Koneru Lakshmaiah Education Foundation (Deemed to be University)

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(Skill Development Project)

A Project Report

On

SURVEILLANCE CAR USING ESP32 CAM MODULE

SUBMITTED BY:

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(DST-FIST Sponsored Department)

DECLARATION

The Project Report entitled **"SURVEILLANCE CAR USING ESP32 CAM MODULE"** is a record of bonafide work of **2200040115 G.KEERTHAN SAI** submitted in partial fulfillment for the award of B.Tech in Electronics and Communication Engineering to the K L University. The results embodied in this report have not been copied from anyother departments/University/Institute.

ABSTRACT

This project focuses on the development of a cost-effective surveillance solution using the ESP32-CAM module integrated into a mobile platform. The system aims to provide real-time monitoring capabilities for indoor and outdoor environments, enhancing security and surveillance applications. The ESP32-CAM module, known for its compact size and integrated camera, serves as the core component for capturing video footage and transmitting it wirelessly to a remote monitoring station.

The surveillance car platform is designed to be highly maneuverable, allowing it to navigate through various terrains and obstacles. Integration with motor controllers enables remote control functionality, allowing operators to steer the vehicle and adjust camera angles remotely. Additionally, the system incorporates features such as motion detection and night vision to enhance its surveillance capabilities, ensuring continuous monitoring even in low-light conditions.

Communication between the surveillance car and the remote monitoring station is facilitated through wireless protocols such as Wi-Fi or Bluetooth, providing flexibility in deployment scenarios. A user-friendly interface accessible via web or mobile applications allows operators to view live video feeds, control the surveillance car, and configure settings remotely.

Through the utilization of the ESP32-CAM module and innovative design of the surveillance car platform, this project offers an affordable and scalable solution for remote monitoring and surveillance applications, with potential applications in home security, industrial monitoring, and public safety.

Literature Survey

1. **ESP32-CAM Module**: Understanding the capabilities, limitations, and applications of the ESP32-CAM module in surveillance systems.
2. **Surveillance Systems**: Exploring different approaches, techniques, and components commonly used in surveillance systems, such as cameras, sensors, communication modules, and microcontrollers.
3. **Vehicle Surveillance**: Studying existing projects or research on surveillance systems integrated into vehicles, including cars, drones, or robots, to understand design considerations, challenges, and best practices.
4. **Wireless Communication**: Investigating methods for wireless communication between the surveillance car and a control center or remote monitoring system, considering factors like range, reliability, and security.
5. **Image Processing and Analysis**: Reviewing techniques for real-time image processing and analysis on embedded systems like ESP32, including object detection, motion tracking, and facial recognition.
6. **Power Management**: Examining strategies for efficient power management in mobile surveillance systems, considering factors like battery life, power consumption, and charging methods.
7. **Data Storage and Transmission**: Exploring approaches for storing and transmitting surveillance data, such as onboard storage, cloud services, or real-time streaming.
8. **Security and Privacy**: Investigating methods for securing data transmission, preventing unauthorized access, and ensuring privacy compliance in surveillance systems.

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Introduction

In an era where security is paramount, leveraging technology to monitor and protect our surroundings has become increasingly essential. Enter the ESP32-CAM module, a compact yet powerful tool that integrates both an ESP32 microcontroller and a camera module into a single unit.

In this project, we embark on the journey of creating a surveillance car armed with the capabilities of the ESP32-CAM. Our aim is to design a versatile and efficient system capable of patrolling and monitoring areas autonomously, all while providing real-time video feedback.

By combining the robust features of the ESP32 microcontroller with the imaging capabilities of the camera module, we unlock a myriad of possibilities for surveillance applications. Whether it's safeguarding our homes, monitoring remote locations, or enhancing security measures in industrial settings, our surveillance car promises to deliver reliable performance and actionable insights.

Throughout this project, we will delve into the intricacies of hardware setup, firmware development, and software integration, ensuring that our surveillance car is not only functional but also customizable to meet specific requirements. From navigating obstacles to streaming live video feeds, every aspect of the system is meticulously crafted to fulfill its surveillance objectives with precision and efficiency.

Join us as we explore the potential of the ESP32-CAM module and unleash the full capabilities of our surveillance car, ushering in a new era of intelligent monitoring and security solutions.

