helps to understand the visual representation of an electrical circuit. It shows how different components are connected. The combination of the microcontroller, sensors, and motors allows the robotic car to perform tasks autonomously. The circuit diagram is represented in Fig 17 and 18.

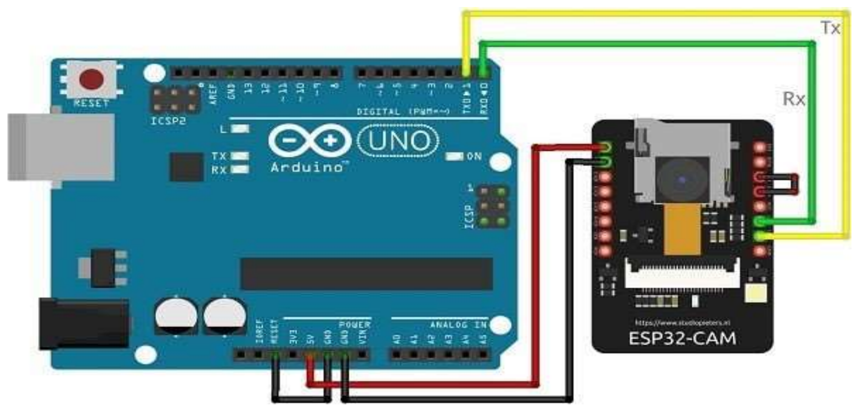

Fig. 17. *Circuit Diagram 1*

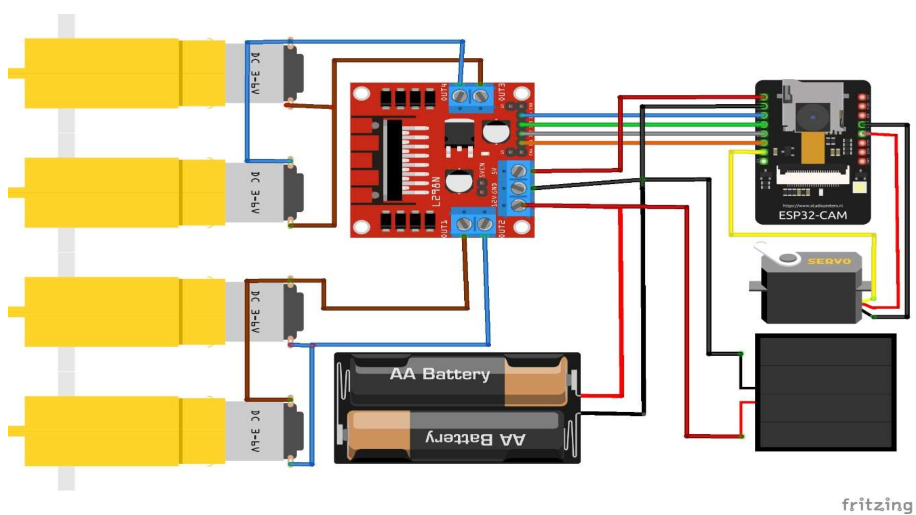

Fig. 18. *Circuit Diagram 2*

3.6 Budget

Arduino MEGA 2560	1250
Car kit and DC motor (4p)	550
ESP32-CAM	950
Motor driver	150
Jumper Wires	150
Li-Po battery (4p)	200
Battery charger	200
Digital Voltmeter	150
Solar Panel	200
Servomotor	100
Extra cost	100
Total taka	4000

4. Result

The robotic car is tested in various scenarios such as single-object detection, multi-object detection, Dim light, etc. The result object from the camera is displayed on the monitoring and display screen. Where it contains output from the camera and the direction options for navigation. Fig 19-24, represents the single object and multiple object detection.

