IntelliGaze: A Wearable AI Camera System

Microprocessor Lab Project Presentation

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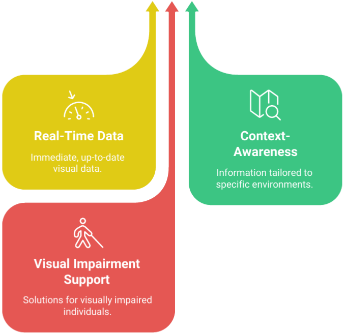
Outline

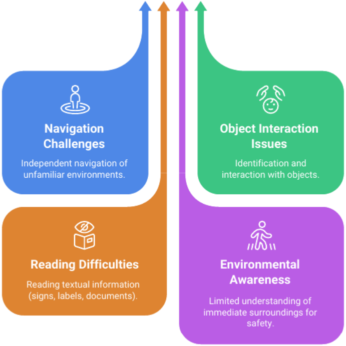
Introduction: The Need for Enhanced Vision

Addressing Visual Accessibility Challenges - Motivation

Core Problem



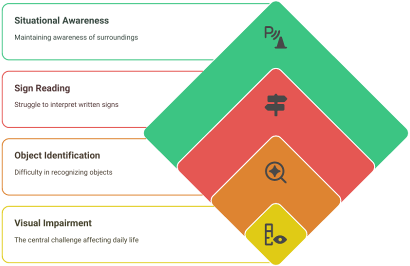
Limitations that can hinder



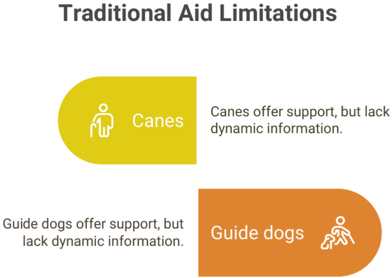
Problem Statement & Project Aim

Defining the Core Issue and Our Solution

Core Problem



Limitations that can hinder

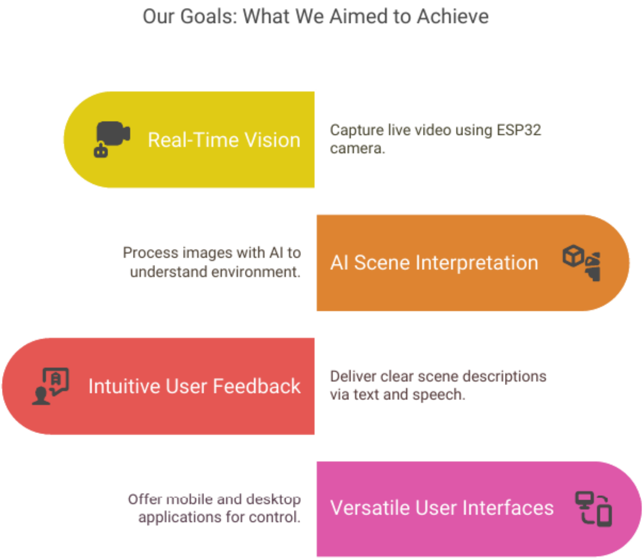


Our Aim with IntelliGaze

To provide a system that actively processes visual input from a wearable camera and delivers concise, relevant descriptions, thereby mitigating these challenges and empowering users.

