Master's Thesis project

(Fill in only the parts in light yellow)

This document has to be registered at the Students' Secretariat, not later than six weeks in advance of the Master's Thesis examination date

Title	Gesture Recognition-Based Haptic Control for Smart Home Accessibility
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Master's Thesis Director (fill only if there exists a director who is not a professor of the Master program. In this case, also the tutor's data have to be included above)	
Director's Department/Company	
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Timeline (Estimated start and end dates)	20/05/2024-18/07/2024
Location(s) (Where the work will be carried out)	Madrid
Budget in € (If applicable)	

Description

Include a summary of the following aspects of the Master's Thesis you plan to carry out: **Objectives, description, methodology, tasks, materials to be used, time-schedule and bibliography**. Recommended length: 2 pages.

Objectives

The primary objective of this master thesis is to design, implement and validate a mobile haptics interface capable of managing basic aspects of an accessible smart home. This interface will learn from the user's specific gestures, allowing individuals with various movement capacities, restrictions, or preferences to comfortably train the app to effectively suit their unique needs.

Description

This project aims to develop a lightweight gesture recognition system for smartphones that utilizes machine learning techniques to interpret a limited vocabulary of gestures. The system will adapt to different users, ensuring accessibility for people with varying levels of mobility. By leveraging accelerometer data, the interface will recognize and respond to simple letter gestures, enabling users to easily control their home environment.

Specifically, users can control various household appliances by drawing simple letter gestures, such as "L", "I", "O", and "U". For example, one gesture can be used to turn lights on or off, another gesture to control the television, adjust the air conditioner temperature, or change the volume. These gestures will be mapped to basic home control functions, allowing users to manage their home appliances with simple movements.

Currently, there are products on the market that utilize accelerometer data for gesture recognition, such as Motorola's Moto Actions [1]. This feature includes a series of gesture controls built into their smartphones. For instance, users can open the camera by quickly twisting their wrist twice or turn on the flashlight with a chopping motion. These functionalities utilize the phone's accelerometer and gyroscope to detect gestures and trigger the corresponding actions. Although these features are diverse, they mainly focus on controlling basic phone functions like the camera and flashlight.

Voice assistants are another popular method for controlling smart home devices. Products like Google Nest Hub [3] and Amazon Echo [4] rely on voice commands to manage smart home functions. However, these methods require users to use voice commands, which may not be suitable for individuals with speech impairments.

Our project aims to provide an alternative solution through gesture recognition technology. By using simple letter gestures detected by the smartphone's accelerometer, our system offers a more inclusive and accessible way for users to control their home appliances.

Methodology

For this project, a waterfall methodology will be employed, which is suitable for relatively simple software projects with limited time frames. This approach involves a sequential design process, where each phase depends on the deliverables of the previous one and corresponds to a specialization of tasks. The phases will overlap slightly to ensure a smooth transition between stages. The phases include requirement analysis, system design, implementation, testing, deployment and documentation.

The specific tasks associated with each phase are detailed in the following section.

Tasks

Requirement Analysis:
- Research existing methodologies and models for gesture recognition using accelerometer data [2][6].
- Define requirements and the scope of the project.

System Design:
- Choose a lightweight model from TensorFlow Lite and design the system architecture [7].
- Plan the integration of the gesture recognition model and user training module.

Implementation:
- Develop the mobile application and integrate the machine learning model.
- Create the data collection framework for collecting and preprocessing accelerometer data from user gestures [5].

Testing:
- Collect user gesture data and preprocess it.
- Train the model and test its accuracy and reliability with real user data.

Deployment:
- Finalize the application and ensure all components function correctly.

Documentation:
- Document all phases of the project.

Materials to be Used

Software: TensorFlow Lite, Android Studio, Python, and relevant machine learning libraries.
Hardware: Smartphone equipped with accelerometers.
Documentation and Resources: Access to online repositories, research papers, and TensorFlow documentation.

Time Schedule

Week 1-2: **Literature Review and Model Selection**
- Review relevant literature.
- Select an appropriate TensorFlow Lite model.

Week 2-3: **Application Development**
- Develop the mobile application framework.
- Integrate the selected model into the application.
- Identify gestures that will be most frequently used by users and their characteristics.

Week 3-4: Data Collection and Preprocessing
- Set up a framework for collecting and preprocessing accelerometer data.

