



Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich



Task Description for a Semester Thesis on

Hand-Detection for Sign Language Aid on Android-Based Smart Glasses

at the Department of Information Technology and
Electrical Engineering

for

Luca Specht

lspecht@student.ethz.ch

Advisors: Michele Magno, michele.magno@pbl.ee.ethz.ch
Luca Pascarella, luca.pascarella@pbl.ee.ethz.ch
Andrea Ronco, andrea.ronco@pbl.ee.ethz.ch

Professor: Prof. Dr. Luca Benini, lbenini@ethz.ch

Handout Date: 27.03.2023
Due Date: 03.07.2023

Project Goals

Smart glasses have opened up a world of opportunities for augmented reality (AR) applications. The increasing popularity of these devices has led to a surge in the development of AR technology, creating exciting possibilities for enhanced user experiences. The efficiency of computing is essential for AR applications to function seamlessly and deliver the desired level of immersion, making it a critical factor for the success of these devices.

One area that has the potential to benefit significantly from wearables is real-time sign language translation. Smart glasses could be an effective aid to break the existing language barrier between individuals with hearing impairments. Hand detection is a crucial component of sign language translation, and state-of-the-art object detection neural networks are showing promising results for this task.

In the context of your thesis, you will develop a hand-detection application based on state-of-the-art computer vision algorithms. The application will be deployed on the SDW4100 development board, based on Qualcomm's wearable SoC. Finally, you will evaluate your design on the platform.

Tasks

The project will be split into three phases, as described below:

Phase 1 (Week 1-4)

1. Literature Research on hand and object detection [1, 2]. Identification of suitable datasets for the training and evaluation of the neural network.
2. Setup and familiarization with the development environment, both software side (Android Studio) and hardware (SDW4100 platform). Familiarization with the tools to flash and sideload android apps.
3. (Optional) Understanding how to move to WearOS (if possible)

Phase 2 (Week 5-11)

1. Implementation of the ML model offline, using the previously identified dataset(s), and preliminary evaluation for the classification task.
2. Development of the Android/WearOS app backbone (camera interface, controls, layout)
3. Deployment of the network in the Application
4. Optimizations of the inference performance with quantization, pruning, architecture-level techniques, and use of the Hexagon accelerator

Phase 3 (Week 12-14)

1. Polishing of the codebase, documentation
2. Final evaluation of the application in terms of accuracy of the model, inference time, and power consumption with and without optimizations.
3. Report and Presentation

Milestones

The following milestones need to be reached during the thesis:

- Development of the App with appropriate layout, hardware interfaces, and permission management.
- Development of the Machine Learning model and evaluation
- Deployment and integration in the app. Power and latency evaluation
- Final report and presentation.

Project Organization and Grading

During the thesis, students will gain experience in the independent solution of a technical-scientific problem by applying the acquired specialist and social skills.

The grade is based on the following: Student effort; thoroughness and learning curve; achieving qualitative and quantitative results with a scientific approach; supporting practical findings with theoretical background and literature investigations; final presentation and report; documentation and reproducibility. All theses include an oral presentation, a written report and are graded. The report and presentation need to have publication grade quality to achieve a good grade. Students are graded based on the official ITET grading form¹.

For students of IIS (Prof. Benini) a special grading scheme exists, please contact your supervisor for details there. Before starting, the project must be registered in myStudies and all required documents need to be handed in for archiving by PBL.

Laboratory Rules

The students agree to follow the lab rules set by PBL staff, for detail please contact us. The most important points are:

¹<https://ethz.ch/content/dam/ethz/special-interest/itet/department/Studies/Forms/Grading%20Form.xlsx>

- All ETH safety regulations need to be followed², in addition to ones given by PBL staff
- No device in the lab is used without introduction by your supervisor or PBL staff
- No device leaves the lab without being officially borrowed, this is done by PBL staff and needs your Legi.
- Any damage to devices or tools needs to be reported immediately to PBL staff.
- The Lab-desk is clean and free for others after you finished your task, or when you take longer breaks. All tools are correctly sorted into their drawers/cupboards when you leave

Weekly Report

There will be a weekly report/meeting held between the student and the assistants. The exact time and location of these meetings will be determined within the first week of the project in order to fit the students and the assistants schedule. These meetings will be used to evaluate the status and document the progress of the project (required to be done by the student). Beside these regular meetings, additional meetings can be organized to address urgent issues as well. The weekly report, along with all other relevant documents (source code, datasheets, papers, etc), should be uploaded to a clouding service, such as Polybox and shared with the assistants.

Project Plan

Within the first month of the project, you will be asked to prepare a project plan. This plan should identify the tasks to be performed during the project and sets deadlines for those tasks. The prepared plan will be a topic of discussion of the first week's meeting between you and your assistants. Note that the project plan should be updated constantly depending on the project's status.

Final Report and Paper

PDF copies of the final report written in English are to be turned in. Basic references will be provided by the supervisors by mail and at the meetings during the whole project, but the students are expected to add a considerable amount of their own literature research to the project ("state of the art").

²<https://ethz.ch/staffnet/en/service/safety-security-health-environment/sicherheit-in-laboren-und-werkstaetten/laborsicherheit.html>

Final Presentation

There will be a presentation (15 min presentation and 5 min Q&A for BT/ST and 20 min presentation and 10 min Q&A for MT) at the end of this project in order to present your results to a wider audience. The exact date will be determined towards the end of the work.

References

Will be provided by the supervisors by mail and at the meetings during the whole project.

Place and Date Zürich, 03/21/23 Signature Student 

Bibliography

- [1] J. Redmon, S. Divvala, R. Girshick, and A. Farhadi, “You Only Look Once: Unified, Real-Time Object Detection,” May 2016, arXiv:1506.02640 [cs]. [Online]. Available: <http://arxiv.org/abs/1506.02640>
- [2] “Sign Language Recognition: A Deep Survey | Elsevier Enhanced Reader.” [Online]. Available: <https://www.sciencedirect.com/science/article/pii/S095741742030614X>