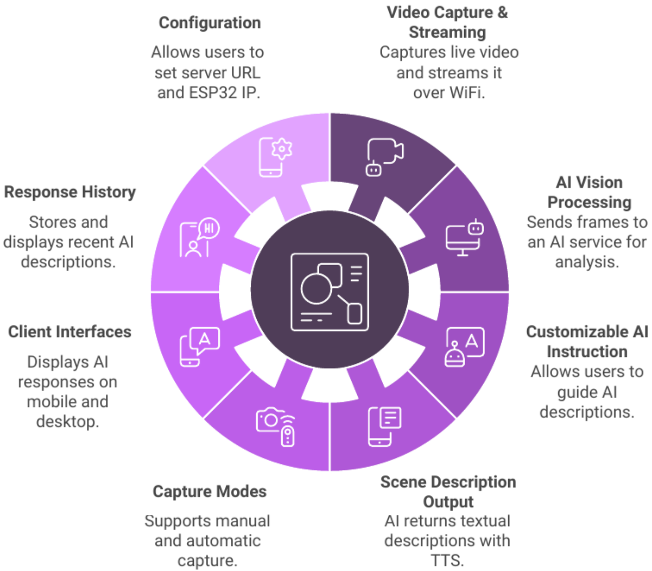
Project Objectives

Our Goals: What We Aimed to Achieve



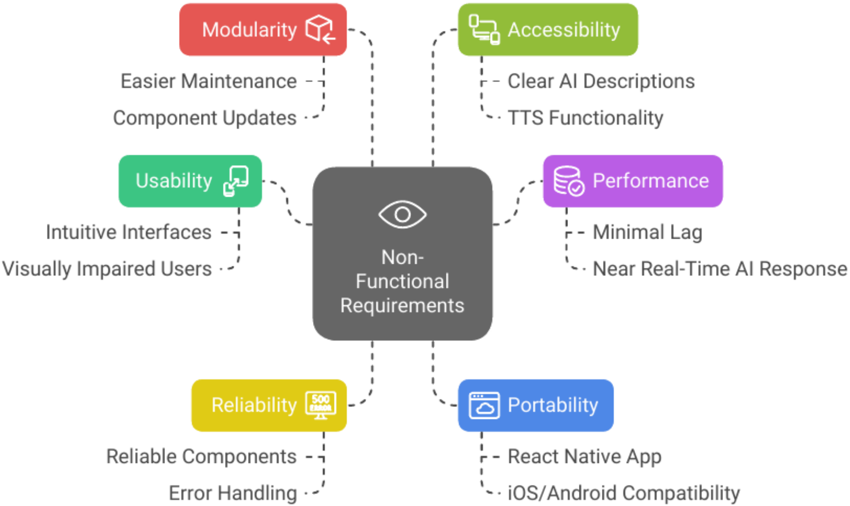
Functional Requirements

What the System Must Do



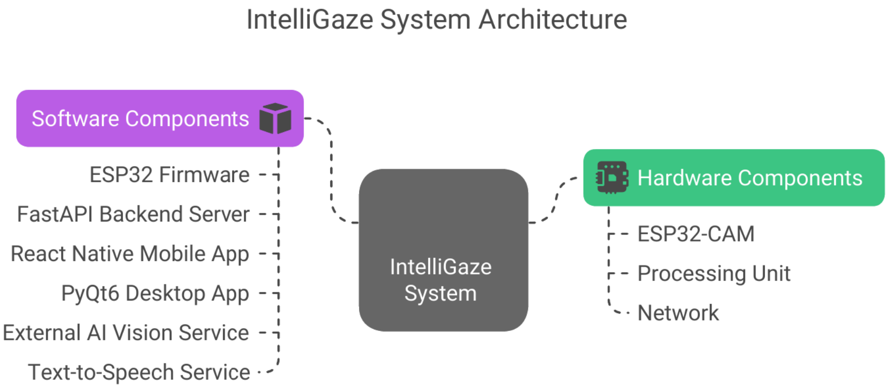
Non-Functional Requirements

Quality Attributes of the System



Hardware & Software Components

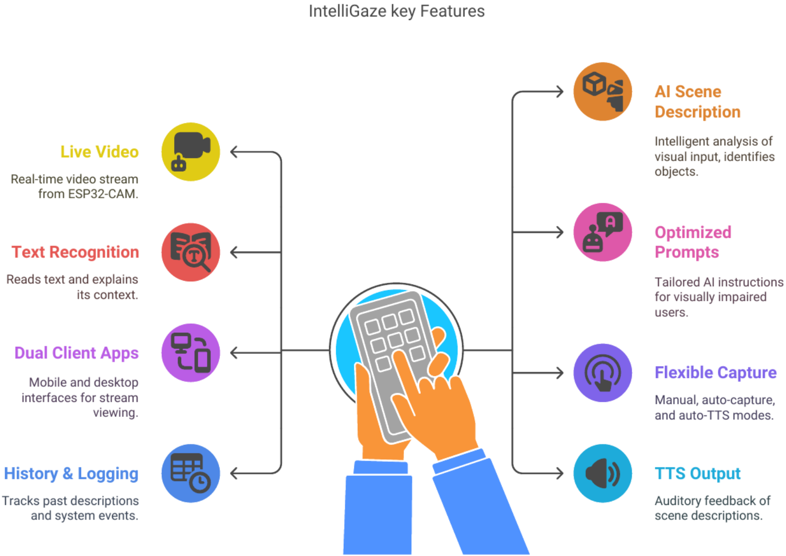
The Building Blocks of IntelliGaze



Primary & Secondary components of the IntelliGaze system.

