SATISH PRADHAN DNYANASADHANA

COLLEGE OF ARTS, SCIENCE AND COMMERCE

THANE.

Project Synopsis (Year 2024-2025)

Project Title

Artificial Intelligence Object Recognition Camera

Project Developed By

Vaibhav Mane & Sandip Longre

Guide By

Asst.Prof. Sonali Sutar.

Respective Guide:-

INDEX

INTRODUCTION

Welcome to the **AI Object Recognition Camera project**, where cutting-edge IoT and AI technologies come together to create innovative solutions for real-time object detection.

The rapid growth of IoT and AI has unlocked new possibilities for enhancing embedded systems, enabling real-time interaction with the environment. This project, the **AI Object Recognition Camera**, combines these technologies to create a smart camera system capable of recognizing objects in real-time. At its core is the **ESP32-CAM module**, a cost-effective microcontroller with built-in Wi-Fi and camera support, enhanced by a **TFT display** for visual feedback and a **tactile switch** for user interaction.

To enable accurate object recognition, the system uses **Google Cloud Platform (GCP)** for cloud-based AI processing, allowing high-precision image analysis while keeping the hardware efficient. This solution is versatile, suitable for applications such as smart home systems, robotics, and industrial monitoring, making it a scalable tool for IoT and AI-driven environments.

ABSTRACT

The **AI Object Recognition Camera** is a compact, IoT-based smart camera designed for real-time object detection and recognition. Central to this system is the **ESP32-CAM module**, which captures high-quality images and transmits them to **Google Cloud Platform's (GCP) AI services** for advanced object recognition processing. The recognized object data is then promptly displayed on a **TFT screen** connected to the camera, offering immediate visual feedback to the user. A **tactile switch** is included, allowing users to manually trigger image capture and initiate the recognition process.

The software stack supporting this project comprises the **Arduino IDE** for programming the ESP32-CAM, **Node.js** for backend processing, and **GCP's AI API** for executing object recognition algorithms. This integration demonstrates how AI and IoT technologies can be seamlessly combined to produce an efficient and cost-effective solution.

Beyond its primary function, the project serves as a foundational model for a variety of applications. It highlights the potential for further innovation in smart surveillance, automation systems, and interactive IoT solutions. The system is designed to be scalable, enabling easy adaptation to different use cases and environments, from home security and industrial monitoring to advanced robotics and interactive systems. The **AI Object Recognition Camera** thus exemplifies how modern technology can address real-world challenges by merging intelligent data processing with accessible, practical hardware solutions.

SOFTWARE & HARDWARE DETAILS

Hardware Components:

- **ESP32-CAM Module**: The core of the system, this microcontroller with integrated camera and Wi-Fi capability captures images for processing.
- **TFT Display:** A small, color display connected to the ESP32-CAM, used to show the recognized objects and status messages.
- **Tactile Switch:** A physical button used to initiate the image capture and recognition process.
- **Breadboard and Jumper Wires:** Used for prototyping and connecting the components together.

Software Components:

- **Arduino IDE:** Used for writing and uploading the firmware to the ESP32-CAM module.
- **Node.js:** Facilitates backend processing and communication between the ESP32-CAM and Google Cloud Platform.
- **Google Cloud Platform (GCP):** Provides AI and machine learning services through its Vision API, which processes images sent by the ESP32-CAM and returns recognized objects.

OBJECTIVE & SCOPE

The primary objective of this project is to develop an IoT-based AI camera system capable of recognizing objects in real-time and displaying the results locally. By leveraging the power of AI and cloud computing, the project aims to create an efficient and intelligent system that can be used in a wide range of applications, from simple object detection to complex automation processes.

- **AI integration with embedded systems:** The project showcases real-time object recognition on low-cost hardware like the ESP32-CAM using embedded AI algorithms.

- **Low-cost, scalable solution:** The system is designed to be cost-effective and scalable for both small and large deployments, accessible to industries and hobbyists.

- **Enhancing smart surveillance and automation:** It provides real-time feedback for advancing smart surveillance, automation, and IoT systems.

- **Flexible platform for development:** The system offers a base for further innovations in applications like facial recognition, robotics, and traffic monitoring.

- **Cloud computing for AI processing:** Utilizing Google Cloud, the system ensures enhanced object recognition accuracy through continuous AI model improvement.

