SMART ASSSITANCE SYSTEM for the VISUALLY IMPAIRED

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Abstract* - The Smart Assistance System for the Visually Impaired enhances mobility, independence, and safety by integrating advanced IoT technologies. It features an obstacle detection mechanism using ultrasonic sensors and ESP32 for real-time auditory alerts, helping users avoid collisions. A live location tracking system with NEO-6M GPS and Telegram bot ensures guardians receive regular location updates for added safety. Most Importantly, an AI-powered currency detection module identifies banknotes and provides audio feedback via an MP3 module. This accessible and cost-effective solution empowers visually impaired individuals, offering scalable and adaptable assistive applications to improve their quality of life.

***Project Overview* –** The Smart Assistance System for the Visually Impaired is an innovative and multifaceted solution designed to address the mobility, safety, and everyday challenges faced by visually impaired individuals. The system integrates multiple IoT technologies, offering a seamless and user-friendly experience. Key components of the system include an obstacle detection mechanism, a live location tracking system, and a currency detection module. The obstacle detection feature uses an ESP32 microcontroller and ultrasonic sensors to detect objects within a 40 cm range, triggering a buzzer for real-time auditory alerts. This ensures safer navigation by helping users avoid potential collisions. The live location tracking system utilizes the NEO-6M GPS sensor and ESP32 to continuously monitor the user's position. Through Telegram bot integration, guardians can receive location updates every 5 minutes or instantly in emergencies, ensuring peace of mind and enhanced safety. To assist in financial transactions, the currency detection module uses a MobileNetV2 AI model deployed on a Flask server. The ESP32-CAM captures images of currency note, sends them to the server for prediction, and provides audio feedback via an MP3 module, announcing the detected denomination.

This project not only empowers visually impaired individuals by enhancing their independence and confidence but also highlights the transformative potential of IoT and AI technologies. Its scalable and adaptable design allows for future enhancements, making it a valuable and impactful solution for assistive technology applications.

Components used:

1. ***Espressif ESP32 DevKit***
2. ***Espressif ESP-Cam Module***
3. ***Ultrasonic HC-SR04***
4. ***SG90 Servo Motors***
5. ***DS3231 RTC Module***
6. ***Ublox Neo-6m GPS Module***

FIG: Smart Assistance System for the Visually Impaired

The model has 5 key-features:

1. Currency Detection using ESP-cam and MobileNetV2 ML Model

2. Medicine Dispenser using Servo motors

3. GPS Tracking using NEO-6M module and Telegram bot

4. Voice Clock

5. Obstacle Avoidance

A. Currency Detection System Using ESP32-CAM and MobileNetV2

Fig: ESP-32 Camera Module (Front and Back View)

To develop a currency detection system capable of identifying denominations, we began by collecting a dataset comprising approximately 1,500 images for each of three denominations (10 Taka, 50 Taka, and 100 Taka). These images were captured under varying lighting conditions and angles to ensure robustness and versatility.

Data Preprocessing and Model Selection:

The dataset was preprocessed to prepare it for training the model. Preprocessing included resizing, normalization, and augmenting the images to improve generalization and model performance. We selected the MobileNetV2 architecture for this task due to its efficiency, accuracy, and adaptability. MobileNetV2, being a lightweight and pre-trained model, allowed us to fine-tune it for our specific use case of predicting the desired denominations.

Model Integration Challenges:

Once the model was trained and converted to TensorFlow Lite (TFLite) format, we attempted to deploy it directly onto the ESP32-CAM module. However, due to the limited computational and memory resources of the ESP32-CAM, direct integration proved challenging.

Proposed Solution: Flask Server Integration

To address this limitation, we implemented a client-server architecture:

Server Development: Using Python, we developed a Flask server to host the model. This setup allowed the model to run on a laptop or any sufficiently powered system.

ESP32-CAM Communication: The ESP32-CAM module was programmed to capture images of currency notes and send them to the server via an HTTP request.