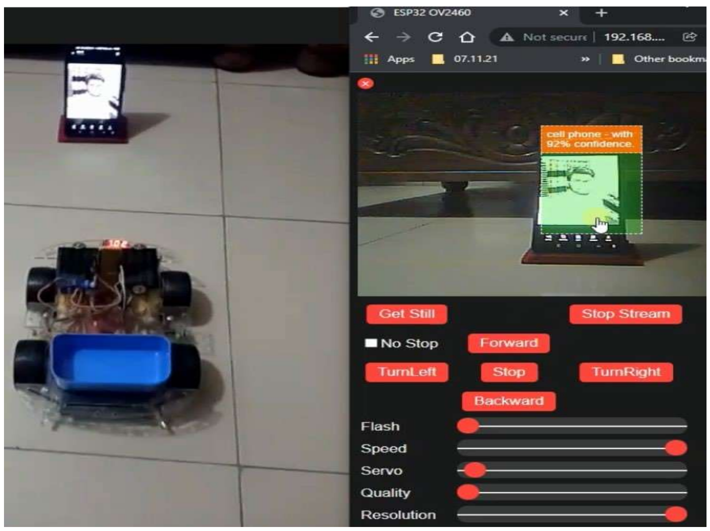

Fig. 19. *Object Detection*

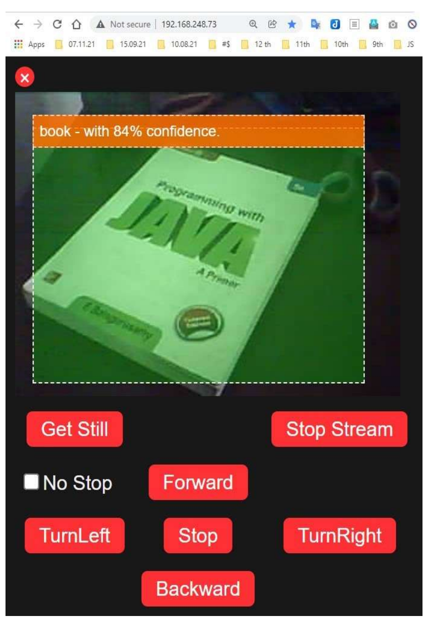

Fig. 20. *Single Object Detection*

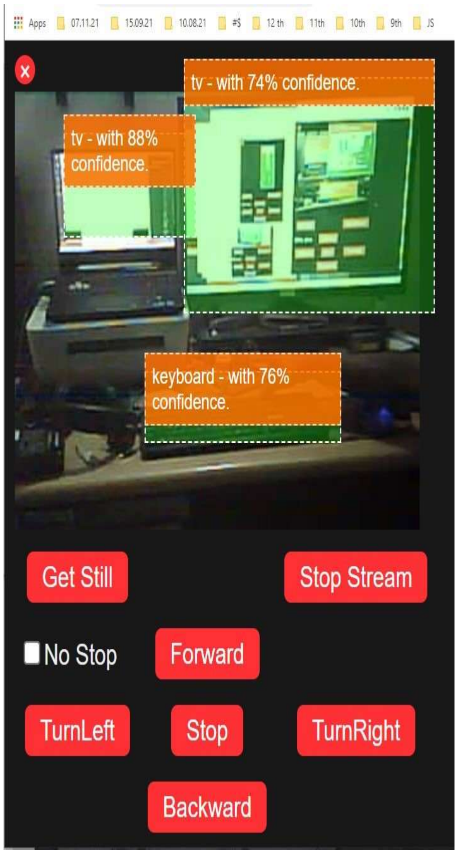

Fig. 21. *Multiple Object Detection*

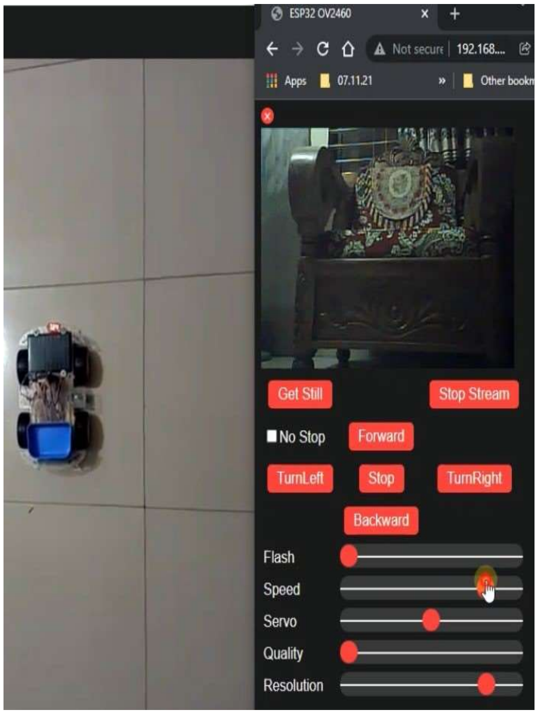

Fig. 22. *Live Streaming*

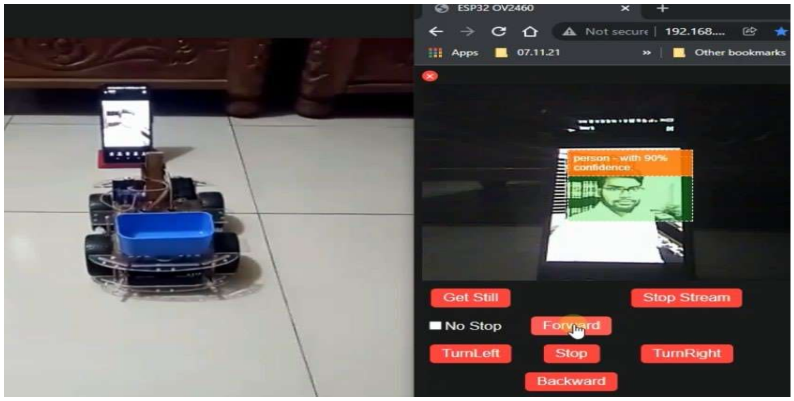

Fig. 23. *Other scenarios-01*

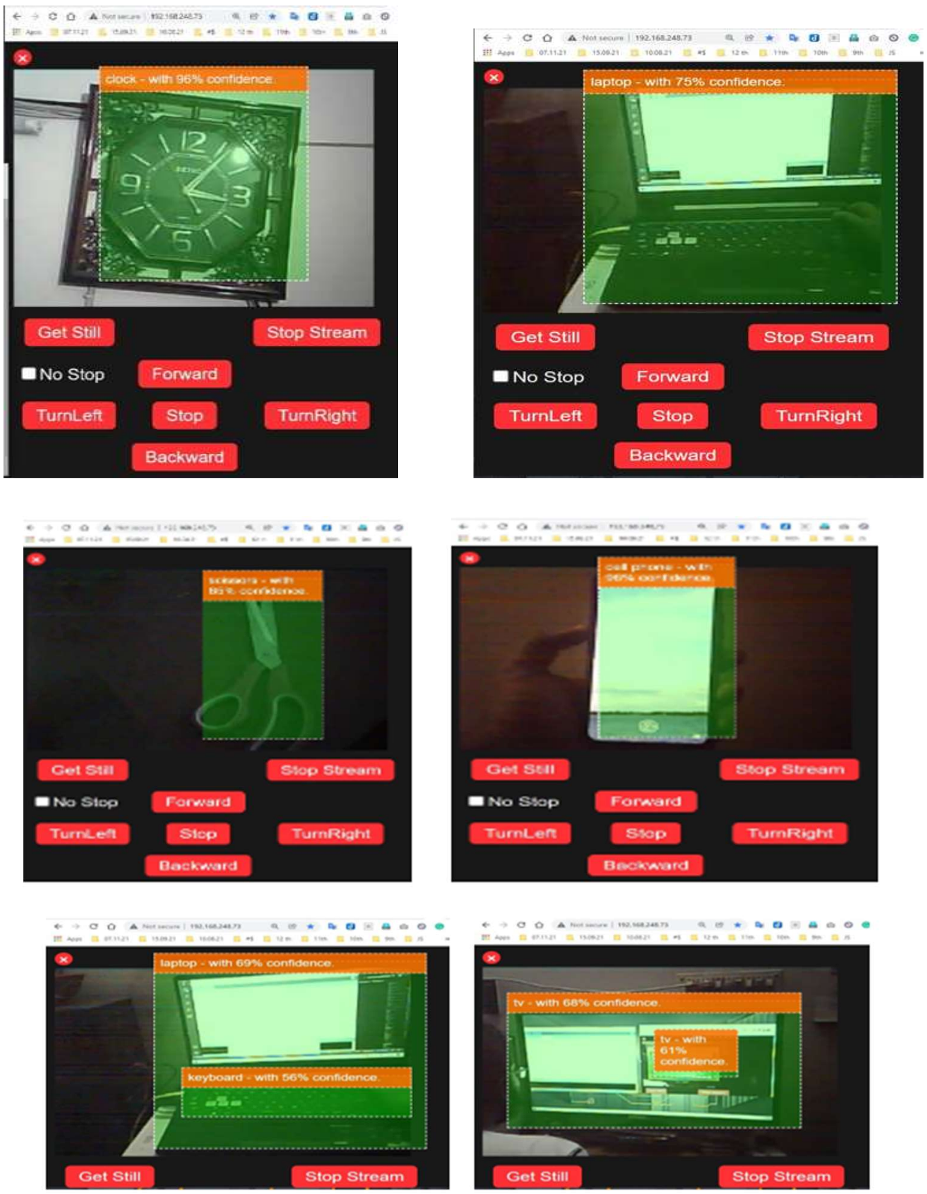

Fig. 24. *Other scenarios-02*

4.1 Discussion

The results of the IoT live streaming and object-detecting AI robotic car are significant due to its advanced functionality, adaptability, and potential for real-world applications. The combination of IoT and AI not only enhances the robot's capabilities but also opens up new avenues for its use in various sectors, making it a valuable tool in modern technology. Several key aspects that highlight its effectiveness and potential applications:

Functionality and Efficiency: The robotic car operates effectively using an ESP32-CAM board, which allows for real-time data transmission and control. This integration of IoT and AI enhances the robot's capabilities, making it more efficient than human operators in various tasks. It also helps to reach unreached places during disasters, military operations, and other exploration.

Real-time Monitoring and Navigation: The combination of IoT and AI enables the robotic car to perform autonomous navigation and intelligent object detection. This is particularly beneficial in environments that are hazardous or inaccessible to humans, showcasing the robot's utility in critical situations. Real-time monitoring helps to predict the situation very easily and effectively.