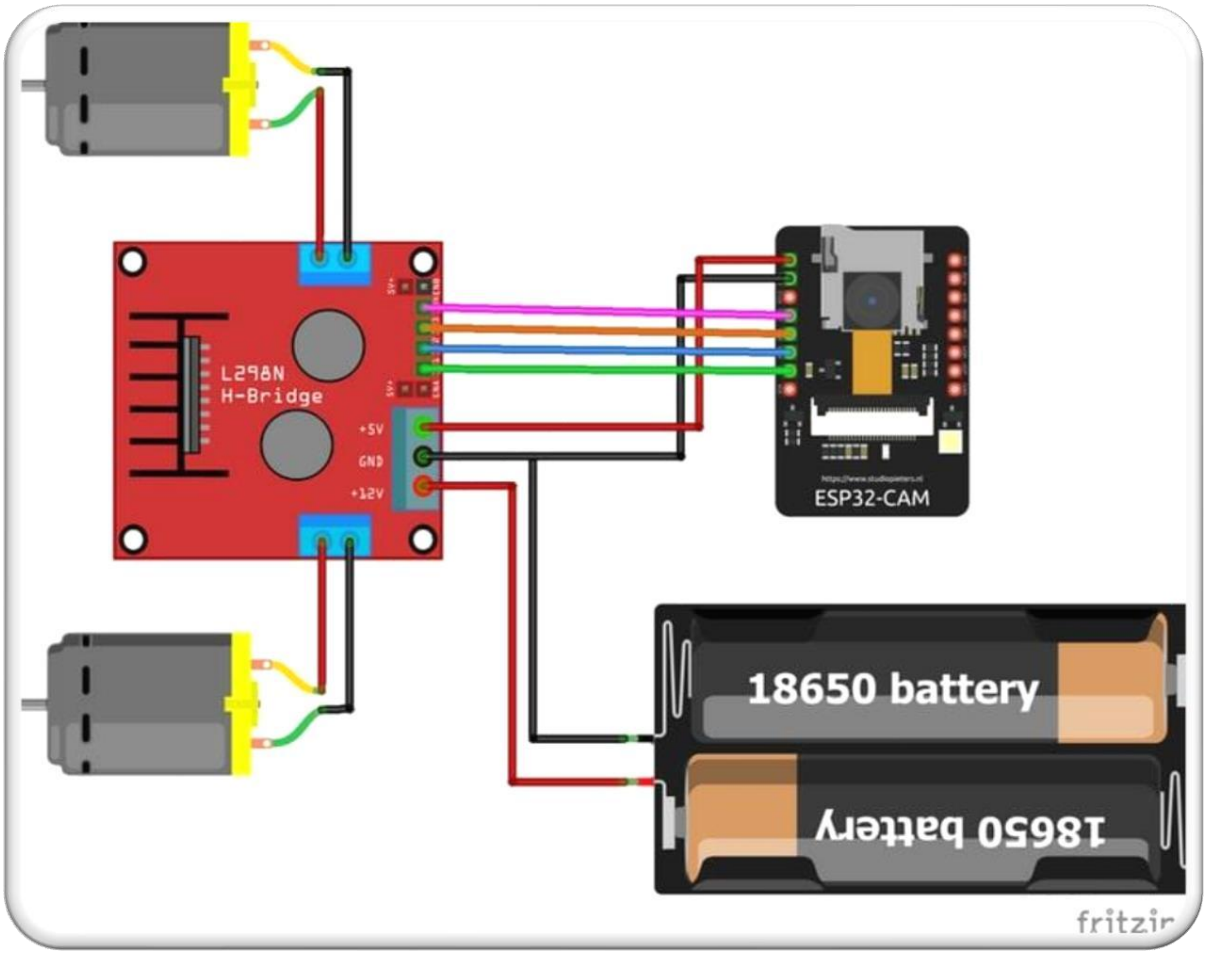
Aim of the Project

The aim of a project for a surveillance car using an ESP32-CAM module could vary depending on the specific goals of the project and the needs of the user. However, some common aims might include:

1. **Remote Monitoring**: Creating a surveillance system that allows users to remotely monitor a specific area or property in real-time using the ESP32-CAM's camera capabilities.
2. **Security**: Enhancing security by providing a mobile surveillance solution that can patrol an area and detect any suspicious activities or intruders.
3. **Automation**: Developing a system that can autonomously navigate through predefined routes or respond to certain triggers, such as motion detection, to capture images or videos.
4. **Data Logging**: Logging visual data (images or videos) for later review or analysis, which can be useful for surveillance purposes or for gathering data about a particular environment.
5. **Integration**: Integrating the surveillance car with other systems or platforms, such as IoT frameworks or home automation systems, to enable more advanced functionalities or to provide alerts and notifications.
6. **Accessibility**: Creating a cost-effective and accessible solution for surveillance that can be easily deployed and customized by hobbyists, researchers, or small businesses.

