

Practical 3: Processing accelerometer data

In this practical, you will process data collected from your accelerometer.

0. Tools needed

- Conda /Virtualenv to manage dependencies
- Java 8+: Download jdk-17 here. If you are on a Mac machine, make sure to select the right distribution for the chip you have. For m1 chips, get arm64. For intel chips, get x64.

1. Setup and installation

First we need to install package that can pre-process your accelerometer data. To do this, activate your virtual environment either using conda or virtualenv.

Conda activation

```
$ conda create -n acc_parsing
$ conda activate acc_parsing
```

or virtualenv activation

```
$ mkdir venvs/ ; cd venvs/
$ python -m venv acc_parsing
$ source acc_parsing/bin/activate
```

Once your environment has been activated, install the package using `pip` :

```
$ pip install accelerometer
```

You should keep your environment active for the remaining for the practical.

2. Extracting data

We can now extract the raw data from your devices.

Accelerometer

- Plug in your accelerometer to your computer. Go to the external drive where it is located and copy the .CWA drive over wherever you want. Rename the file as `myAcc.cwa` .

```
$ mkdir ~/acc_data
$ cp /Volumes/AX317_41145/CWA-DATA.CWA ~/wearable-teaching/practicals/data/myAcc.cwa
```

- **Safely disconnect the device and put your accelerometer back on!**
- Currently the raw data stored in the CWA file does not allow easy extraction of the 3-axis acceleration data, so we need to convert this to a more suitable format such as CSV for further manipulation. Run the following in your `practicals` folder:

```
$ cd ~/wearable-teaching/practicals
```

```
$ accProcess.py data/myAcc.cwa --rawOutput True --activityClassification False --deleteIntermediateFiles False
```

3: Preprocessing

In this practical, we will focus on the preprocessing steps performed on your accelerometer data for activity recognition. This is an often time-consuming, yet very important, step before your data is useful for further analysis. You are provided with a half-completed jupyter notebook to work with.

After this you will our built pipeline and perform activity recognition on your accelerometer data with machine learning.

Building features from your accelerometer traces

Your raw accelerometer traces are now in `practicals/data/myAcc.csv.gz`. It contains 4 columns: time, x, y and z accelerometer readings.

Go through the jupyter notebook `Features.ipynb` in your `prac2_process_acc` folder.

Biobank Pipeline

While you have had a taste of raw sensor data preprocessing through the jupyter notebook, many other operations (such as readings imputation, non-wear time detection ..) can be done on your raw data to further improve your dataset for downstream machine learning tasks.

So instead of using the dataset you just created, `my_data.csv`, we will now go back to your raw data again - the CWA file. We will run some scripts which form the standard analysis pipeline on accelerometer data in the Biobank studies such as this paper. This involves preprocessing operations as well as running a machine learning model that had been trained on the Biobank data for activity recognition.

Note that these operations also involve mapping the fine-grained annotations you had into larger classes. You shall still be in the `practical` folder.

```
$ accProcess.py data/myAcc.cwa --useFilter False
```

To visualise the time series and activity classification output:

```
$ accPlot.py data/myAcc-timeSeries.csv.gz data/plot.png
```

Now unzip your `.csv.gz` file if you haven't done so already.

```
gunzip data/myAcc-timeSeries.csv.gz
```

Finally, we want to check the model predictions against your true annotations.

```
$ cd prac3
$ python3 check_annotations.py ../data/myAcc-timeSeries.csv ../data/me-annotation.csv --plotFile check_results.png
```

Inspect `plot.png` in your `data` folder and various `.png` generated in your `prac3` folder to see how the model has done!

