# Radar Based Patient Discrimination

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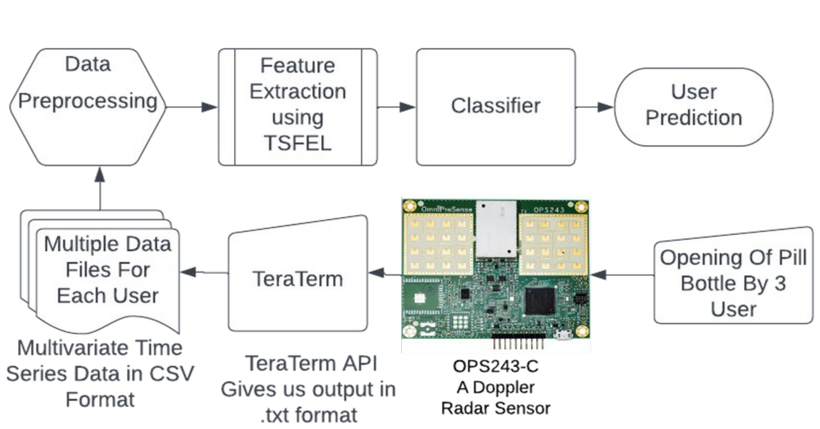
## INTRODUCTION

Many people around the world are prescribed medication by health care professionals. However, most of this medication is taken at home, where little is known about correct adherence to consuming the medication.

**Motivation**: It is relatively common for people, especially those older, to unknowingly consume the medication in a manner that will decrease the effectiveness or harm the user.

**Aim**: To develop a radar-based system to monitor subjects taking medications from a pill bottle and identify them using a 243-C FMCW and Doppler Radar Sensor to detect and report speed, range, direction, and motion.

## SYSTEM OVERVIEW

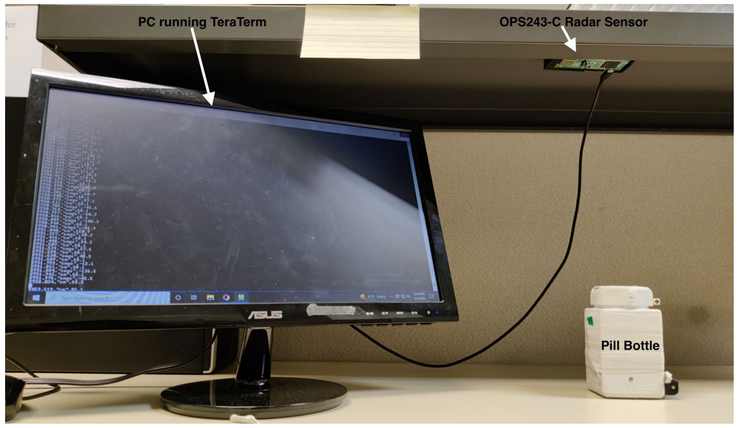



- First, three users collect data by opening the pill, taking the pill out, and then closing the pill bottle each user performs these steps 20 times.
- The radar sensor then collects the data and sends it to Teraterm, giving us data in .txt format.
- The data from Teraterm is then passed through a python script to convert into a CSV file. In this, we also preprocess the data by padding the data for a shorter time with zeroes and by resampling the data to 0.1s to get regular multivariate time series data.
- Then TSFEL library is used to extract features from the time series data in the form of statistics like mean, standard deviation, variance, etc.
- Finally, the feature gathered from TSFEL are then passed to a classifier predicts the user based on the features.

## METHODOLOGY

### Data Acquisition

- Connected the radar to a computer through USB connection
- Tuned Tera-term/MQTTX parameters to optimize sampling rate, sensitivity, etc. of radar
- Users would open the bottle, take the pills (M&Ms) out, put them back in, and close the bottle.
- Used Tera-term/MQTTX to receive and collect data from radar
- Processed the data (padding zeroes)
- Extracted summarizing statistics of the time series data into a CSV file.

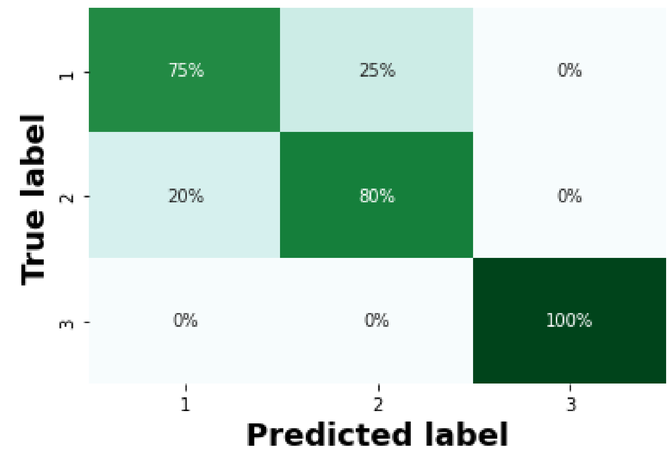



### Bagging Classifier

An ensemble classifier that fits base classifiers on random subsets of the original data and aggregates their individual predictions into a single final prediction.

Training and Testing:
- Used TSFEL feature extraction to cut the number of statistics used in the decision making.
- Used a 8:2 training-testing data ratio.

Below are the predictions made by the classsifier in a confusion matrix format




## RESULTS & FUTURE WORK

Results:

We achieved an overall 70% accuracy using a bagging classifier by training on 96 samples and testing on 24 samples. The results presented in the confusion matrix may seem skewed but it is due to an uneven distribution in the test data. In addition, user 3's actions were more distinct and pronounced because they reached into the bottle instead of spilling the pills out like users 1 and 2.

Future Work

- We will implement feature selection, a step after feature extraction which will filter out the relevant features and tune the combinations of machine learning algorithms and feature extraction to maximize accuracy.
- We will increase the amount of data by taking more samples from the user to get better accuracy
- We will use Data Augmentation techniques like jittering,Scalling and Magnitude Wrap to further increase the data

References

Miller, E., MacFarlane, Z., Martin, S., Banerjee, N., & Zhu, T. (2022). Radar-based monitoring system for medication tampering u sing data augmentation and multivariate time series classification. *Smart Health*, *23*, 100245.

Aldeer, M., Howard, R. E., Martin, R. P., & Ortiz, J. (2021, May). User Identification Across Multiple Smart Pill Bottle Systems. In *Proceedings of the 20th International Conference on Information Processing in Sensor Networks (co-located with CPS-IoT Week 2021)* (pp. 400-401).

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