Ultimately, the aim of the project would be to leverage the capabilities of the ESP32-CAM module to create a functional and efficient surveillance car system that meets the specific requirements and objectives of the project.

Proposed Methodology



Designing a surveillance car with an ESP32-CAM module involves several steps. Here's a proposed methodology:

1. **Define Requirements**: Clearly outline what you want your surveillance car to do. Consider factors like range, video quality, control mechanisms, etc.
2. **Hardware Selection**: Choose the necessary hardware components. This includes the ESP32-CAM module, motor driver, motors, wheels, chassis, battery, and any additional sensors or modules you might need.
3. **Assembly**: Assemble the hardware components. Mount the ESP32-CAM module securely on the chassis, connect the motors to the motor driver, attach the wheels, and connect all necessary wires and components.
4. **Programming ESP32-CAM**: Write the firmware for the ESP32-CAM module. You'll need to program it to capture and stream video, control the motors based on user input, and possibly interact with additional sensors (like ultrasonic sensors for obstacle avoidance).
5. **Remote Control Interface**: Develop a remote control interface for the surveillance car. This could be a mobile app, a web interface, or even a dedicated controller. Ensure it can send commands to the ESP32-CAM module to control the movement and other functionalities of the car.
6. **Video Streaming Setup**: Configure the ESP32-CAM module to stream video over Wi-Fi. You might use protocols like RTSP (Real-Time Streaming Protocol) or HTTP to achieve this. Ensure the streaming setup meets your requirements for video quality and latency.
7. **Testing and Debugging**: Test the surveillance car thoroughly. Check if it can move as expected, if the video streaming works correctly, and if it responds properly to remote control commands. Debug any issues that arise during testing.
8. **Optimization and Refinement**: Optimize the surveillance car's performance and refine its features based on testing feedback. This might involve improving the control algorithm, enhancing the video streaming quality, or adding new functionalities.

Components Explanation

A surveillance car using an ESP32-CAM module typically consists of several key components:

1. **ESP32-CAM Module**: This is the heart of the surveillance car. The ESP32-CAM is a microcontroller module based on the ESP32 chip, which integrates both Wi-Fi and Bluetooth capabilities. It also features a camera interface, allowing it to capture images and video.
2. **Motor Driver**: The motor driver circuit controls the movement of the surveillance car. It interprets commands from the ESP32-CAM and translates them into signals that drive the motors. Depending on the design, it may control DC motors or stepper motors for locomotion.
3. **Chassis and Wheels**: These physical components provide the structure and mobility for the surveillance car. The chassis is typically a platform where all other components are mounted, and the wheels facilitate movement.
4. **Power Supply**: An appropriate power supply is required to power the ESP32-CAM module, motor driver, and other electronic components onboard the surveillance car. This could be a battery pack or another power source.
5. **Camera**: The ESP32-CAM module features an onboard camera, which is used to capture images and video footage for surveillance purposes. This camera can be controlled and manipulated using the ESP32-CAM's firmware.
6. **Sensors (Optional)**: Depending on the surveillance requirements, additional sensors such as ultrasonic sensors, infrared sensors, or motion sensors may be added to detect obstacles, measure distances, or detect movement in the car's vicinity.
7. **Microcontroller Programming**: The ESP32-CAM module needs to be programmed to perform specific tasks related to surveillance, such as capturing images or video, transmitting data over Wi-Fi, controlling the motors, and responding to sensor inputs. This programming can be done using the Arduino IDE or other compatible development environments.

