Technische Universität Braunschweig

Context Awareness Through the RF-Channel

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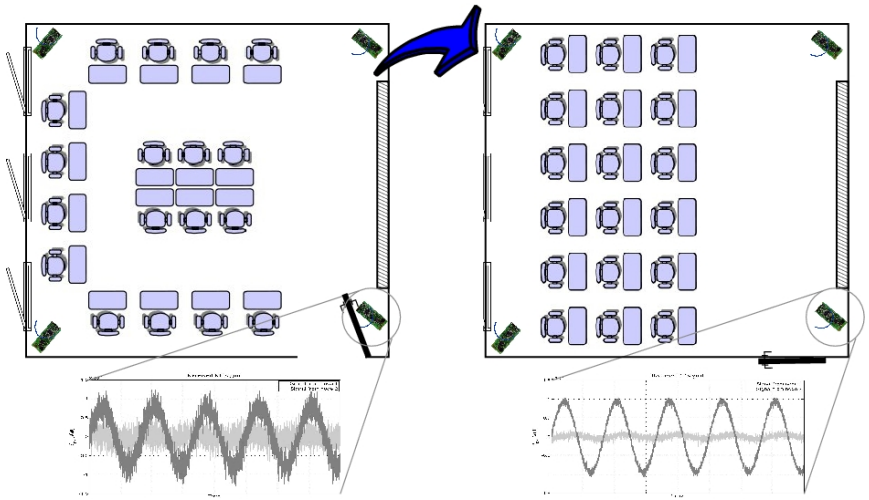
Outline

- Introduction
- Experimental setting
- Presence and room condition
- Location of a person
- Amount of people in a room
- Activity of a person
- Impact of the Node count
- Comparison of Classifiers
- Conclusion

Introduction



- RF communication is used in most context aware systems
- RF signals can be used to determine Presence, location, count and activity of a person

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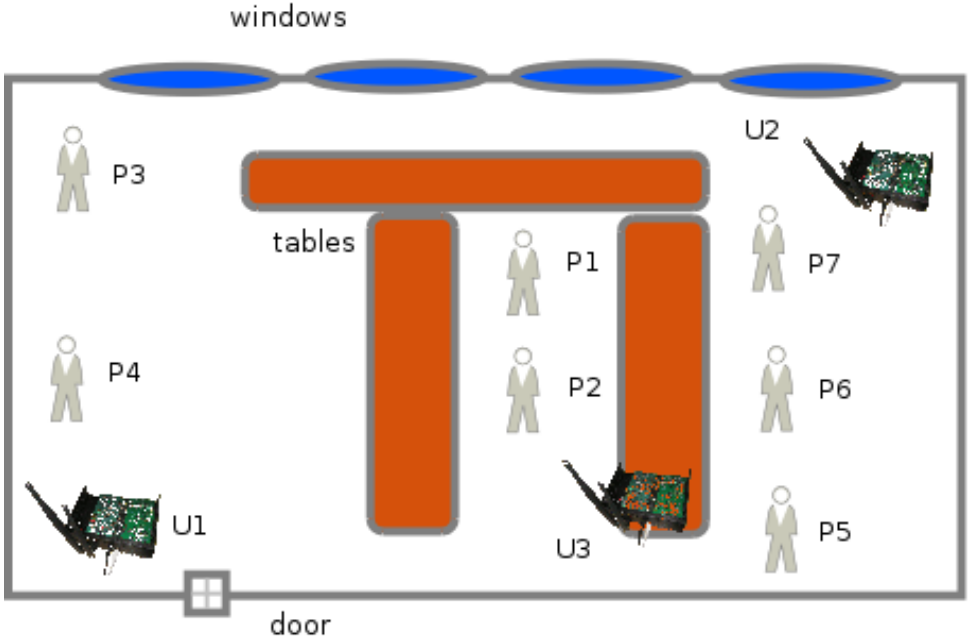
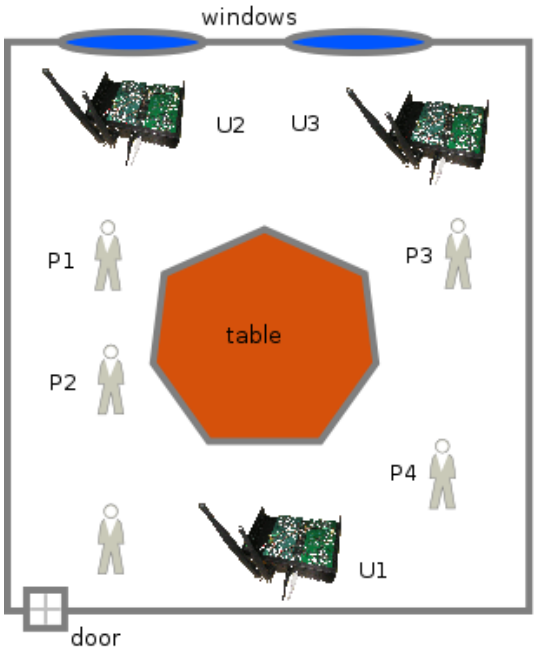
Experimental setting