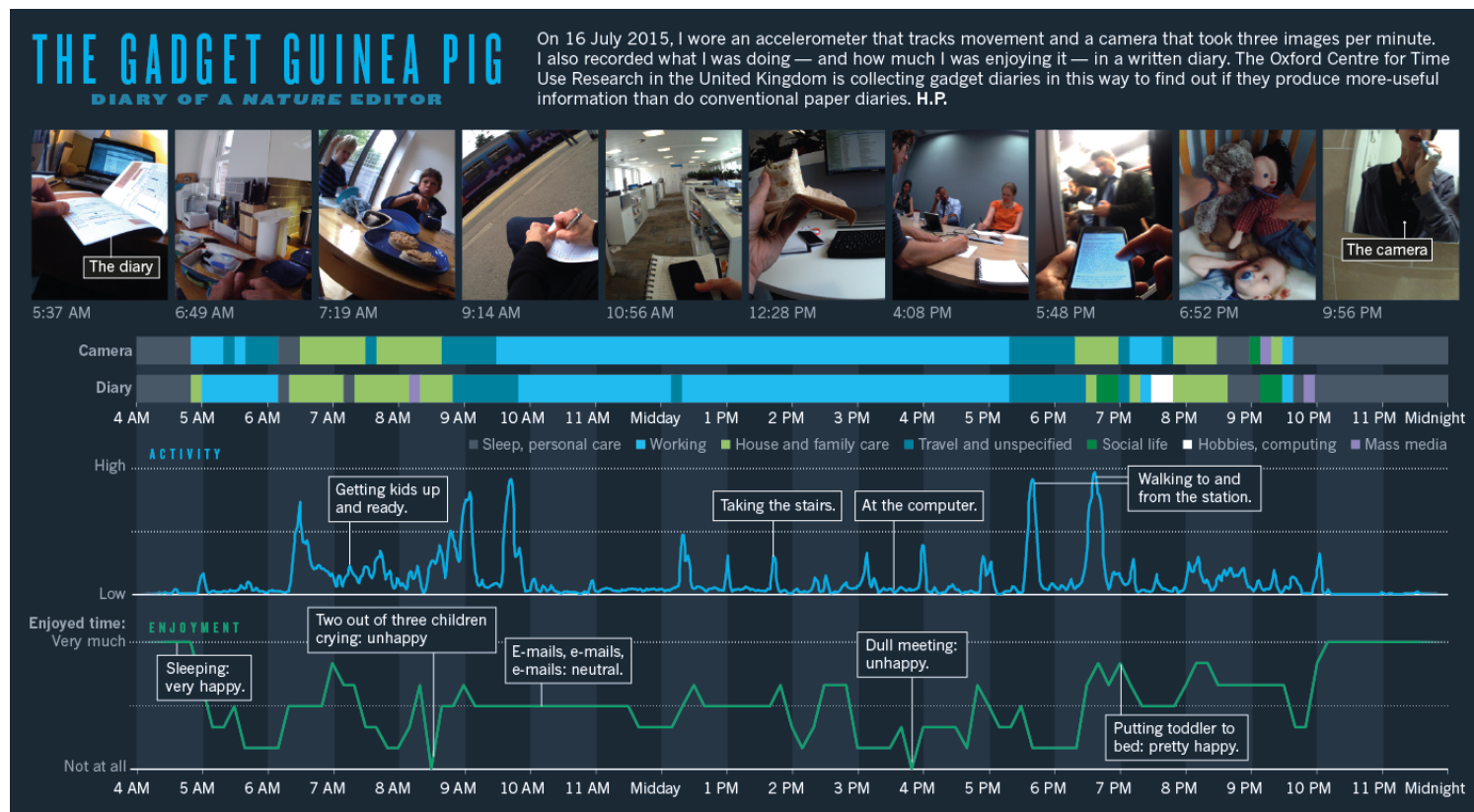
4. Visualising your data

For this practical, we wish for you to produce some visualisations to share in a presentation. This practical is open-ended in nature, you can explore any topic as the basis of your visualisation according to your interests.