Model Prediction and Response: The server processed the image using the deployed AI model, predicted the denomination, and sent the result back to the ESP32-CAM.

Audio Feedback Integration

To enhance the user experience, we integrated an MP3 module and speaker with the ESP32-CAM. Based on the server's response, the system played an audio message announcing the detected denomination.

Outcome and Key Advantages

This approach enabled real-time currency detection with minimal hardware requirements on the ESP32-CAM. By offloading computation to a server, we ensured the system remained efficient, scalable, and adaptable to other machine learning tasks.

This solution demonstrates how the combination of edge devices, pre-trained models, and server-based architectures can create efficient AI-powered systems within resource-constrained environments.

B. Live Location Tracking System Using NEO-6M GPS Sensor and ESP32

Fig: ESP-32 DevKit and NEO-6M GPS Module

We developed a live location tracking system utilizing the NEO-6M GPS sensor and ESP32 microcontroller. This system allows users to share their live location with a guardian, ensuring real-time updates for safety and emergency purposes.

System Design

NEO-6M GPS Sensor: The GPS module captures the user's current latitude and longitude, displaying it on the serial monitor by default.

ESP32 Microcontroller: The ESP32 serves as the main controller, processing GPS data and managing communication with external services.

User-Friendly Location Sharing

Initially, we attempted to build a personalized mobile app using Firebase and MIT App Inventor to share the live location. However, due to implementation challenges, we pivoted to using a Telegram bot for its simplicity and reliability.

Telegram Bot Integration

GPS Data Transmission: The NEO-6M sensor sends location data to the ESP32, which forwards it to the Telegram bot.

Location Decoding: The bot processes the data and generates a Google Maps link for the guardian, allowing them to view the user's live location easily.

Tracking Modes

Automated Tracking: The system sends the user's location to the guardian every 5 minutes, ensuring continuous updates.

Emergency Mode: By pressing a push button, the system instantly transmits the current location, providing a rapid response mechanism in critical situations.

Benefits and Applications

Safety Assurance: Ideal for vulnerable individuals, including children and the elderly, to keep guardians informed of their location.

Customizable Alerts: The integration with Telegram allows for quick communication and easy access to location data.

Scalability: The system can be extended for use in fleet management, outdoor activities, or emergency response systems.

By leveraging the flexibility of the ESP32 and the accessibility of Telegram bots, this project provides a reliable and cost-effective live location tracking solution.

C. Medicine Pill Dispenser System Using ESP32 and SG-90 Servo Motors

Fig: SG90 Servo Motor

This project implements a smart medicine pill dispenser designed to assist individuals in managing their medication schedules effectively. By using servo motors, an RTC module, and the ESP32 microcontroller, the system ensures timely and convenient pill dispensing with both automated and emergency functionalities.

System Components

1. Servo Motors: Control the rotation mechanism for dispensing pills from the storage cabinet.

2. RTC Module: Maintains an accurate real-time clock to manage automated dispensing schedules.

3. ESP32 Microcontroller: Acts as the central processing unit, coordinating the RTC module, servo motors, and user inputs.

4. Pill Cabinet: Stores up to 6 pills at a time for dispensing.

5. Push Button: Allows manual dispensing during emergencies.

Functionality

1. Automated Mode:

* The system is programmed with three time slots per day (e.g., morning, afternoon, evening).
* The RTC module tracks the current time, and at each scheduled time, the ESP32 triggers the servo motor to rotate, dispensing one pill.

2. Emergency Mode:

* A push button allows the user to dispense a pill instantly, bypassing the automated schedule.

3. Pill Dispensing Mechanism:

* Pills are stored in a cabinet.
* When triggered, the servo motor rotates to release a single pill through the dispensing slot.

Features and Benefits

* **Timely Medication:** Ensures pills are dispensed at the correct time, reducing the risk of missed doses.

Dual Modes: Offers flexibility with both scheduled and on-demand dispensing options.

Compact and Simple Design: Stores up to 6 pills, making it suitable for short-term medication schedules.

