Supplement A

Two supplemental figures are included in this document. Figure 1 contains an overview of the electrical system and the data processing used to train and test the classification algorithms. First, as explained in the main portion of the paper, the sensors are read using either a Raspberry Pi 4 for lower frequency sensors or a Teensy 3.6 for higher frequency sensors. The tactile data is preprocessed to remove linear drift and any induced offsets. The processed tactile data is then segmented, i.e., divided into individual footsteps. The segmented tactile data is used to know when to segment the data from the other sensors, so that each footstep is clearly represented. Once each footstep is found, 100 statistical features are extracted for each step and the machine learning algorithm is applied to the step for classification.
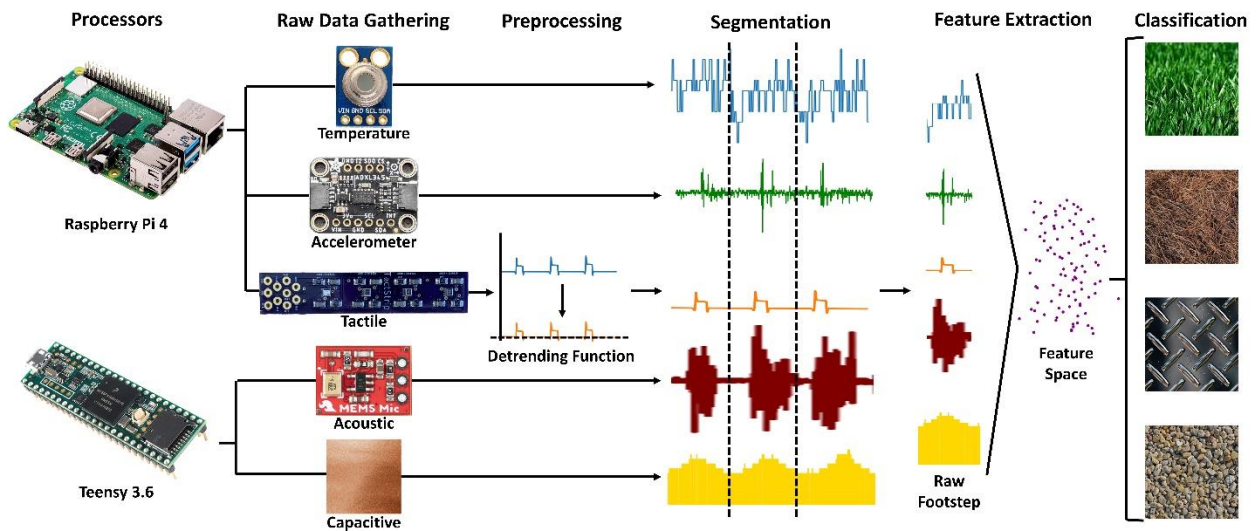

Figure 1. Overview of the electrical and data processing used for the classification process.

Figure 2 contains four plots representing the processing used on the tactile data. For clarity, these plots show the data for only two pressure sensors located on one tactile sensor. In total, the foot has two tactile sensors for a total of eight pressure sensors. First, the raw data is gathered. As can be seen in the plot titled "Raw Data," this data contains a series of distinct plateaus that each represent a footstep. A detrending function is applied to the raw data to remove any linear drift and offset, which is at times introduced during the manufacturing process. The detrending function ensures that all data is zero-centered and facilitates the terrain classification. The tactile data for a single footstep is then summed, and all the tactile data, summed and individual, is segmented. Finally, features are extracted from both the summed data and the individual sensor data separately and used, with the features from the other types of sensors, to train and test the classification algorithms. These statistical features are commonly used statistical values like the maximum, minimum, and average, and more details can be found in the main body of the paper.
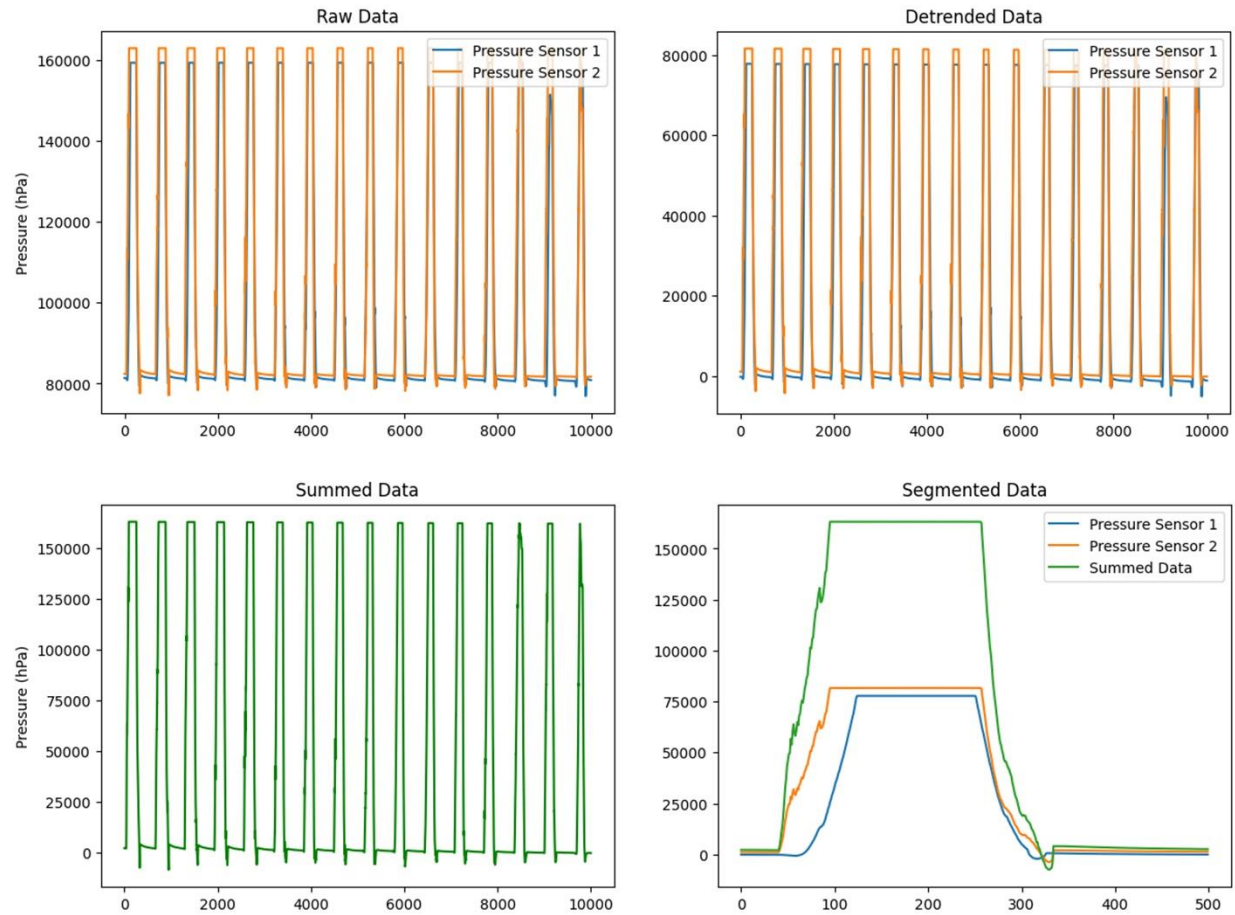
Figure 2. Overview of the preprocessing done on the tactile data. Only two of four sensors from one tactile sensor are shown for clarity. The x-axes represent datapoints and are not representative of any sort of time step.