University of Bologna

Industry 4.0
Kenan Bektas, Kimberly Garcia

Assignment 2: Gaze-based Activity Recognition

Deadline: May 17, 2024; 22:00 CET

Mobile devices with high-speed connectivity provide us with access to vast amounts of data. For instance, head-worn augmented reality (AR) displays can overlay digitized visual information on physical objects and provide relevant insights about those objects. Eye-tracking systems help us assessing user's attention, situation awareness, cognitive load, and performance in real time or within a specific time frame [2]. Thus, eye trackers can provide valuable insights about user behavior in many daily activities [3]. Over the past decade, eye tracking systems have become feasible in AR applications that can continuously adapt to the user's activities [1] and the requirements and constraints of their context [4], i.e., pervasive AR.

In this assignment, you will gain experience working with gaze data. You find the files required for this assignment in our course's repository.[1]

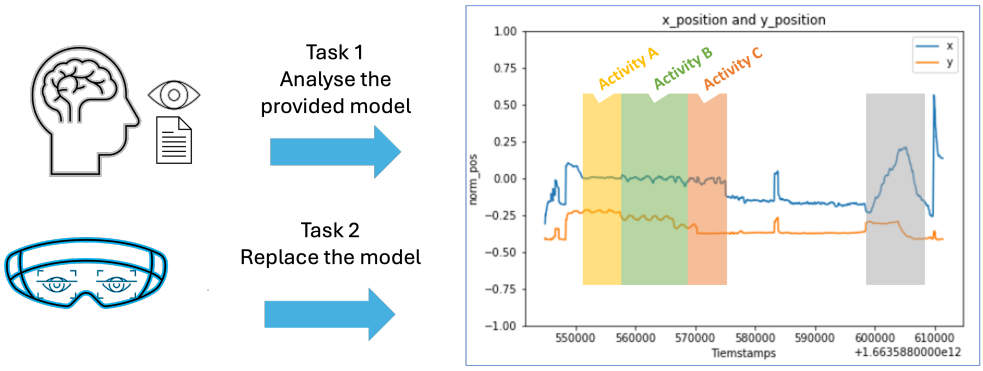

Figure 1: Gaze-Based activity recognition.

① Analysis of a pre-trained activity recognition model

In this task, you will run the notebooks for visualizing gaze data and the one for classifying it into different activities (i.e., read, inspection, and search). Take your time to go through the notebook and understand what happens on each cell.

Prerequisites:

- An eye tracking dataset recorded during reading, searching, and inspection activities. The dataset will allow you to *train* and *test* another classifier.
- A Jupyter notebook that processes and visualizes the raw data.
- A Jupyter notebook that allows you to define features and labels for the classification.
- A Jupyter notebook that gives you a starting point for training a simple classifier.
- You do **not** need an eye tracker to work on this exercise.

[1] https://github.com/Interactions-HSG/2023-HS-MCS-UbiComp-Public/tree/main/Assignment2

(2) Replace the provided model for a different one

The provided model is a simple classifier that uses a Support Vector Machine (SVM), which is *trained* with features that are extracted from the eye movement metrics (i.e., dispersion and duration of fixations) that were covered in the lecture and related literature. Your task is to try out another classifier (different from the SVM provided) and compare it with the results that the SVM produces[2]. You should test the performance of your solution (i.e., confusion matrix) on the *test* dataset that we provide.

By the deadline, submit a report containing:

- The function that shows you used a different classifier.
- An analysis of the comparison between at least two classifiers that use the provided gaze data. Which one is better?

(3) **Discussion on gaze data.** Now that you are familiar with gaze data, answer the following questions.

- In your own words what are fixations and saccades?

By the deadline submit:

- Include on your report the answers to the question indicated above.

(4) Hand-in and Grading

The evaluation of this assignment is **binary**. To pass the assignment, you should answer the questions, and should provide your working function. By the deadline, please submit your document in Virtuale.

[2]You can use the same library

Bibliography

[1] K. Bektaş, J. Strecker, S. Mayer, D. K. Garcia, J. Hermann, K. E. Jenß, Y. S. Antille, and M. Solèr. Gear: Gaze-enabled augmented reality for human activity recognition. In *Proceedings of the 2023 Symposium on Eye Tracking Research and Applications*, ETRA '23, New York, NY, USA, 2023. Association for Computing Machinery. ISBN 9798400701504. doi: 10.1145/3588015.3588402. URL https://doi.org/10.1145/3588015.3588402.

[2] K. Bektas. Toward a pervasive gaze-contingent assistance system: Attention and context-awareness in augmented reality. In *ACM Symposium on Eye Tracking Research and Applications*, ETRA '20 Adjunct, New York, NY, USA, 2020. Association for Computing Machinery. ISBN 9781450371353. doi: 10.1145/3379157.3391657. URL https://doi.org/10.1145/3379157.3391657.

[3] J. L. Kröger, O. H.-M. Lutz, and F. Müller. What does your gaze reveal about you? on the privacy implications of eye tracking. In *IFIP International Summer School on Privacy and Identity Management*, pages 226–241. Springer, 2019. doi: https://doi.org/10.1007/978-3-030-42504-3_15.

[4] J. Orlosky, M. Sra, K. Bektaş, H. Peng, J. Kim, N. Kos'myna, T. Höllerer, A. Steed, K. Kiyokawa, and K. Akşit. Telelife: The future of remote living. *Frontiers in Virtual Reality*, 2:147, 2021. ISSN 2673-4192. doi: 10.3389/frvir.2021.763340. URL https://www.frontiersin.org/article/10.3389/frvir.2021.763340.