

# Recognizing Activities of Daily Living Using Audio and IMU Data from Commodity Smartwatches

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**Abstract**—TBD

**Index Terms**—component, formatting, style, styling, insert

## I. INTRODUCTION

Early research in activity detection aimed at finding differences in signal characteristics of the collected accelerometer data, and determining the ideal sensor placement. In [2], activities were grouped together into four categories by levels of physical activity, and sensors were placed throughout the body to determine the best location for each of the categories. Their results found each category performed best with a different sensor location. A sensor placed on the waist was best at detecting low level activities like eating, while a sensor on the chest or wrist was best at medium level activities like housework.

While different sensor placement based on an activity would be ideal for performance, it would not be practical for widespread use. An accelerometer by itself is not enough to determine an activity, context would be needed, and different sensors on the body are an inconvenience for users. Human activity recognition is widely used in healthcare applications, with the elderly being a large part of the user demographics [4], to suit their needs the data collection would require an unobtrusive setup. To address the inconvenience of full body sensors and the need for context, [5] used a wrist-worn device equipped with an accelerometer and camera to recognize daily activities. The camera provided context for the activities, and the accelerometer provided characteristics of the body movement associated with different activities, both of which were used to train a model to predict the activity.

The advancement in smart devices, like smartwatches and conversational assistants, allow for more sensors in a user friendly device. Conversational assistants, like a Google Home, and smartwatches are used to train a model to recognize activities of daily living [1] [3].

We propose a research project, recognizing activities of daily living using the IMU and audio data from a commodity smartwatch. We will be following existing research performed in the paper, Leveraging Sound and Wrist Motion to Detect Activities of Daily Living with Commodity Smartwatches. Our process will involve conducting experiments wearing a smartwatch and performing a variety of basic activities such

as writing, brushing teeth, and washing hands. We will record IMU data and audio data using the mic on the watch as input to a deep learning model which fuses the inertial data and acoustic data to determine the activity being performed. Recognizing activities of daily living using inertial data has been the focus of a number of studies in the recent past, but fewer studies have included acoustic data in the model. We believe using both types will result in more accurate recognition. Some activities such as writing are more easily captured using inertial data while other activities such as cutting paper are more captured using acoustic data. Smart watches prove especially practical for recording both types of data because the mic is at close proximity to the hand which is often close to the activity being performed and the IMU records useful motion on the wrist as opposed to a smartphone in the pocket or strapped to the chest.

[Hardware setup] The authors of [3] used the same watch for all of their experiments. They used a Fossil Gen 4, Android Wear OS 2.21, Custom application collects data synchronously and stores locally on watch. Max inertial sensor samples at rate 50 Hz, acoustic sampled at 22.05 KHz. We will be using different watch manufacturers in our experiment to ensure generic compatibility.

The paper that we follow conducted two generally different experiments. In the first experiment, an individual performs a series of activities for 30 seconds wearing a Fossil smartwatch which records inertial and acoustic data. There is a clear distinction between each activity and the watches are programmed to listen at frequent intervals. The authors implemented a variety of machine learning models to recognize the activity in this experiment with an accuracy of 94.3. The second experiment implements a less controlled, more realistic setting. [Describe] Accuracy of 55.8.

## II. SECTION

### A. Subsection

## ACKNOWLEDGMENT

Paper we are implementing [3].

TABLE I  
SCHEDULE

Phase	Activities	Due Date
Planning	<ul style="list-style-type: none"> <li>• Identify existing research data</li> <li>• Identify available hardware</li> <li>• Plan for how to capture and store data</li> <li>• Identify how to process data</li> <li>• Identify machine learning classification models</li> </ul>	March 18
Data Collection	<ul style="list-style-type: none"> <li>• Capture and process raw data</li> <li>• Capture audio data at all times</li> <li>• Review existing research data</li> <li>• Get volunteers for experiments</li> </ul>	April 1
Analysis	<ul style="list-style-type: none"> <li>• Fuse data collected from different sources</li> <li>• Label data collected</li> <li>• Run the classification models</li> <li>• Analyze results</li> </ul>	April 15
Finalize Report	<ul style="list-style-type: none"> <li>• Write up final report</li> <li>• Create presentation</li> </ul>	April 22

#### REFERENCES

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