**Tortoise: An Assistive System for People with Memory Loss Conditions**

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**Abstract**

Tortoise is an advanced assistive solution for individuals with memory loss, utilizing assistive wearable technology with a mobile application to facilitate facial recognition, object location memory, and wandering prevention. By enabling users to recognize familiar faces, locate commonly used objects, and prevent wandering via real-time GPS monitoring, Tortoise significantly enhances the independence and safety of individuals with memory loss. Combining cutting-edge AI technology with user-friendly interfaces, Tortoise not only empowers users by restoring confidence in their daily interactions, but also offers caregivers and family peace of mind through timely alerts and location tracking.

**Introduction**

Memory loss conditions, such as Alzheimer’s disease and dementia, are increasingly prevalent, impacting millions worldwide. According to the World Health Organization, around 50 million people currently live with dementia, and nearly 10 million new cases are reported annually. These conditions can severely impair an individual’s ability to recognize faces, remember the locations of everyday objects, and navigate their surroundings safely, leading to a significant reduction in independence and quality of life. Research indicates that assistive technologies can play a vital role in supporting individuals with memory loss, potentially delaying the need for full-time care and significantly enhancing their ability to manage daily tasks.

Recent advancements in computer vision and wearable technology have created new opportunities to support those with memory loss. The proposed system, Tortoise, seeks to harness these technological innovations to develop a comprehensive assistive solution. This system integrates a smart headset with facial recognition capabilities and a smartwatch application designed to help with object location memory and wandering prevention, aiming to enhance the autonomy and safety of individuals with memory loss conditions.

Tortoise is an advanced assistive system designed for individuals with memory loss, combining smart devices to support facial recognition, object location memory, and wandering prevention. By helping users identify familiar faces, find frequently used objects, and prevent wandering through real-time GPS monitoring, Tortoise greatly enhances the independence and safety of those with memory challenges. Integrating cutting-edge AI technology with intuitive interfaces, Tortoise not only empowers users by restoring confidence in their daily activities but also provides caregivers and family members with peace of mind through timely alerts and location tracking.

**Dataset**

The Tortoise system uses a dynamic training dataset where users upload 3-10 initial facial images per class, which are augmented to 1,000. The base model is pretrained on the VGGFace2 dataset, containing 3.31 million images across 9,000+ classes. For object recognition, 2,000 raw images per class are augmented to 100,000, resulting in a total training set of 300,000 images, all resized to 224x224 pixels.

**Problem Formulation**

The Tortoise system addresses the challenge of supporting individuals with memory loss by focusing on enhancing their independence and safety. Key issues include improving the efficiency and scalability of facial recognition systems to handle expanding numbers of facial classes, enhancing object recognition with faster and more accurate processing, and implementing effective wandering prevention through a reliable geofencing mechanism. Additionally, there is a need to design a user-friendly mobile application that caters to elderly users with cognitive impairments and to transition from a single user to a multi-user architecture for broader deployment in senior living facilities. By tackling these problems, Tortoise aims to improve the quality of life for users and provide peace of mind for their caregivers

**Methodology**

The Tortoise system addresses memory loss challenges by focusing on three areas: facial recognition, object recognition, and wandering prevention. Using live image feeds from smart devices, it employs a two-step facial recognition process. An OpenCV facial detection algorithm first identifies faces, followed by facial recognition using a VGG16-based CNN. Recognized faces are displayed on a mobile app, providing real-time assistance. For object recognition, Tortoise uses similar live feeds, with a CNN (trained on EfficientNet or YOLO v8) classifying objects and recording their locations via GPS to help users find items at home, enhancing independence.

To prevent wandering, Tortoise incorporates geofencing technology. The system monitors GPS locations and alerts caregivers when predefined boundaries are breached, providing real-time updates to ensure quick intervention.

Tortoise consists of two core components: a smart headset and a smartwatch application. The smart headset, equipped with an RPi Camera Module v3, captures live feeds, processed locally by an embedded Raspberry Pi Pico. Results are shown on a heads-up display (HUD) and transmitted to the smartwatch app. The smartwatch app, the primary interface for users and caregivers, offers key features such as:

1. **Face and Object History:** Records classifications and locations of detected faces and objects.
2. **Geofencing Alerts:** Notifies caregivers when users cross boundaries, with live GPS updates.
3. **User Input:** Allows users to upload images to improve facial recognition accuracy.
4. **Additional Features:** Designed for future enhancements to improve user experience.

Tortoise’s success depends on the accuracy of its CNN systems. Two training options are available: Google Colab provides a cost-effective cloud-based platform, while the NVIDIA GeForce RTX 4090 GPU accelerates training for faster, more accurate model development.

**Outcome**

By integrating advanced technologies into a user-friendly platform, Tortoise aims to greatly improve the autonomy and safety of individuals with memory loss while providing caregivers with peace of mind through reliable monitoring and timely alerts.

The alpha prototype of the Tortoise project marks significant progress in developing assistive technologies for those with memory loss. The successful demonstration of the proposed architecture showcases the system's potential and viability. By integrating smart devices and a smartwatch application, the foundation has been set for a system that offers essential support in facial recognition and object location, enhancing users' independence and providing reassurance to caregivers. The core machine learning components—facial recognition via VGGFace2 and object recognition using EfficientNet—have proven robust and effective. Tortoise's ability to differentiate between recognized and unrecognized faces, along with the strong performance of the object recognition system, highlights the project's technological strengths.

Despite these achievements, several improvements are planned for the beta prototype. We will implement incremental learning techniques to reduce training time and enhance system efficiency, addressing inefficiencies in the current VGGFace2 finetuning process. The beta version will also feature a geofencing alert mechanism to improve monitoring and provide timely caregiver notifications in case of wandering. The mobile application will be redesigned to fix bugs and improve its user interface, making it more accessible for elderly users. Additionally, we plan to integrate the YOLOv9 architecture to significantly reduce inference times and improve object detection accuracy. Finally, the transition to a multi-user system will enable the simultaneous monitoring of multiple individuals, particularly in senior living facilities.

**References**

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