Ease of Use: Push-button operation for emergencies and automated scheduling for convenience.

Applications

Elderly Care: Ideal for older adults who may forget to take their medication.

Chronic Conditions: Supports individuals with diseases requiring consistent medication, such as diabetes or hypertension.

Hospitals and Clinics: Can be scaled up for use in healthcare facilities to manage patient medication schedules.

D.VOICE CLOCK:

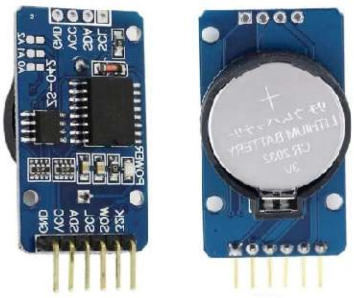

Fig: DS3231 RTC Module

This project also implements a voice clock, a useful feature for individuals who require an auditory method of knowing the time. By combining an RTC module, MP3 module, speaker, and ESP32 microcontroller, the system announces the current time at the press of a button.

System Components

1. RTC Module: Provides real-time clock functionality, maintaining accurate time even without a power supply.

2. MP3 Module: Stores and plays pre-recorded audio files corresponding to time announcements.

3. Speaker: Delivers the audio output to the user.

4. ESP32 Microcontroller: Processes input and coordinates the RTC module, MP3 module, and speaker.

How It Works

1. Button Input: When the user presses a push button, the ESP32 triggers the system.

2. Time Retrieval: The RTC module sends the current time to the ESP32.

3. Audio Playback: Based on the retrieved time, the ESP32 instructs the MP3 module to play the corresponding audio file.

4. Time Announcement: The speaker announces the current time to the user.

Features and Advantages

Ease of Use: Provides a straightforward method of checking the time without requiring visual input.

Customizable Output: Audio files can be recorded in different languages or tones, catering to user preferences.

Compact Design: Can be integrated into wearable devices or standalone setups.

Accessibility: Particularly useful for visually impaired individuals or those with limited mobility.

Applications

Assistive Devices: Enhances accessibility for individuals with special needs.

Daily Use: Can be used as a convenient time-checking tool in homes or offices.

This voice clock system demonstrates how simple hardware components can be combined to create a user-friendly and accessible feature.

E. Obstacle Detection System

Fig: HC-04 Ultrasonic Sensor

This project was designed to assist visually impaired individuals by providing an obstacle detection system that alerts them to nearby objects, enhancing their safety and mobility.

System Components

1. Ultrasonic Sensor: Measures the distance between the user and obstacles in front.

2. Buzzer: Serves as an audio alert mechanism.

3. ESP32 Microcontroller: Acts as the main controller, processing data from the ultrasonic sensor and triggering the buzzer when necessary.

Functionality

1. Distance Measurement: The ultrasonic sensor continuously calculates the distance between the user and obstacles.

2. Critical Distance Alert: When the distance falls below a pre-defined threshold (critical point), the ESP32 activates the buzzer.

3. Auditory Feedback: The buzzer emits a sound to alert the user of the obstacle, allowing them to take appropriate action to avoid it.

Advantages

* **Real-Time Alerts:** Provides immediate feedback, ensuring quick responses to obstacles.

* **Simplicity and Reliability:** The use of basic components ensures robustness and ease of implementation.

* **Cost-Effectiveness:** Affordable components make it accessible for widespread use.

Applications

* **Mobility Assistance:** Supports visually impaired individuals in navigating environments safely.

* **Adaptability:** Can be integrated into walking sticks, wearable devices, or standalone units.

The Smart Blind Assist system represents a comprehensive solution on to enhance the lives of visually impaired individuals. Its innovative use of IoT and machine learning demonstrates significant potential to address real-world challenges and contribute meaningfully to inclusivity and accessibility.

ALL THE CODES OF THIS PROJECT CAN BE FOUND AT:

VIDEO EXPLAINING THE FUNCTIONS BY THE TEAM MEMBERS CAN BE FOUND AT: