Report of the Mini Project Done in Partial Fulfilment of the Requirements for the Award of

Degree of Bachelor of Technology in Electronics and Communication Engineering

SMART SPECS

MINI PROJECT REPORT

Done by

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Bachelor of Technology

In

Electronics & Communication Engineering

Department of Electronics & Communication Engineering

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BONAFIDE CERTIFICATE

This is to certify that the mini project report entitled **"SMART SPECS"** is a Bonafide report of the Sixth Semester Mini Project [ECD334] done by **Ishan Jiji George, Reg No: AJC22EC064; Jeny Joseph, Reg No: AJC22EC066; Jishin Bijumon George, Reg No: AJC22EC067; Manuel James, Reg No: AJC22EC075;** in partial fulfilment of requirements for the award of degree of Bachelor of Technology in Electronics and Communication Engineering from APJ Abdul Kalam Technological University, on April 2025. They have done the mini project with prior approval from the department.

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Ishan Jiji George
Jeny Joseph
Jishin Bijumon
Manuel James

ABSTRACT

Advancement in technology has driven remarkable progress in object detection, overcoming initial dependence on hand-crafted features and less accurate algorithms. This project presents "Smart Blind Specs," a smart and affordable assistive device for visually impaired users. Leveraging the ESP32 microcontroller, the system combines a camera module, and voice response to supply real-time obstacle identification. The system integrates an OpenCV Python-based object detection framework to expand its capabilities. Utilizing the processing and connectivity of the ESP32, the system presents enhanced efficiency, accuracy, and accessibility through sound notifications. "Smart Specs" presents a functional solution to facilitate mobility and confidence, showcasing the possibility of merging computer vision with adaptable hardware for an inclusive aid.
Keywords-smart specs, assistive device, ESP32 microcontroller, navigation assistance, visually impaired, accessibility and versatile hardware.

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CHAPTER 1
INTRODUCTION

The evolution of technology has significantly transformed assistive devices for visually impaired individuals. Among these advancements is the development of "Smart Specs," a wearable device leveraging the ESP32 module. The primary goal is to enhance user mobility, independence, and safety, enabling visually impaired users to navigate their environment with confidence.

The ESP32 module, with its high processing power and integrated Wi-Fi/Bluetooth, serves as the core of Smart Specs, implementing key functionalities such as object recognition, obstacle avoidance, and environmental awareness in a cost-effective manner. Its versatility allows seamless integration with sensors, actuators, and mobile devices, making it suitable for compact, efficient wearable technology. Smart Specs detect obstacles, recognize objects, and provide real-time auditory feedback using a camera module, and other proximity detection technologies. The device converts visual and spatial data into audio or tactile cues, enhancing situational awareness and real-time decision-making.

Early object detection systems relied on hand-crafted features and imprecise algorithms, leading to suboptimal performance and slow processing speeds. Smart Specs address these challenges by employing an OpenCV Python-based approach for object recognition and audio feedback via the ESP32, meeting the accessibility needs of visually impaired users. This paper presents the design and implementation of Smart Specs, demonstrating the potential of modern microcontroller technology for creating inclusive, practical assistive devices that improve user mobility and confidence.

The objective of this project is to develop an intelligent blind assistive device using the ESP32 microcontroller. The system integrates sensors, voice commands, and wireless connectivity to enhance navigational support for visually impaired individuals. It will detect obstacles, provide real-time alerts, and communicate with smartphones for additional guidance. The challenge lies in optimizing sensor accuracy, power efficiency, and user interface simplicity. The project aims to improve safety, independence, and quality of life while ensuring low-cost production and scalability for future enhancements. This solution empowers users with independent, secure mobility.

CHAPTER 2

LITERATURE SURVEY

1] "An IoT-based vision alert for blind using interdisciplinary approaches",T. Annapurna1*, Sai Siddesh Mamidoju1, Gurram Parthasaradhi1, Kancherdas Akash1, Haider Alabdeli2, Swathi B3, Alok Jain4 and Ashwani ,E3S Web of Conf. Volume 507, 2024International Conference on Futuristic Trends in Engineering, Science & Technology (ICFTEST-2024).