Adaptability and User-Centric Design: The development process utilized a Rapid Application Development (RAD) approach, which allows for flexibility and adaptability in the design. This method has led to a high success rate, as the system can be modified based on user feedback before finalization.

5. Advantages and Disadvantages

Advantages

- The proposed method significantly improves object detection capabilities compared to existing systems in the accurate detection of objects.
- The robotic car is used in emergencies where timely information is critical.
- The development process focused on creating a low-cost and low-maintenance robot that requires minimal technical knowledge from users. This makes the technology accessible to a broader audience, enhancing its usability.

Disadvantages

- The system is designed for specific tasks. If future needs arise that require expansion or modification, it may be challenging to adapt the existing framework.
- The effectiveness of the robotic car heavily relies on stable internet connectivity for real-time data transmission. In areas with poor connectivity, the performance of the system may be compromised
- The current design may face challenges related to power supply, especially during prolonged operations. Enhancements in power management are necessary to ensure sustained functionality.

6. Conclusion

The proposed method emphasizes its efficiency, potential for future development, integration of advanced technologies, and ability to address critical real-world challenges. The robot is based on an ESP32-CAM board with a movable base. This robot is more efficient than humans. The robotic car demonstrates a higher efficiency compared to human operators in various tasks, particularly in environments that are hazardous or difficult to access. This efficiency is crucial for applications in military, medical, and emergency response scenarios, where human safety is a priority. The system can be expanded to operate in diverse environments, such as high and low terrains, space exploration, and even battlefields, enhancing its versatility and applicability. There are some recommendations for Future works. To improve the effectiveness and efficiency of the system. The following recommendations can be put into consideration

- ❖ A robotic arm can be added.
- ❖ Power supply could be more efficient than present this will help the demo Robot with more life to live.
- ❖ Try to find a way to amplify the Wi-Fi module signal to work at a greater Distance.
- ❖ It could be more effective by coding more AI code.

Compliance with Ethical Standards

Conflicts of interest: Authors declared that they have no conflict of interest.

Human participants: The conducted research follows the ethical standards and the authors ensured that they have not conducted any studies with human participants or animals.

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