Galilean Compass

AI Object Identification for Internet of Things

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Department: Department of Technology | Competition Category: Business, Engineering, and Technology

Introduction 1

Project Goal: Develop an object-identifying device to assist visually impaired individuals that acts as a second pair of eyes, improving autonomy and quality of life.

How It Works: Point the device's camera at an object (e.g., shirt), the device recognizes the object and identifies it (e.g., "This is a shirt") and provides real-time feedback to the user.

Target Audience: Visually impaired individuals and their caregivers. Low-cost, customizable alternative to existing assistive technologies.

This is a proof-of-concept of applying an AI model to an ESP32-CAM

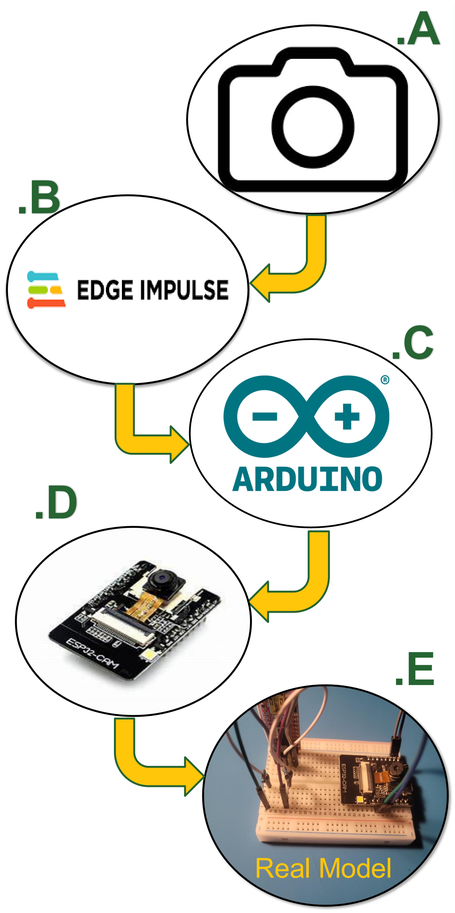
We aim to achieve the following:

Make the system affordable and portable

Detect and recognize objects (e.g., glasses, remote, keys)

Provide real-time verbal feedback via Text-to-Speech (TTS) (in the future)

Methodology 2



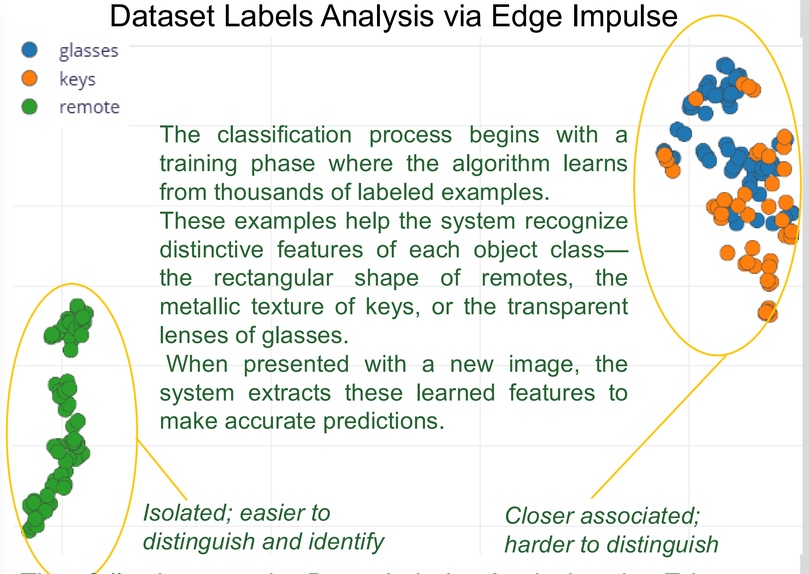
Data Collection:
Capture 50-100 high-quality images of each object (Glasses, Remote, and Keys). A well-labeled dataset ensures accurate model training.

AI Model Development with Edge Impulse: Use Edge Impulse to build and train the AI model for object recognition. The model is trained using the labeled dataset and exported as a TensorFlow Lite (.tflite) file.

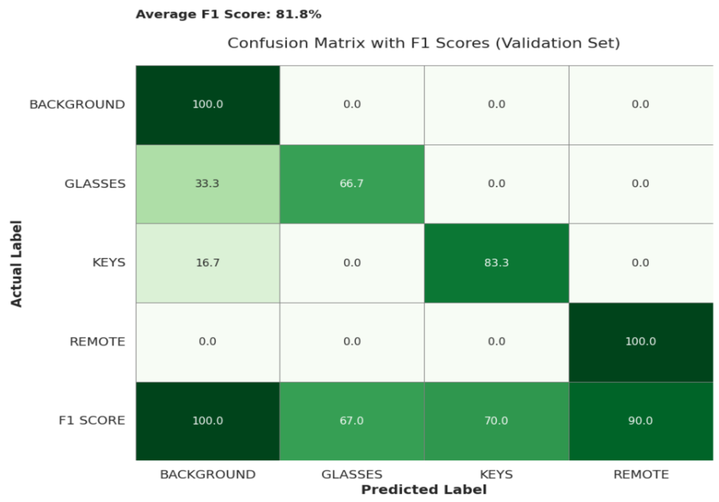
Arduino integration: Use Arduino IDE to upload the TensorFlow Lite model to the ESP32-CAM microcontroller. ESP32-CAM captures images and performs real-time inference to identify objects.

Model Deployment on ESP32-CAM:
Deploy the machine learning model using an ESP 32 CAM to identify objects.

Results 3



The following graph *Data Labels Analysis via Edge Impulse* depicts the collective image and correlation between them and the Labels they have been identified as.



This table shows the F1 Score, a metric commonly used to evaluate classification models. It is the harmonic mean of Precision and Recall (Sensitivity), providing a balance between the two. The F1 score is particularly useful when the data is imbalanced, as it considers both false positives and false negatives, making it a more comprehensive measure than accuracy alone.

Precision vs Recall vs F1

Precision = How accurate are the model's positive predictions?

Recall = How many actual items did the model find?

F1 Score = A balance between precision and recall.

Conclusions 4

This project showcases the potential of Tiny ML to provide cost-effective, real-time object recognition for visually impaired individuals. It highlights how embedded AI can enhance accessibility, empowering users to perform tasks that would otherwise require external assistance.

This project brought new knowledge in terms of building an AI model as well as designing and building an IoT device catered to an end-goal.

Further research will can help refine the accuracy of the AI as well as increase the dataset to identify more objects within the house for individuals with visual impairments.

Potential improvements may include description for the identified objects (i.e.: the sock is red). Increased detection range. Research of text to speech functions for the target purpose is ongoing.

References

1. *S. Sharma, R. Gupta, A. Kumar, A TinyML solution for an IoT-based communication device for hearing impaired, Expert Systems with Applications, Volume 246, 2024, 123147, ISSN 0957-4174, https://doi.org/10.1016/j.eswa.2024.123147.*
2. *https://edgeimpulse.com/*
3. *Object Detection using ESP32-CAM and Edge Impulse. (2024). Circuitdigest.com.*

Acknowledgments

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