Key Features

Core Capabilities of IntelliGaze



Detailed Circuit Diagram

ESP32-CAM to ESP32-CAM-MB Connections

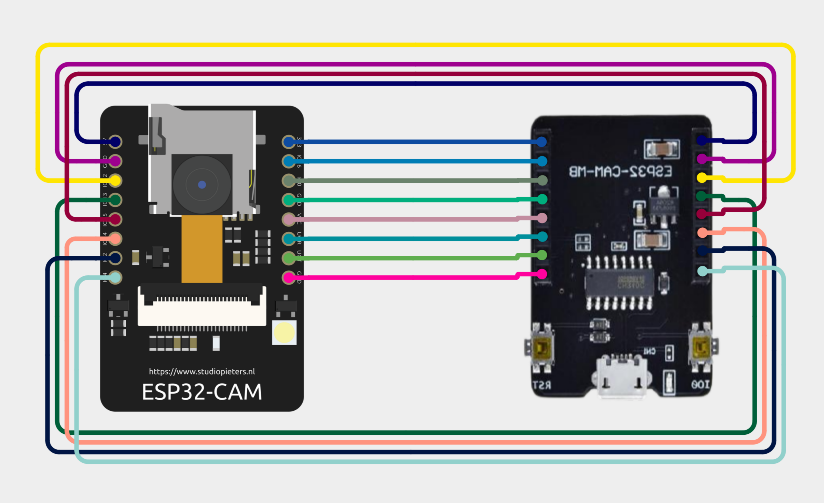


Figure: Essential pin connections for power, programming (via MB board), and camera operation.

Code: ESP32 Camera Configuration

`camera-feed.ino` - Initialization in `setup()`

```
camera_config_t config;
config.ledc_channel = LEDC_CHANNEL_0;
// ... Pin definitions for D0-D7, XCLK, PCLK, VSYNC, HREF, SIOD,
    SIOC, PWDN, RESET ...
config.pin_d0 = Y2_GPIO_NUM; config.pin_d7 = Y9_GPIO_NUM;
config.pin_xclk = XCLK_GPIO_NUM; // ... and other pins
config.xclk_freq_hz = 20000000;
config.pixel_format = PIXFORMAT_JPEG;

if(psramFound()){
  config.frame_size = FRAMESIZE_VGA; // 640x480
  config.jpeg_quality = 10; // Higher quality
  config.fb_count = 2;      // Use 2 frame buffers
} else {
  config.frame_size = FRAMESIZE_QQVGA; // Lower resolution
  config.jpeg_quality = 15;            // More compression
  config.fb_count = 1;
}
esp_err_t err = esp_camera_init(&config);
if (err != ESP_OK) { /* Handle initialization error */ }
```

Listing 1: Camera Settings

Code: ESP32 MJPEG Streaming

camera-feed.ino - stream_handler Function

```
static esp_err_t stream_handler(httpd_req_t *req){
  while(true){
    fb = esp_camera_fb_get(); // Get frame from camera
    if (!fb) { /* Error handling */ res = ESP_FAIL; }
    else {  res = httpd_resp_send_chunk(req, "--frame", strlen("--frame"));
      if(res == ESP_OK){
        size_t hlen = snprintf(part_buf, 64,
          "Content-Type: image/jpeg\r\nContent-Length: %u\r\n\r\n", fb->len);
        res = httpd_resp_send_chunk(req, part_buf, hlen); }
      if(res == ESP_OK){  res = httpd_resp_send_chunk(req, (const char *)fb->buf, fb->len);}
      esp_camera_fb_return(fb); // Return frame buffer
    }
    if(res != ESP_OK){ break; }
    delay(30);
  }
  return res;
}
```