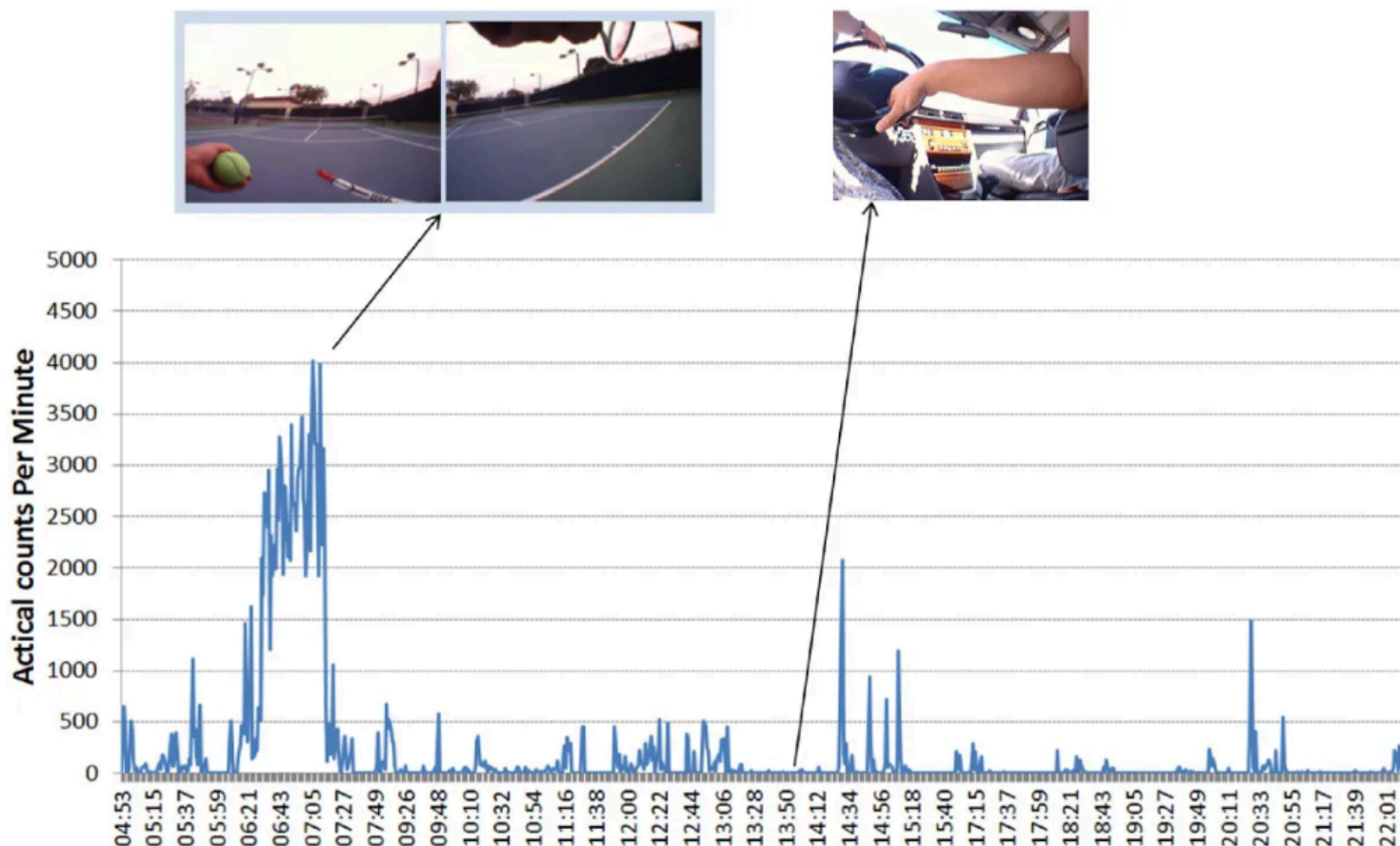
Timeline

Prepare a timeline to illustrate your days.

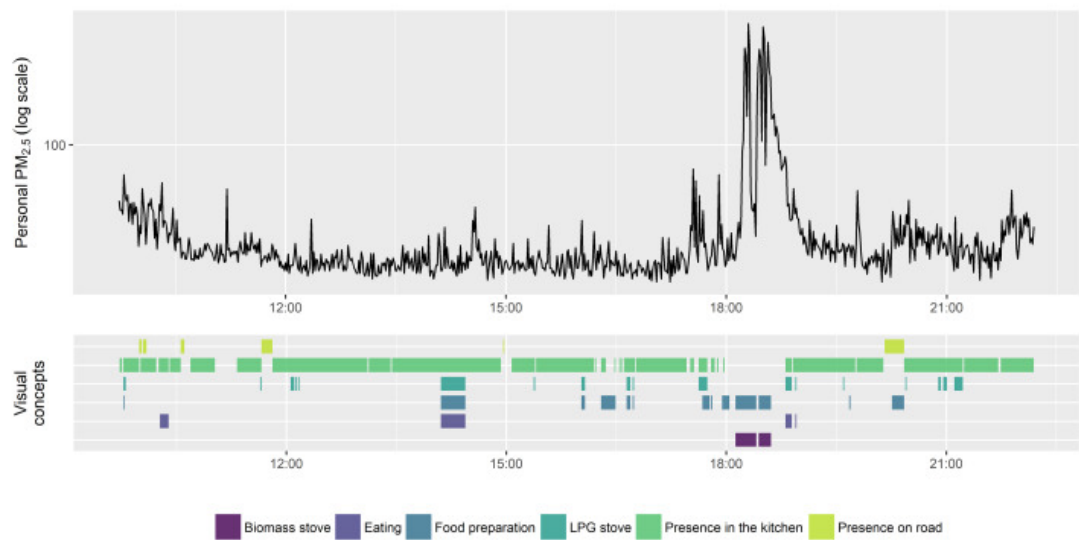
Taken from Nature news feature 'The lab that knows where your time really goes'



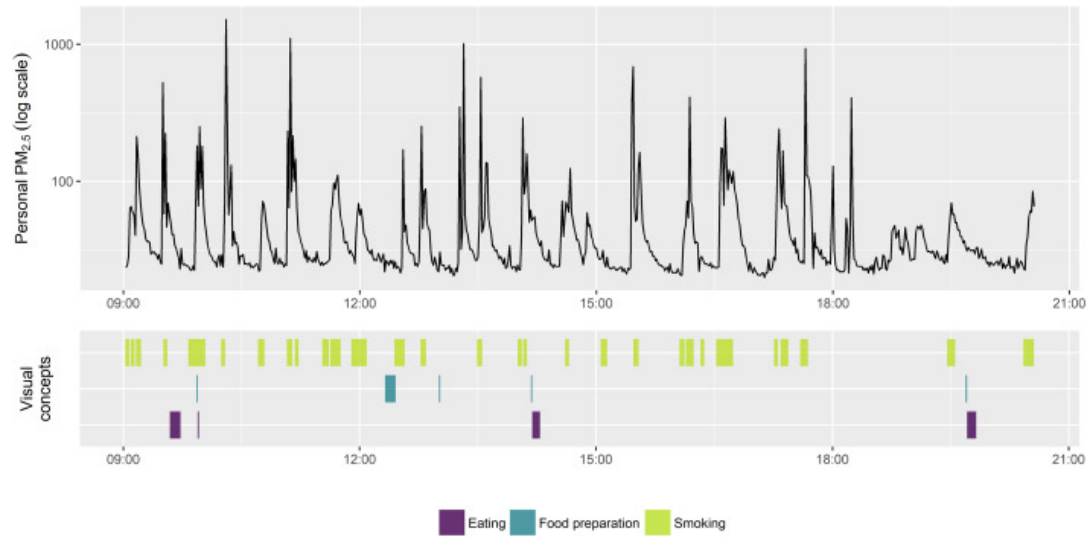
From 'Using wearable cameras to categorise type and context of accelerometer-identified episodes of physical activity', Doherty et al.



A



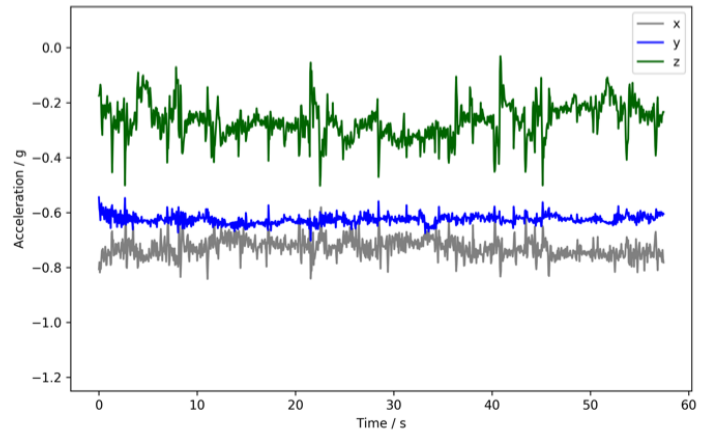
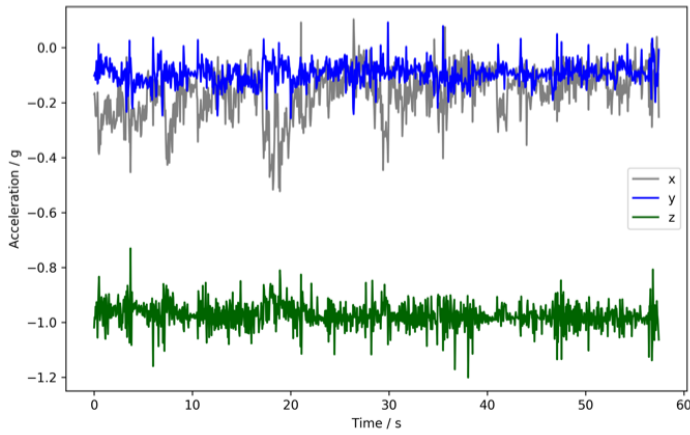
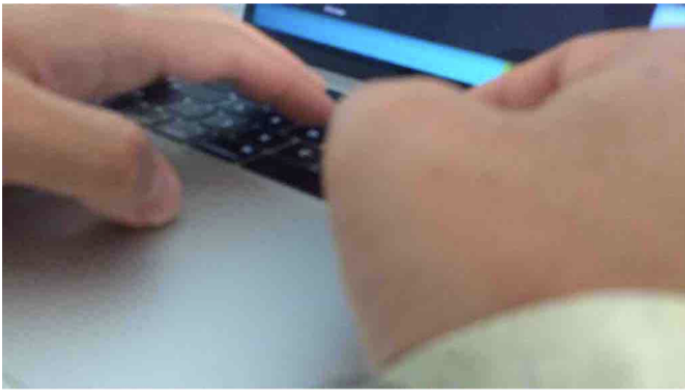
B



Side-by-side

Compare the data captured by the two devices (camera vs accelerometer) when you are performing different activities. Prepare a table of different activities, e.g. 'sitting', 'eating', 'walking' and show a side-by-side comparison of the two sources of data.

Here is a comparison of the activities 'typing on computer Vs. typing on phone' as captured by the two devices. 'Are Accelerometers for Activity Recognition a Dead-end?', Tong et al.



CDT-HDS Wearable Challenge

Feb, 2020

Hang Yuan

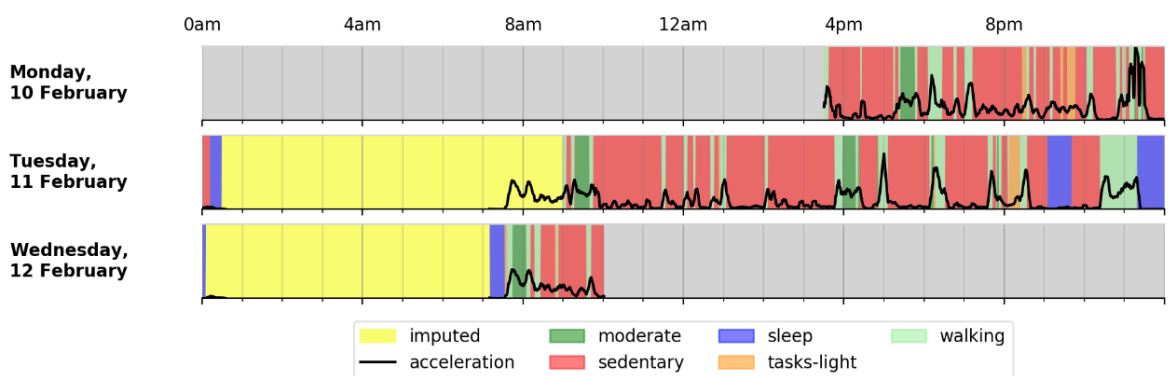
Total sessions
9

Total duration
133
min

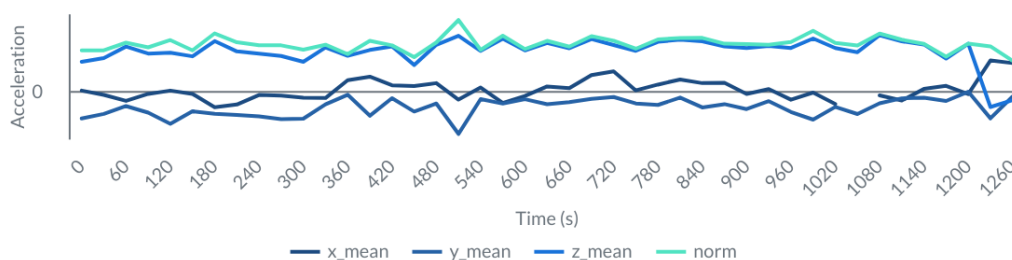
Subject count
3

Ethnicity group
3

Two days in the life of an CDT student



Hang's Cycle Trace



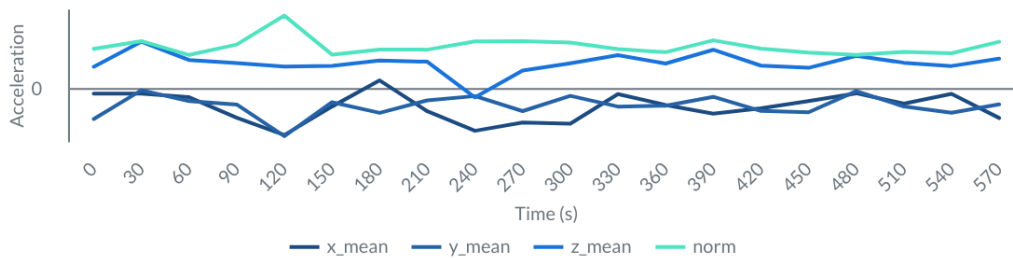
T1: Double click to edit

Findings

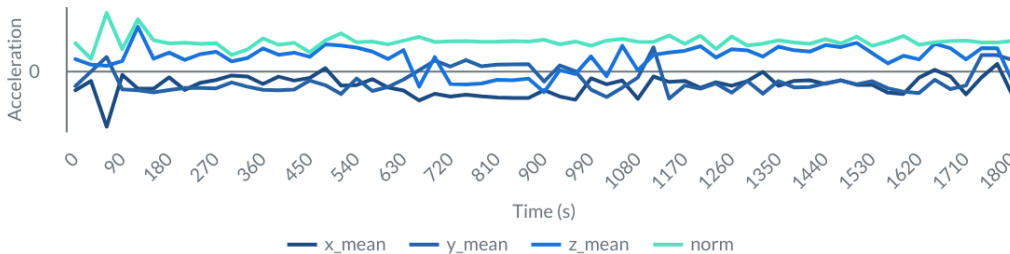
- Gym/home workout are

For Double-click to edit

Maxime's Cycle Trace



Franck's Cycle Trace



Symptoms were not all misclassified

- Directions of axes could switch frequently
- Axes likely to switch at the end of a bike journey
- Some exercises might be easier to classify than the others



Acknowledgement

Special thanks to
Yifan Yu, Maxime
Kayser
and Franck Nijimbere
for sharing their
valuable data with me.

Aiden and Catherine
for their guidance.

Propose your own task

The above is an example from last year.

If none of the above visualisations inspire you, feel free to propose and pursue your own idea.

Some ideas might be:

- Compare the different annotation schema you had used
- Look into the distribution of activities in your data

Handin: Prepare a 'freestyle' visualisation of your data. Work as a group and prepare 3 slides which need to be sent to Hang by 2pm on Friday. At 3pm on Friday, each group will then present their 3 slides (6 minutes).

5. Returning your camera and accelerometer

You should have loaded your images onto your computer by now so you can safely delete the data from your camera!

Plug your camera in, and navigate to the `utilities` folder within `oxford-wearable-camera-browser` and type the following:

```
$ cd ~/oxford-wearable-camera-browser/utilities/  
$ python3 autographer.py --delete True
```

Plug your accelerometer in, and delete the `.CWA` file:

```
$ rm /Volumes/AX317_41145/CWA-DATA.CWA
```

Handin: Return the camera and accelerometer to Hang by the end of the week (it's fine to wear it for a few more days to generate extra data to support your final presentation). Hang will stop your accelerometer from recording data.

