

# Real World Activity Data for Light Based Activity Recognition

## 1. Background

- **Visible Light Sensing (VLS)** is an emerging topic in the field of Visible Light Communication
- VLS for Gesture, body position and **activity recognition**
- SolAR [Sandhu et al., 2021] showed the possibility for a **wrist mounted solar panel** for energy positive activity recognition using **Machine Learning**
- Minor changes in light intensity indicate underlying activity
- Data gathered by SolAR was obtained in a **lab environment**

## 2. Research Question

*How does the introduction of real-world data influence the classification accuracy of solar cell based Human Activity Recognition?*

### Subtasks:

1. Make a fitting **prototype**
2. **Collect data** using the prototype
3. Use the data to **train and test** a Machine Learning algorithm

## 4. Results

- SVM, NB and NC performed poorly (accuracy < 55%)
- Data is not linearly separable, normally distributed or clustered
- RF, KNN, DT, GB and MLP performed well (accuracy of 67% to 87%)
- Mostly confusing the activities standing and sitting
- In some cases walking, sitting and traversing stairs are confused for each other

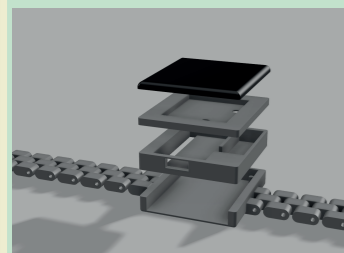
	Running	Walking	Stairs	Standing	Sitting
Running	84.71	10.80	2.27	0.32	1.90
Walking	5.30	84.98	3.74	2.59	3.39
Stairs	4.64	15.22	80.14	0.00	0.00
Standing	0.10	2.28	0.04	88.12	9.46
Sitting	1.69	4.22	0.00	23.31	70.79

Average labelling rate for five activities  
rows: Actual labels, columns: Predicted labels.

## 3. Methodology

### Prototyping

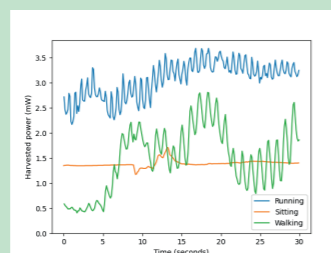
- Prototype using solar cell in series with resistor
- **Measure voltage** over known resistance
- **Store voltage readings** on an SD card



Digital prototype

### Data Collection

- Perform activities under **normal circumstances**
- Include small **actions**, like writing
- **Label** data points for a given activity



Sample of collected data

### Training & Testing

- Extract defining **features** from the collected data
- Split data for training and testing
- Train and test eight unique **machine learning** algorithms

#### Classification algorithms

- Random Forest (RF)
- K-Nearest Neighbour (KNN)
- Support Vector Machine (SVM)
- Decision Tree (DT)
- Naive Bayes (NB)
- Nearest Centroid (NC)
- Gradient Boosting (GB)
- Multi Layer Perceptron (MLP)

## 5. Conclusion

### Introduction of realistic data, together with actions:

- has no significant effect on general accuracy
- decreases confusion between walking and running
- increases confusion between sitting and standing
- increases confusion between {running, walking} and {sitting, standing}

### References

[Sandhu et al., 2021] M. M. Sandhu, S. Khalifa, K. Geissdoerfer, R. Jurdak and M. Portmann, "SolAR: Energy Positive Human Activity Recognition using Solar Cells," 2021 IEEE International Conference on Pervasive Computing and Communications (PerCom), 2021, pp. 1-10, doi: 10.1109/PERCOM50583.2021.9439128.

**Author** Jasper Vos

**Supervisors** Marco Antonio Zúñiga Zamalloa  
Miguel Chavez Tapia