CODE

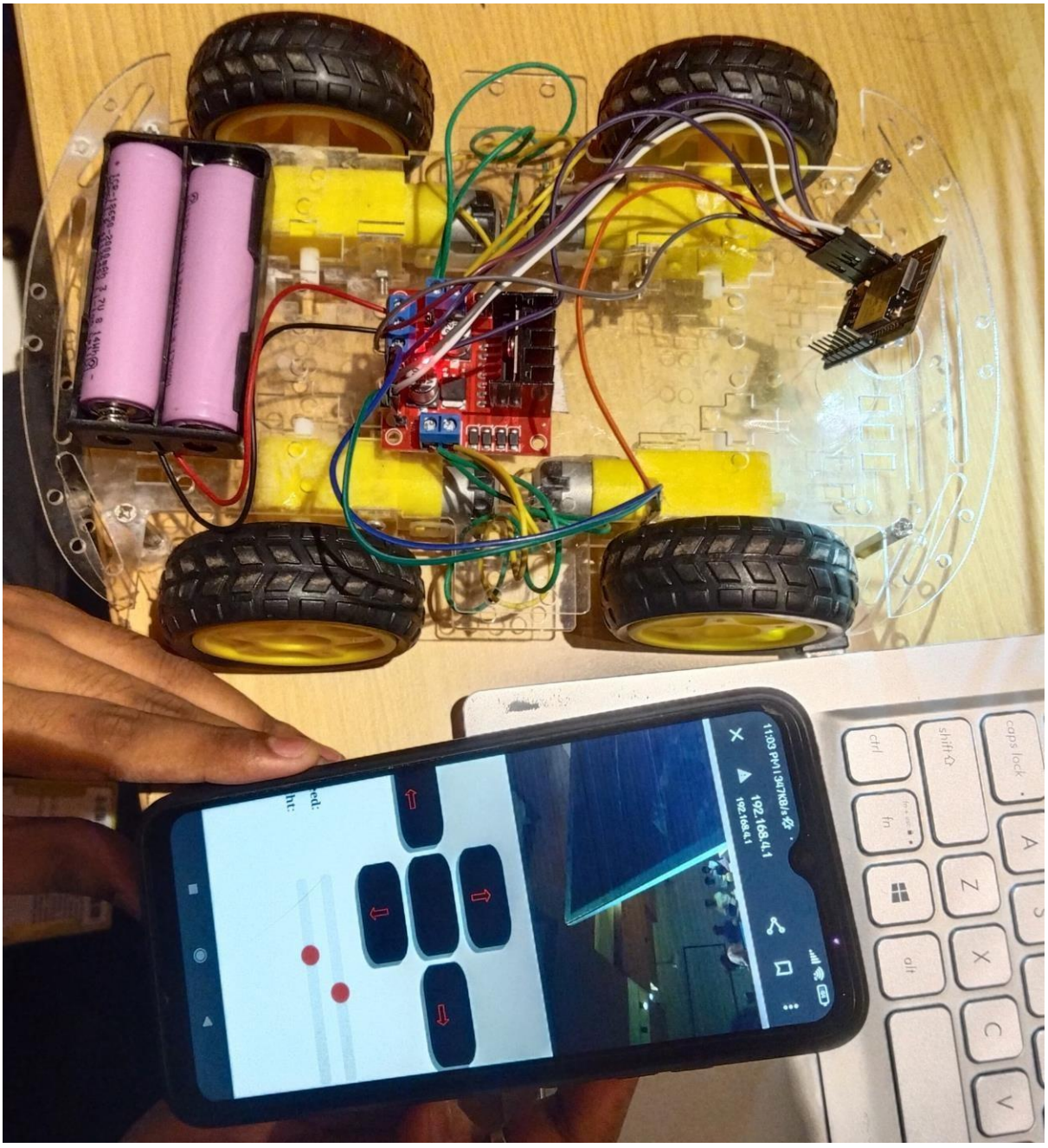
```
#include "esp_camera.h"
#include <Arduino.h>
#include <WiFi.h>
#include <AsyncTCP.h>
#include <ESPAsyncWebServer.h>
#include <iostream>
#include <sstream>

struct MOTOR_PINS
{
  int pinEn;
  int pinIN1;
  int pinIN2;
};

std::vector<MOTOR_PINS> motorPins =
{
  {12, 13, 15},  //RIGHT_MOTOR Pins (EnA, IN1, IN2)
  {12, 14, 2},  //LEFT_MOTOR  Pins (EnB, IN3, IN4)
};
#define LIGHT_PIN 4

#define UP 1
#define DOWN 2
#define LEFT 3
#define RIGHT 4
```

```
#define STOP 0


#define RIGHT_MOTOR 0
#define LEFT_MOTOR 1


#define FORWARD 1
#define BACKWARD -1


const int PWMFreq = 1000; /* 1 KHz */
const int PWMResolution = 8;
const int PWMSpeedChannel = 2;
const int PWMLightChannel = 3;


//Camera related constants
#define PWDN_GPIO_NUM     32
#define RESET_GPIO_NUM    -1
#define XCLK_GPIO_NUM      0
#define SIOD_GPIO_NUM     26
#define SIOC_GPIO_NUM     27
#define Y9_GPIO_NUM       35
#define Y8_GPIO_NUM       34
#define Y7_GPIO_NUM       39
#define Y6_GPIO_NUM       36
#define Y5_GPIO_NUM       21
#define Y4_GPIO_NUM       19
#define Y3_GPIO_NUM       18
```

```
#define Y2_GPIO_NUM        5
#define VSYNC_GPIO_NUM    25
#define HREF_GPIO_NUM     23
#define PCLK_GPIO_NUM     22

const char* ssid     = "MyWiFiCar";
const char* password = "12345678";

AsyncWebServer server(80);
AsyncWebSocket wsCamera("/Camera");
AsyncWebSocket wsCarInput("/CarInput");
uint32_t cameraClientId = 0;

const char* htmlHomePage PROGMEM = R"HTMLHOMEPAGE(
<!DOCTYPE html>
<html>
  <head>
  <meta name="viewport" content="width=device-width, initial-scale=1, maximum-scale=1, user-scalable=no">
    <style>
    .arrows {
      font-size:40px;
      color:red;
    }
    td.button {
      background-color:black;
      border-radius:25%;
```

```
    box-shadow: 5px 5px #888888;
  }
  td.button:active {
    transform: translate(5px,5px);
    box-shadow: none;
  }

  .noselect {
    -webkit-touch-callout: none; /* iOS Safari */
      -webkit-user-select: none; /* Safari */
       -khtml-user-select: none; /* Konqueror HTML */
         -moz-user-select: none; /* Firefox */
          -ms-user-select: none; /* Internet Explorer/Edge */
              user-select: none; /* Non-prefixed version, currently
                                    supported by Chrome and Opera */
  }

  .slidecontainer {
    width: 100%;
void loop()
{
  wsCamera.cleanupClients();
  wsCarInput.cleanupClients();
  sendCameraPicture();
  Serial.printf("SPIRam Total heap %d, SPIRam Free Heap %d\n", ESP.getPsramSize(),
ESP.getFreePsram());
}
```