Listing 2: MJPEG Frame Send Loop

Code: FastAPI Vision Endpoint

Flask_server/server.py - AI Processing Request

```python
@app.post("/vision")
async def vision_endpoint(instruction: str = Form(OPTIMIZED_PROMPT)):
    global latest_frame # Obtained from background ESP32 stream worker
    image_b64 = base64.b64encode(latest_frame).decode("utf-8")
    image_data_url = f"data:image/jpeg;base64,{image_b64}"
    payload = {
        "max_tokens": 100,
        "messages": [{
            "role": "user", "content": [
                {"type": "text", "text": instruction},
                {"type": "image_url", "image_url": {"url": image_data_url}} ] }] }
    headers = {"Content-Type": "application/json"}
    async with httpx.AsyncClient(timeout=30) as client:
        resp = await client.post(AI_BACKEND_URL, json=payload, headers=headers)
        return {"response": data["choices"][0]["message"]["content"]}
```

Listing 3: Sending Frame to AI

Code: React Native TTS Utility

`inteligaze/utils/playGroqTTS.ts` - Audio Feedback

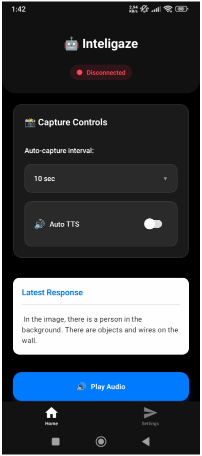
```
export async function playGroqTTS(text: string) {
  try {
    const response = await axios.post(
      'https://api.groq.com/openai/v1/audio/speech',
      { model: 'playai-tts', voice: 'Fritz-PlayAI',
        input: text, response_format: 'wav' },
      { headers: { 'Authorization': `Bearer ${GROQ_API_KEY}`},
        responseType: 'arraybuffer'}
    );
    const fileUri = FileSystem.cacheDirectory + 'tts.wav';
    const base64Audio = arrayBufferToBase64(response.data); // Helper
    await FileSystem.writeAsStringAsync(fileUri, base64Audio,
                                        { encoding: 'Base64' });
    const { sound } = await Audio.Sound.createAsync({ uri: fileUri });
    await sound.playAsync();
  } catch (error) { console.error('Groq TTS error:', error); }
}
```

Listing 4: Calling Groq TTS API

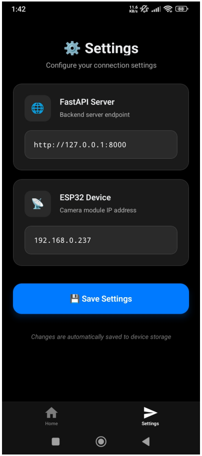
Demonstration: Mobile Application

IntelliGaze in Action - React Native App

Main Vision Interface



Settings Configuration



Key features shown: Connection status, capture controls (auto-capture interval, auto TTS), latest AI response display (on main screen, not fully visible here), configurable server/IP settings.