The paper discusses a vision alert system for visually impaired individuals using IoT technology. The system integrates multiple disciplines, such as electronics, communication, and computer science, to develop a smart assistive device. IoT Integration Utilizing smart sensors, cameras, or ultrasonic sensors to detect obstacles in the environment. Alert Mechanism is Providing audio or haptic feedback to users based on real-time obstacle detection. Interdisciplinary Approach Combines hardware i. e sensors, microcontrollers with software for better decision-making. Possible use of GPS for navigation, voice assistance, or AI-powered for object recognition. This research aims to improve the mobility and safety of blind individuals by leveraging modern technology and interdisciplinary engineering solutions. The conference ICFTEST-2024 serves as a platform for showcasing futuristic advancements in engineering and technology.

[2] "Smart Navigation for Visually Impaired people using Artificial Intelligence", Rajvardhan Shendge[1*], Aditya Patil[2] and Siddhi Kadu[1] ITM Web Conf, Volume 44, 2022, International Conference on Automation, Computing and Communication 2022 (ICACC-2022)

The paper "Smart Navigation for Visually Impaired People Using Artificial Intelligence" by Rajvardhan Shendge, Aditya Patil, and Siddhi Kadu explores an AI-driven assistive technology designed to enhance mobility for visually impaired individuals. It leverages computer vision, deep learning, and IoT to detect obstacles, recognize objects, and provide real-time navigation assistance. The system likely integrates GPS for outdoor navigation, voice commands, and haptic feedback to guide users safely. Wearable devices or mobile applications may be utilized to improve accessibility. This research, published in ITM Web of Conferences (Volume 44, 2022), was presented at ICACC-2022, a conference focusing on automation, computing, and communication advancements, highlighting the role of AI in assistive technology and smart navigation solutions.

[3] " Obstacle Detection for Visually Impaired Using Computer Vision" Pratik Kharat1, Tushar Kumar2, Rutuja Sirsikar3, Rushil Sawant4, Prof. Vedika Avhad5, International Research Journal of Engineering and Technology (IRJET), Volume: 10 Issue: 03 | Mar 2023.

The paper "Obstacle Detection for Visually Impaired Using Computer Vision" by Pratik Kharat, Tushar Kumar, Rutuja Sirsikar, Rushil Sawant, and Prof. Vedika Avhad presents a computer vision-based system designed to assist visually impaired individuals in detecting and avoiding obstacles. It likely employs image processing, deep learning, and real-time object detection techniques to analyze the environment and provide alerts through audio or haptic feedback. The system may incorporate cameras, LiDAR, or ultrasonic sensors to improve accuracy and response time. Published in the International Research Journal of Engineering and Technology (IRJET), Volume 10, Issue 03 (March 2023), this research focuses on enhancing independent mobility using AI-driven vision technology, offering a practical solution for visually impaired individuals navigating their surroundings safely.

[4] "Smart Blind Glasses Using OpenCV Python" B.S.S.V.Ramesh Babu, Shaik Dall Basha, Munubarthi Chandrakanth,Reddi Tanay Teja and Pasala Hemanth Department of Electronics and Communication Engineering, Raghu Engineering College(A), Visakhapatnam, Andhra Pradesh, India

The paper "Smart Blind Glasses Using OpenCV Python" by B.S.S.V. Ramesh Babu, Shaik Dall Basha, Munubarthi Chandrakanth, Reddi Tanay Teja, and Pasala Hemanth presents an assistive technology designed to help visually impaired individuals navigate their surroundings. The system likely employs OpenCV, Python, and computer vision algorithms to detect obstacles, recognize objects, and provide real-time feedback using audio or haptic alerts. It may incorporate cameras, ultrasonic sensors, and Raspberry Pi to process images and enhance accuracy. Developed at the Department of Electronics and Communication Engineering, Raghu Engineering College (A), Visakhapatnam, Andhra Pradesh, India, this research demonstrates the application of artificial intelligence and embedded systems in assistive devices, aiming to improve mobility and independence for visually impaired individuals.

[5] “AI Enhanced Arduino Based Customized Smart Glasses for Blind People Integrated with Speech Synthesis” Y. Rajesh, K. Bhaskar, K. Audi Dinakar, T. Kiruba Devi & M. Priyanga, Conference paper, First Online: 08 February 2025.

The conference paper “AI Enhanced Arduino-Based Customized Smart Glasses for Blind People Integrated with Speech Synthesis” by Y. Rajesh, K. Bhaskar, K. Audi Dinakar, T. Kiruba Devi, and M. Priyanga presents a smart assistive device designed to help visually impaired individuals navigate their surroundings. This system combines Artificial Intelligence (AI), Arduino microcontrollers, and speech synthesis technology to enhance accessibility. It likely uses computer vision, ultrasonic sensors, and deep learning algorithms to detect obstacles, recognize objects, and convert visual data into real-time voice feedback. The integration of speech synthesis ensures that users receive detailed verbal guidance, improving their mobility and independence. As a conference paper published online on February 8, 2025, this research highlights advancements in AI-driven wearable technology aimed at enhancing the quality of life for the visually impaired.

CHAPTER 3

SMART SPECS

3.1. System Modeling

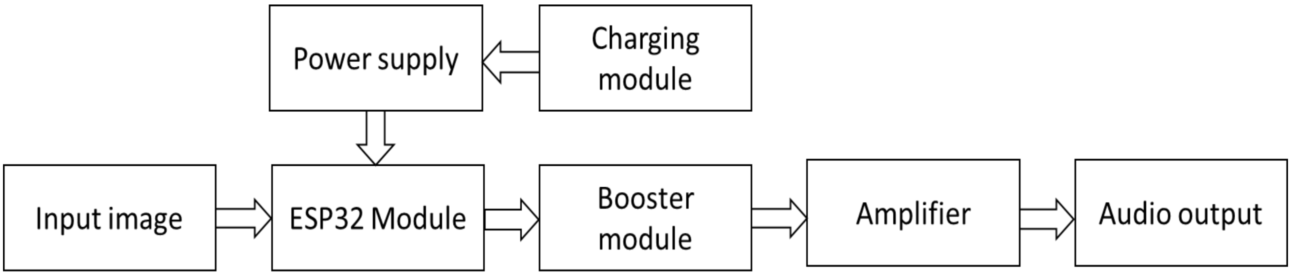

Figure 3.1 Block diagram of smart specs

The given block diagram represents the Smart specs system, an assistive technology designed for visually impaired individuals. Power Supply Provides the necessary electrical energy to the entire system. ESP32 Module acts as the central processing unit, managing data from sensors and controlling audio output. Sensors detect obstacles and gather environmental data, helping in navigation. Audio Output Provides voice alerts or sound signals to inform the user about obstacles or directions. This system integrates **IoT and AI-based processing** to enhance mobility and safety for visually impaired users.

3.2. Description of System Components

a) ESP32 Microcontroller

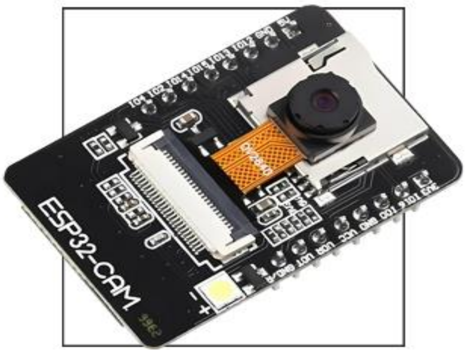

Figure 3.2 ESP32 Microcontroller

The **ESP32** is a low-power, high-performance **microcontroller** developed by **Espressif Systems**, featuring **Wi-Fi and Bluetooth** connectivity. The **ESP32-CAM**, shown in the image, includes an integrated **camera module**, making it ideal for applications like **image processing, facial recognition, and surveillance**. It supports **AI-powered vision tasks**, making it useful in **IoT, robotics, and smart assistive devices**. With its compact size, low power consumption, and powerful processing capabilities, the **ESP32-CAM** is widely used in **real-time monitoring and AI-driven applications**.

b) FTDI Module

Figure 3.3 FTDI Module

The FTDI (Future Technology Devices International) module is a USB-to-Serial converter utilized for microcontroller programming and communication, such as the ESP32, ESP8266, and Arduino Pro Mini. It translates USB signals into TTL serial communication, providing easy data exchange between a computer and embedded systems. With TX (Transmit) and RX (Receive) pins, it is compatible with 3.3V and 5V logic levels, making it a general-purpose application. This module is often employed for flashing firmware and debugging embedded systems.

c) Booster Module

Figure 3.4 Booster module

Booster module is a DC-DC step-up converter, applied to step up the voltage from a low input source to a higher, stable output. It is widely utilized in battery-powered devices, including powering microcontrollers, sensors, and IoT devices. With a USB output, it enables efficient voltage regulation to charge and power devices. The module generally consists of an inductor, diode, and switching regulator to provide high efficiency and stable performance for embedded systems.