PROJECT DESIGN

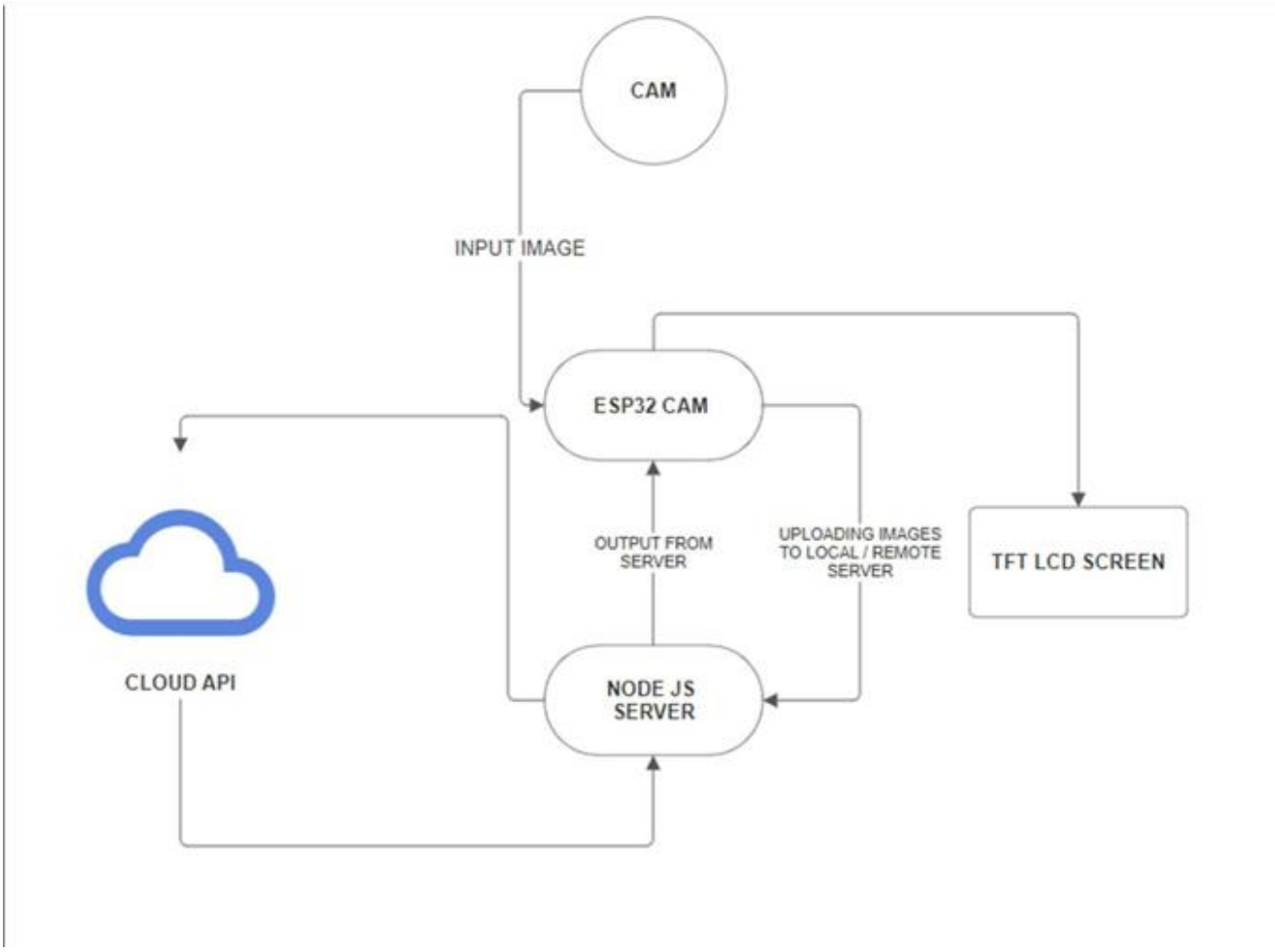
Hardware Design: The hardware setup involves connecting the ESP32-CAM module to the TFT display and tactile switch via a breadboard. The ESP32-CAM captures images and sends them to GCP for processing. Upon receiving the recognition results, it displays the identified objects on the TFT screen. The tactile switch allows users to manually trigger image capture.

Software Design: The software architecture is divided into three key components:

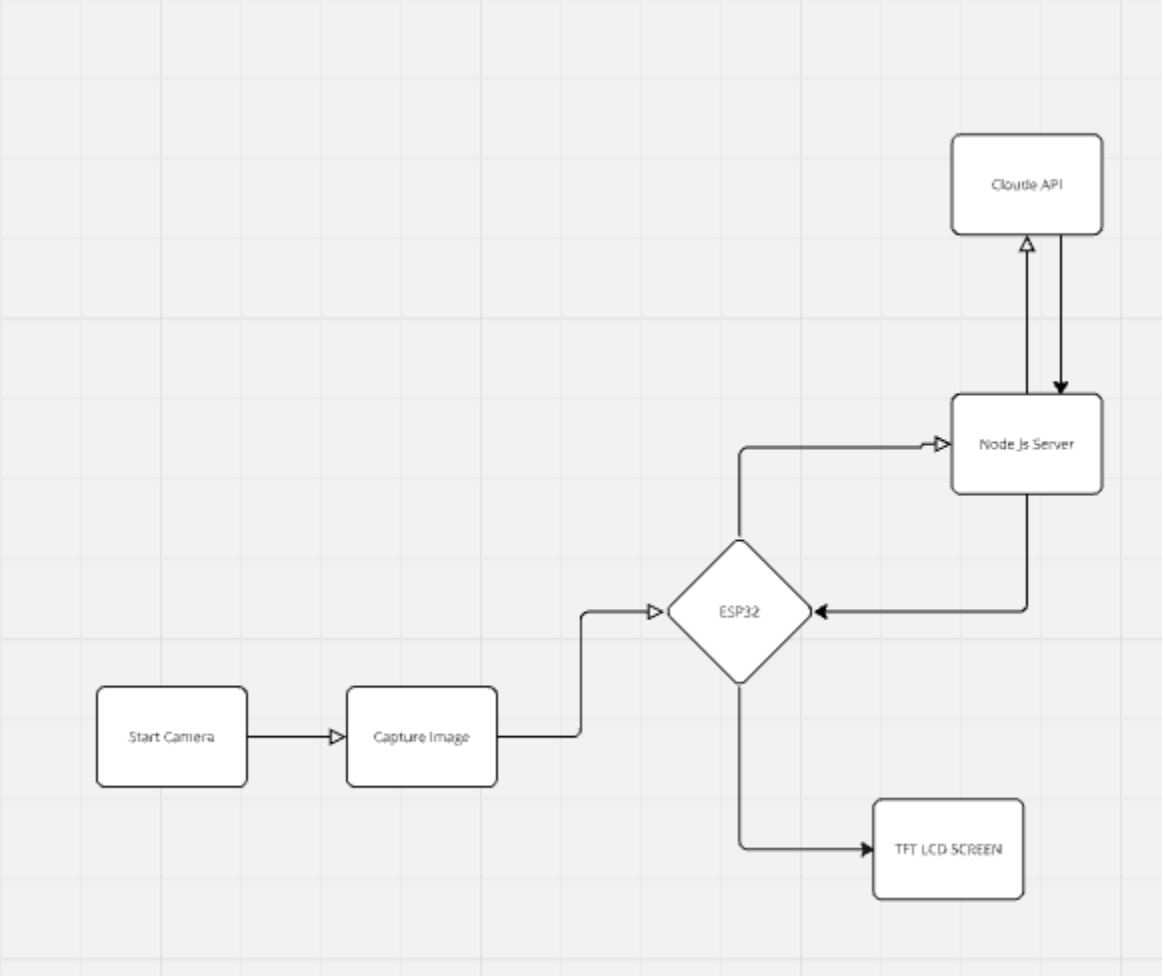
- **ESP32-CAM Firmware:** Developed using Arduino IDE, the firmware handles image capture, communication with GCP, and display control.
- **Backend Processing with Node.js:** Acts as an intermediary between the ESP32-CAM and GCP, managing API calls and data handling.
- **GCP Vision API:** Processes the captured images and returns the recognized object.

Diagram

Flow Chart



ER Diagram


Cloutle API
Node Js Server
ESP32
Start Camera
Capture Image
TFT LCD SCREEN

Conclusion

The **AI Object Recognition Camera** project exemplifies the effective integration of AI and IoT technologies to develop a smart, efficient, and cost-effective object recognition system. By leveraging the **ESP32-CAM** module, **Google Cloud Platform's AI services**, and a user-friendly interface, the project delivers a practical solution with applications in security, education, and beyond. This project demonstrates the substantial potential of AI in enhancing embedded systems, proving that intelligent, real-time data processing can be achieved with accessible hardware.

Moreover, the system's low-cost and scalable nature highlights its suitability for diverse environments and use cases. Its successful implementation provides valuable insights into the capabilities and future directions of intelligent IoT devices. As technology evolves, this project serves as a stepping stone towards more advanced and adaptable solutions in the realm of AI and IoT.

4o mini

REFERENCES

1.Website Reference:

a.www.google.com
b.www.youtube.com
c.www.w3schools.com
d.www.visionapi.com
e.www.howtoelectronic.com

2.Software used:

a.NodeJS
b.ArduinoIDE

FUTURE RECOMMENDATIONS

1. Real-Time 3D Object Recognition

Feature: Cameras that combine AI with 3D scanning to identify objects in real-time.

Application: Augmented reality (AR), robotics, and autonomous vehicles for enhanced navigation and interaction with the environment.

2. Edge AI for Object Recognition

Feature: AI processing on the camera itself, reducing the need for cloud-based processing.

Application: Faster object recognition in drones, surveillance cameras, and home security systems with improved privacy and speed.

3. Sustainable AI Cameras

Feature: AI cameras with low energy consumption or powered by renewable energy sources.

Application: Sustainable surveillance and wildlife monitoring in remote areas where power sources are limited.

4. AI-Integrated Autonomous Drones with Object Recognition

Feature: Autonomous drones equipped with advanced AI object recognition cameras.

Application: Use in search-and-rescue missions, delivery services, or industrial inspections.

5. AI-Assisted Multi-Camera Systems for Large Area Monitoring

Feature: Networks of AI-enabled cameras that work together to track and recognize objects across large areas seamlessly.

Application: Smart city monitoring, crowd management, and enhanced security in public spaces or large infrastructures.