Demonstration: Desktop Application

IntelliGaze - PyQt6 Desktop Client

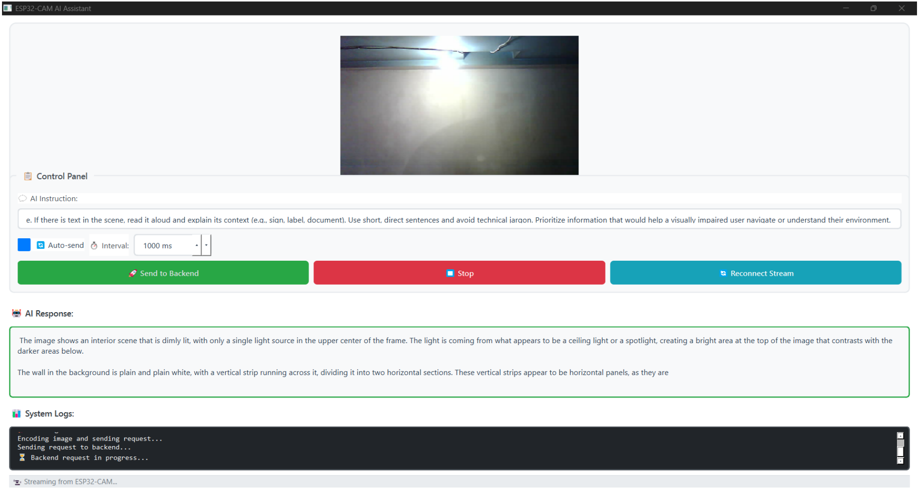
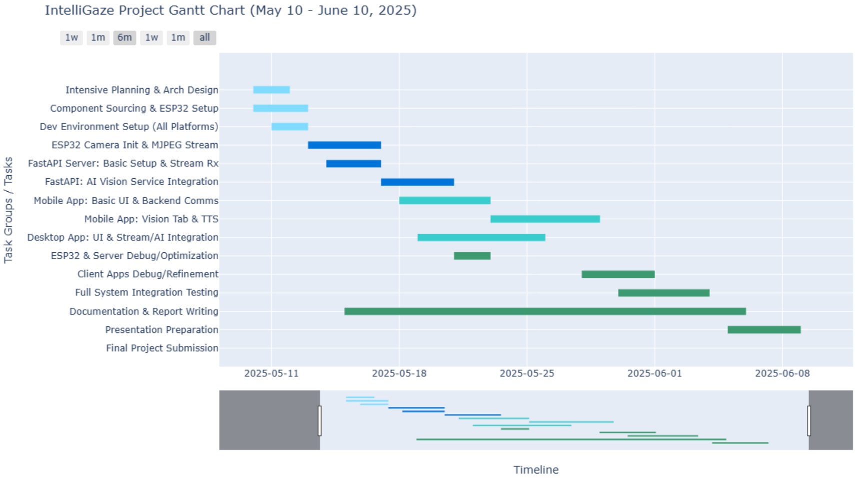


Figure: Desktop interface: Live ESP32-CAM feed, AI instruction input, AI response, and system logs.

Project Timeline: Gantt Chart

IntelliGaze Development Schedule (May 11 - June 10, 2025)

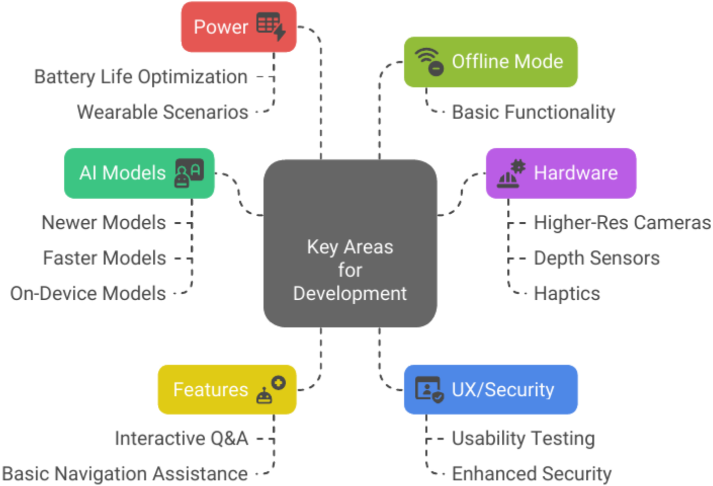


Conclusion

Summary of Achievements

Future Works

Potential Enhancements for IntelliGaze



Team Contributions

Collaborative Efforts in IntelliGaze

- **Touhidul Alam Seyam (230240003):**
  - Project Lead & Chief Architect; Overall system design, development, and end-to-end integration.
  - Lead: React Native mobile app (UI/UX, logic, backend comms).
  - Drove integration of all components; Key troubleshooting; Documentation lead.
- **Shafiul Azam Mahin (230240022):**
  - Lead: PyQt6 Desktop Application (GUI, video feed, direct AI service comms).
- **Eftakar Uddin (230240004):**
  - Lead: FastAPI Backend Server framework (API endpoints, server logic).
- **Muntasir Rahman (230240002):**
  - Lead: ESP32-CAM Firmware (camera init, WiFi, MJPEG streaming).
- **Tasmim Akther Mim (230240025):**
  - Lead: Text-to-Speech (TTS) functionality integration in mobile app (Groq API).

Thank You!

Questions?