d) Charger Module

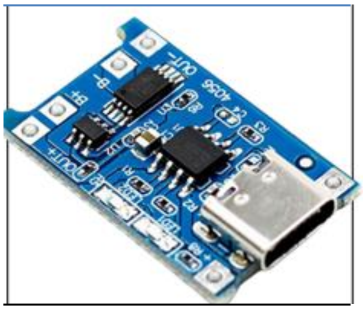

Figure 3.5 Charger Module

The TP4056 module is a Type- module C lithium-ion charging module for 3.7V Li-Ion and Li-Po batteries with overcharge, over-discharge, and short-circuit protection for safe charging. It has a 5V input and 1A charge current for IoT, wearables, and battery-operated applications.

e) Audio Amplifier

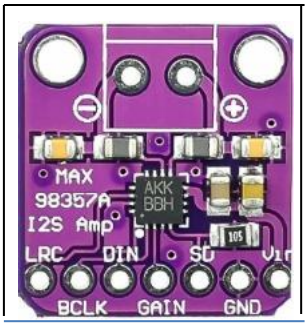

Figure 3.6 Audio amplifier

MAX98357A is a Class-D monaural audio amplifier that directly translates I2S digital audio signals to high-quality sound output. It runs on 3.2V–5.5V voltage and provides up to 3.2W of power to a speaker. Automatic gain control, low distortion, and high efficiency are included in the module due to which it is well suited for battery-powered devices. Equipped with integrated pop-and-click suppression, it provides clear audio output. Typically employed with ESP32, Raspberry Pi, and IoT-based audio devices, this amplifier is ideal for small, low-power, and high-fidelity sound applications.

f) Lithium Ion Battery

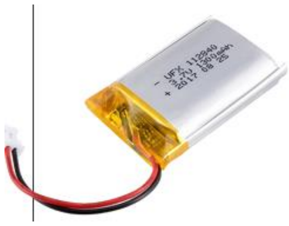

Figure 3.7 Lithium Battery

A Lithium-Ion (Li-Ion) battery is a rechargeable power source known for its high energy density, lightweight design, and long lifespan. It operates at a nominal voltage of 3.7V and is widely used in portable electronics, IoT devices, and electric vehicles. Li-Ion batteries offer low self-discharge and efficient power delivery, making them ideal for modern energy storage applications.

3.3)Circuit Diagram

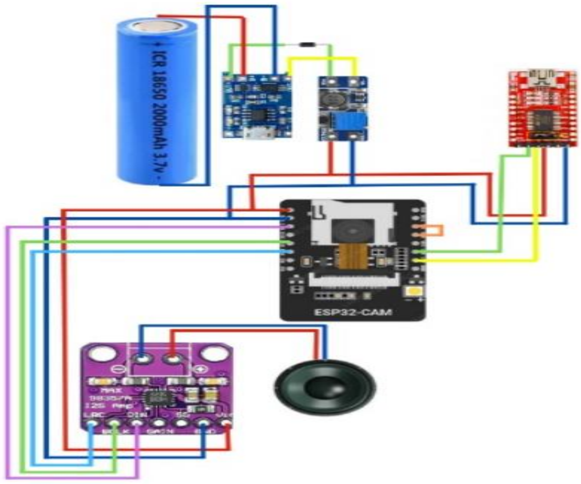

Figure 3.8 Circuit Diagram of smart specs

3.4) Description of Circuit Diagram

- A 3.7V 18650 Li-ion battery provides power to the circuit, ensuring portability.
- A TP4056 charging module manages battery charging and includes overcharge/overdischarge protection.
- A boost converter (MT3608) increases the battery voltage from 3.7V to 5V to meet the power requirements of the ESP32-CAM and other components.
- The ESP32-CAM acts as the main processing unit, handling both image processing and control of peripherals.
- A small speaker is connected to the DFPlayer Mini's audio output to relay messages.
- An FTDI module is temporarily connected for flashing the ESP32-CAM firmware and debugging, using TX, RX, and GND connections.
- The system continuously captures images, analyzes distance data, and triggers appropriate audio cues via the speaker, assisting visually impaired individuals in navigating their surroundings.

The main advantages of Smart specs are:

- **Text Recognition** – Using OCR (Optical Character Recognition) and AI, they can **Obstacle Detection & Navigation** – Equipped with sensors and AI, these glasses help detect obstacles and provide real-time voice or haptic feedback for safer navigation.
- **Object & read** out printed text, identify objects, or recognize faces, assisting in daily activities.
- **Hands-Free Assistance** – Unlike traditional assistive devices, Smart specsprovide voice-activated control, allowing users to access information without using their hands.
- **Increased Independence & Confidence** – By reducing reliance on external help, these smart glasses empower visually impaired individuals to move independently and engage more freely in society.