Week 4-5: Model Training and Initial Testing

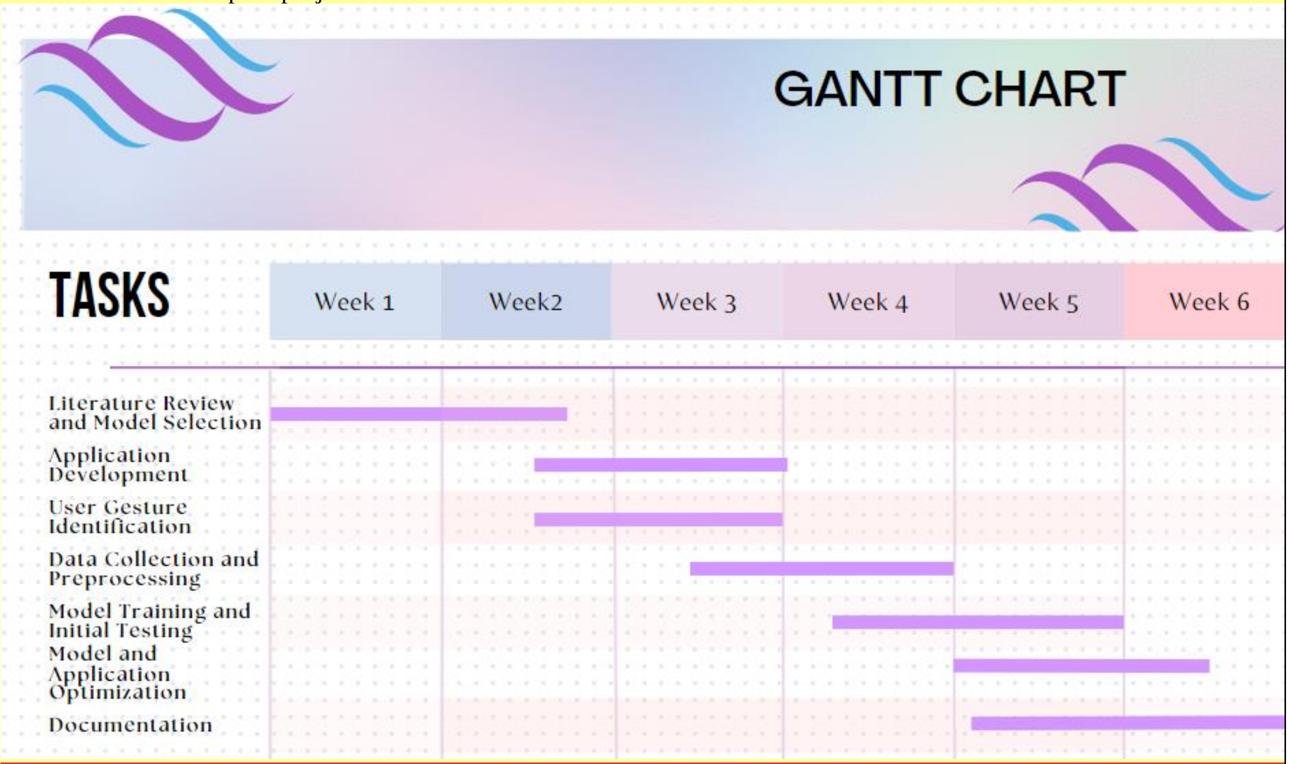
- Train the model using collected data.
- Conduct initial testing to evaluate performance.

Week 5-6: Model and Application Optimization

- Optimize the model and application based on initial testing results.
- Ensure system stability and accuracy.

Week 6: Final Refinement and Documentation

- Complete final optimizations.
- Prepare project documentation and defense materials.



Bibliography

[1] Motorola Moto Actions. Available at: https://es-latam.support.motorola.com/app/answers/detail/a_id/145234/~/moto-actions---motorola-one-action (Accessed: 25 May 2024).

[2] "Using accelerometer and gyroscope data". Available at: https://www.tensorflow.org/lite/examples (Accessed: 25 May 2024).

[3] Google Nest Hub. Available at: https://store.google.com/es/product/nest_hub_2nd_gen?hl=es&pli=1 (Accessed: 25 May 2024).

[4] Amazon Echo. Available at: https://www.amazon.com/echo (Accessed: 25 May 2024).

[5] Mace, D., Gao, W., & Coskun, A. (2013). Accelerometer-based hand gesture recognition using feature weighted naïve bayesian classifiers and dynamic time warping. Proceedings of the 18th International Conference on Intelligent User Interfaces, 83-84. Available at: https://www.bu.edu/peaclab/files/2014/03/mace_IUI13.pdf (Accessed: 25 May 2024).

[6] Xie, M., & Pant, D. (2014). Accelerometer Gesture Recognition. Available at: https://cs229.stanford.edu/proj2014/Michael%20Xie,%20David%20Pan,%20Accelerometer%20Gesture%20Recognition.pdf (Accessed: 25 May 2024).

[7] TensorFlow Lite Models. Available at: https://www.tensorflow.org/lite/models (Accessed: 25 May 2024).

Dates and signatures

	Date	Signature
Student	20/05/2024	
Master's Thesis Tutor		Firmado por ANA BELEN GARCIA el día 28/05/2024 con un certificado emitido por AC DNIE 005 Firmado por VALERO DUBOY MIGUEL ANGEL - DNI ***7520** el día 29/05/2024 con un certificado emitido por AC Sector Público
Master's Thesis Director		

Approval from the Master's Academic Coordination Commission

	Date	Signature
President of the Master's Academic Coordination Commission		