

A Privacy-Protecting Indoor Emergency Monitoring System based on Floor Vibration

Yang Yu, Torben Weis

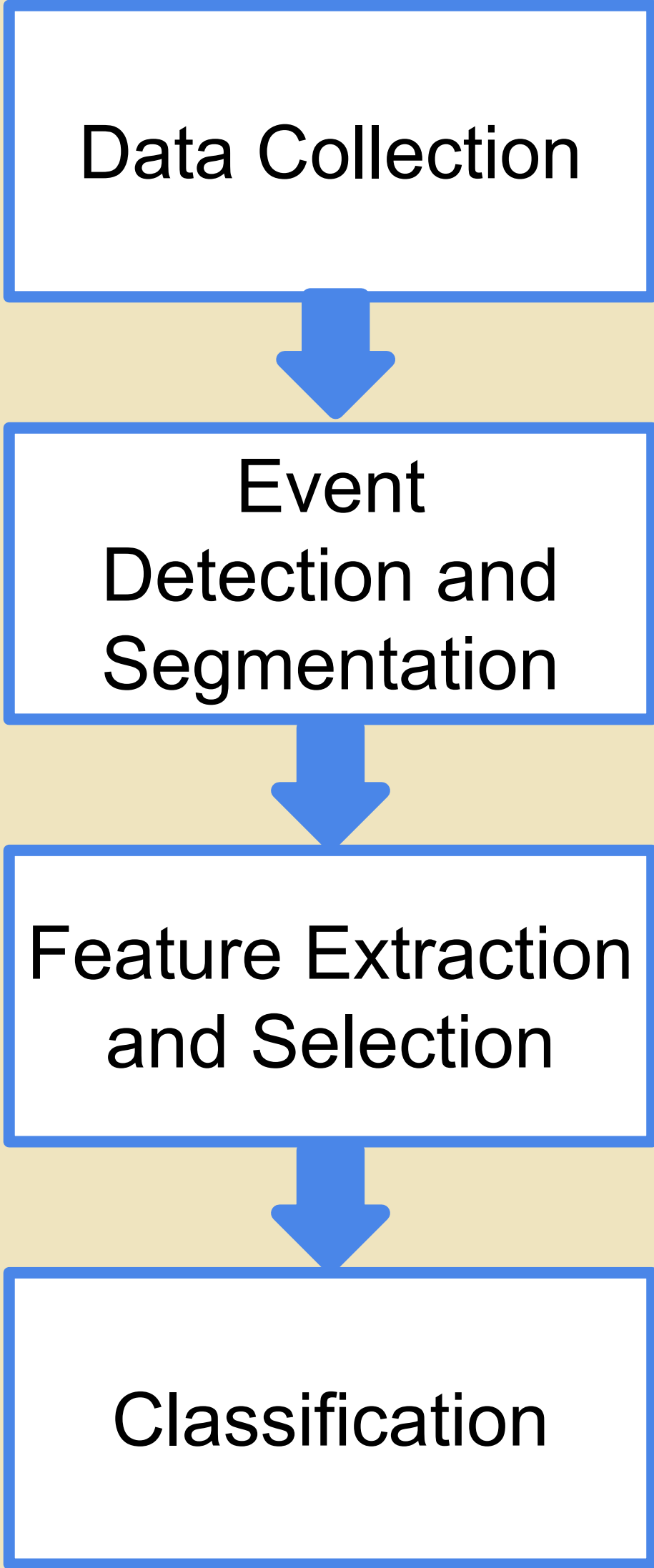
Distributed Systems / University of Duisburg-Essen

The Problem

- Tradeoff between indoor emergency **monitoring** and **privacy protection**
- Passive detection, no wearable device required
- Audio and video signal based approach
 - Privacy is not protected
 - + Rich information
- Manpower emergency detection and report
 - Unreliable
 - Not timely
- Specific sensors like smoke detector...
 - Only emergency of single type can be detected

Approach

- Our approach is based on human behavior
- In emergency situations and normal situations, pedestrians have different moving patterns
- Pattern classification based on floor vibration data of different walking patterns
- Acquire floor vibration signal data with piezoelectric sensors
- Energy-based event detection
- Sliding window based segmentation
- Deep convolutional neural network as end to end feature extraction and classification.



Data Organization and Model Training

- The data sets include:
 - Normal walking: normal situation
 - Fast walking: normal situation
 - Panic moving: running in panic, fast pace moving, emergency situation
 - None: measurements of an empty room.
- The "panic moving" data: experimenters imitated the movement as during the emergency, running fast, or moving with fast pace and small steps
- The classifier is trained with the 4 kinds of data set
- When the classifier predict the current status as “panic moving”, the system

Result

Method	Class	Precision	Recall	F1-score
PCA64 + RF	Walk Normal	0.7670	0.9333	0.8420
	Walk Fast	0.6358	0.5399	0.5839
	Panic Moving	0.7261	0.7351	0.7306
	None	0.9937	0.6318	0.7724
	Weighted Avg.	0.7543	0.7482	0.7420
PCA512 + RF	Walk Normal	0.8120	0.9242	0.8645
	Walk Fast	0.6460	0.4935	0.5596
	Panic Moving	0.7174	0.7914	0.7526
	None	0.9976	0.8431	0.9138
	Weighted Avg.	0.7719	0.7753	0.7685
MF + RF	Walk Normal	0.9031	0.9544	0.9280
	Walk Fast	0.8339	0.8168	0.8253
	Panic Moving	0.9356	0.8790	0.9065
	None	1.0000	0.9920	0.9960
	Weighted Avg.	0.9071	0.9068	0.9064
DNN	Walk Normal	0.9690	0.9874	0.9781
	Walk Fast	0.9357	0.9407	0.9382
	Panic Moving	0.9849	0.9510	0.9676
	None	0.9980	1.0000	0.9990
	Weighted Avg.	0.9687	0.9685	0.9685

Conclusion and Future Work

- The proposed approach can detect emergency while protecting privacy
- Richer monitoring function will be offered