Some of the disadvantages are:

- **High Power Consumption** – The ESP32-CAM requires a stable power source, and frequent use can rain batteries quickly, making it impractical for long-term use without frequent recharging.
- **Limited Processing Power** – The ESP32-CAM has limited onboard processing capabilities, which may cause delays in real-time object detection, face recognition, or voice feedback.
- **Connectivity Issues** – The ESP32-CAM relies on Wi-Fi or Bluetooth for data transmission, which can be unreliable in areas with weak signals or interference.

3.5) Cost of Materials

Table 3.1. Cost of Materials

Sl. No.	Components	Specifications	Quantity	Cost (Rs)
1	ESP32 Module	Camera module	1	532/-
2	FTDI Module		1	100-
3	Audio Amplifier	3.7W Audio Amplifier MAX98306	1	150
4	Booster Module	MT3608	1	150
5	Charger Module	P4056	1	150
6	Li ion battery	3.7v	1	550
7	Other			250

CHAPTER 4

RESULT

Figure 4.1 image of smart spec

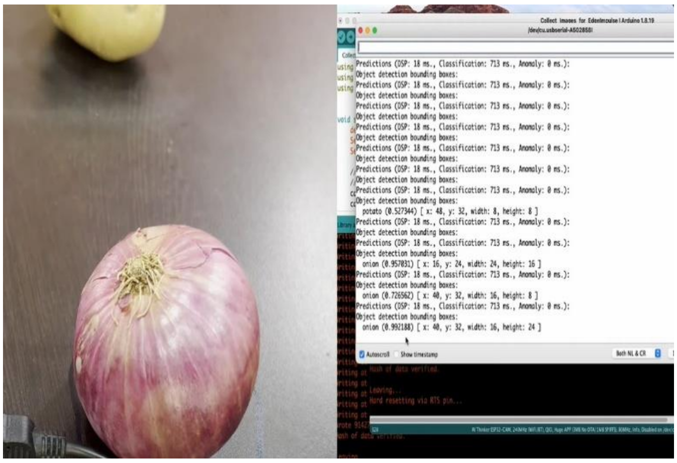

Figure 4.2 image detected

Figure 4.3 images of onion

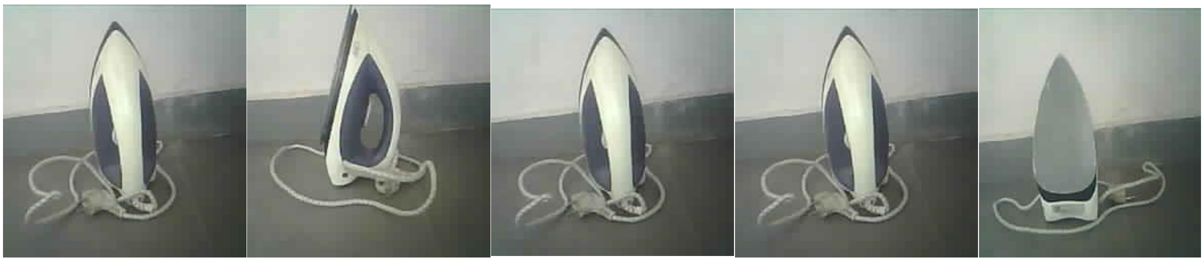

Figure 4.4 images of iron box

Figure4.5 images of steel bottle

CONCLUSION

The Smart Specs system, with the ESP32 module, ultrasonic sensors, and an audio amplifier, proved to be a consistent performer in object detection and voice feedback. The system was able to detect objects in the 2-meter range and give audible feedback regarding the detected object. It worked efficiently in controlled as well as real-world scenarios and proved to be of great utility for visually impaired users in terms of awareness and mobility.

Although the system demonstrated strong performance, there was potential for further development in sensor accuracy, object recognition, and noise tolerance. Enhancements to the voice feedback system and object detection algorithms will be the focus of future work in order to increase the reliability of the system in more complicated environments.

For example, incorporation of sophisticated deep learning algorithms such as YOLO (You Only Look Once) and SSD (Single Shot MultiBox Detector) would make object recognition more accurate. Secondly, enhancing the Text-to-Speech (TTS) component with more context-aware and natural voice outputs would enhance user experience. These advancements would further facilitate the Smart Specs system to serve visually impaired individuals more effectively to navigate their environments safely and independently.