IMPLEMENTATION



Results and Discussion

The surveillance car developed using the ESP32-CAM module demonstrated several notable outcomes, discussed below:

1. **Real-time Video Transmission**: The ESP32-CAM module successfully streamed real-time video footage to a remote device, providing live surveillance capabilities. This feature enables users to monitor surroundings remotely, enhancing security and surveillance applications.
2. **High-Quality Video**: The surveillance car produced high-quality video output, enabling clear visualization of the monitored area. This is crucial for accurate monitoring and analysis, ensuring that details are captured effectively for surveillance purposes.
3. **Stability and Reliability**: Throughout testing, the surveillance car exhibited stability and reliability in video transmission. The ESP32-CAM module maintained consistent connectivity with the remote device, minimizing disruptions in surveillance operations. This reliability ensures continuous monitoring without interruptions, crucial for effective surveillance systems.
4. **Low Latency**: The system demonstrated low latency in video transmission, facilitating real-time monitoring of events. This feature is essential for timely response to security threats, enabling users to react promptly to incidents detected by the surveillance car.
5. **Adaptability**: The ESP32-CAM module's versatility allowed for easy integration with the surveillance car platform. Its compact size and low power consumption make it suitable for various surveillance applications, including indoor and outdoor environments.
6. **Cost-Effectiveness**: Utilizing the ESP32-CAM module in the surveillance car design resulted in a cost-effective solution compared to traditional surveillance systems. The module's affordability makes it accessible for deployment in diverse surveillance projects, offering a cost-efficient means of enhancing security measures.

Conclusion and Future Scope

Conclusion:

The conclusion for using an ESP32-CAM module for a surveillance car project would depend on various factors including the specific requirements, functionalities achieved, and limitations encountered during the project. Here's a potential conclusion:

"In conclusion, the utilization of the ESP32-CAM module for a surveillance car project presents a cost-effective and versatile solution for remote monitoring and surveillance applications. The module's integration of both Wi-Fi connectivity and a camera sensor offers the capability to stream live video feed to a remote device, enabling real-time surveillance from anywhere with internet access.

Future Scope:

The future scope for a surveillance car utilizing an ESP32-CAM module is quite promising, especially considering the rapid advancements in technology and the increasing demand for security solutions. Here are some potential areas where this technology could be further developed and utilized:

1. **Enhanced Surveillance Capabilities**: Future iterations of the surveillance car could feature advanced image processing algorithms to enable features like facial recognition, object detection, and anomaly detection. This would allow the car to identify and track specific individuals or objects in real-time.
2. **Integration with IoT and Cloud Services**: Integrating the surveillance car with Internet of Things (IoT) platforms and cloud services could enable remote monitoring and control capabilities.