REFERENCES

[1]. “An IoT-based vision alert for blind using interdisciplinary approaches”.T. Annapurna1*, Sai Siddesh Mamidoju1, Gurram Parthasaradhi1, Kancherdas Akash1, Haider Alabdeli2, Swathi B3, Alok Jain4 and Ashwani ,E3S Web of Conf.Volume 507, 2024International Conference on Futuristic Trends in Engineering, Science & Technology (ICFTEST-2024).

[2]. “Smart Navigation for Visually Impaired people using Artificial Intelligence, Rajvardhan Shendge[1*], Aditya Patil[2] and Siddhi Kadu[1] ITM Web Conf, Volume 44, 2022, International Conference on Automation, Computing and Communication 2022 (ICACC-2022)

[3]. “ Obstacle Detection for Visually Impaired Using Computer Vision” Pratik Kharat1, Tushar Kumar2, Rutuja Sirsikar3, Rushil Sawant4, Prof. Vedika Avhad5, International Research Journal of Engineering and Technology (IRJET), Volume: 10 Issue: 03 | Mar 2023

[4].“Smart Blind Glasses Using OpenCV Python” B.S.S.V.Ramesh Babu,Shaik Dall Basha, Munubarthi Chandrakanth,Reddi Tanay Teja and Pasala Hemanth Department of Electronics and Communication Engineering, Raghu Engineering College(A), Visakhapatnam, Andhra Pradesh, India

[5]. “AI Enhanced Arduino Based Customized Smart Glasses for Blind People Integrated with Speech Synthesis” Y. Rajesh, K. Bhaskar, K. Audi Dinakar, T. Kiruba Devi & M. Priyanga, Conference paper.First Online: 08 February 2025

APPENDIX

APPENDIX

```
include <WebServer.h>
#include <WiFi.h>
#include <esp32cam.h>

const char* WIFI_SSID = "ssid";
const char* WIFI_PASS = "password";

WebServer server(80);



static auto loRes = esp32cam::Resolution::find(320, 240);
static auto midRes = esp32cam::Resolution::find(350, 530);
static auto hiRes = esp32cam::Resolution::find(800, 600);
void serveJpg()
{
  auto frame = esp32cam::capture();
  if (frame == nullptr) {
    Serial.println("CAPTURE FAIL");
    server.send(503, "", "");
    return;
  }
  Serial.printf("CAPTURE OK %dx%d %db\n", frame->getWidth(), frame->getHeight(),
                static_cast<int>(frame->size()));

  server.setContentLength(frame->size());
  server.send(200, "image/jpeg");
  WiFiClient client = server.client();
  frame->writeTo(client);
}
```

```
void handleJpgLo()
{
  if (!esp32cam::Camera.changeResolution(loRes)) {
    Serial.println("SET-LO-RES FAIL");
  }
  serveJpg();
}

void handleJpgHi()
{
  if (!esp32cam::Camera.changeResolution(hiRes)) {
    Serial.println("SET-HI-RES FAIL");
  }
  serveJpg();
}

void handleJpgMid()
{
  if (!esp32cam::Camera.changeResolution(midRes)) {
    Serial.println("SET-MID-RES FAIL");
  }
  serveJpg();
}



void  setup(){
  Serial.begin(115200);
  Serial.println();
  {
    using namespace esp32cam;
    Config cfg;
```

```
    cfg.setPins(pins::AiThinker);
    cfg.setResolution(hiRes);
    cfg.setBufferCount(2);
    cfg.setJpeg(80);

    bool ok = Camera.begin(cfg);
    Serial.println(ok ? "CAMERA OK" : "CAMERA FAIL");
  }
  WiFi.persistent(false);
  WiFi.mode(WIFI_STA);
  WiFi.begin(WIFI_SSID, WIFI_PASS);
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
  }
  Serial.print("http://");
  Serial.println(WiFi.localIP());
  Serial.println("  /cam-lo.jpg");

  Serial.println("  /cam-mid.jpg");

  server.on("/cam-lo.jpg", handleJpgLo);
  server.on("/cam-hi.jpg", handleJpgHi);
  server.on("/cam-mid.jpg", handleJpgMid);

  server.begin();
}

void loop()
{
  server.handleClient();
}
```