- U1: Sender
- U2, U3: Receiver

Experimental setting

One Sender

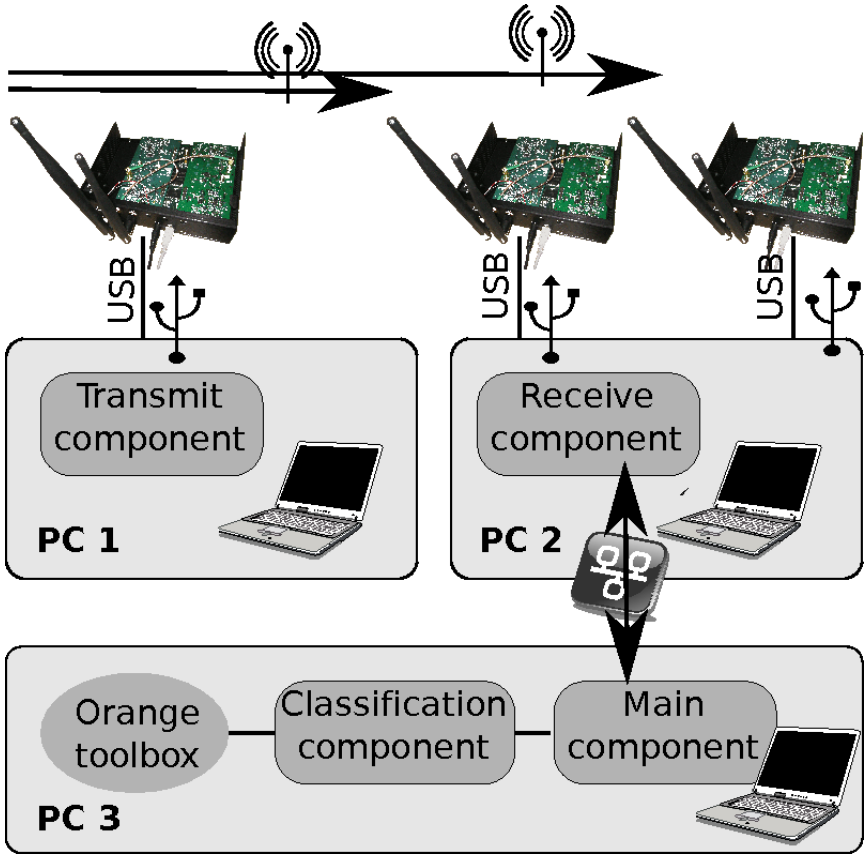
- continually sends
- saw signal
- 900 Mhz / 2.4 Ghz

Two Receivers calculate:

- Root mean square (RMS)
- Signal to noise ratio (SNR)
- Average magnitude sqared (AMS)

USRP 1 Software radio

Experimental setting



- Data mining with Orange

Classifiers:

- Bayes
- K-NN
- Rule learner
- Tree learner
- C4.5

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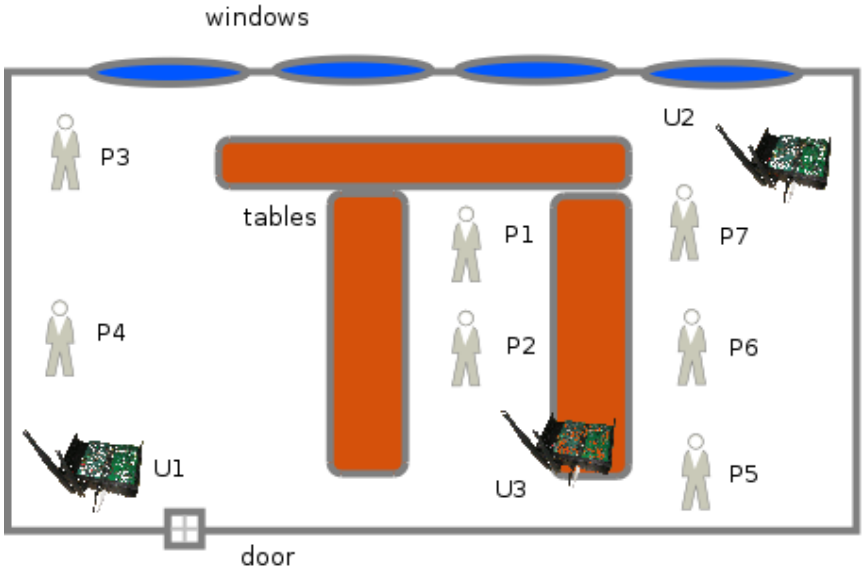
Presence and room condition



Situation:

- Empty room, door closed
- Empty room, door open
- One Person standing, door closed

Presence and room condition

- 900 Mhz:

(b) k-NN classifier. The overall accuracy achieved for this method is 0.8333

	Actual		
Predicted	door	presence	empty
door	1.0	0.2	0.0
presence	0.0	0.8	0.3
empty	0.0	0.0	0.7

Presence and room condition

- 2.4Ghz

(b) k-NN classifier. The overall accuracy achieved for this method is 0.8667

	Actual		
Predicted	door	presence	empty
door	1.0	0.0	0.0
presence	0.0	0.7	0.1
empty	0.0	0.3	0.9

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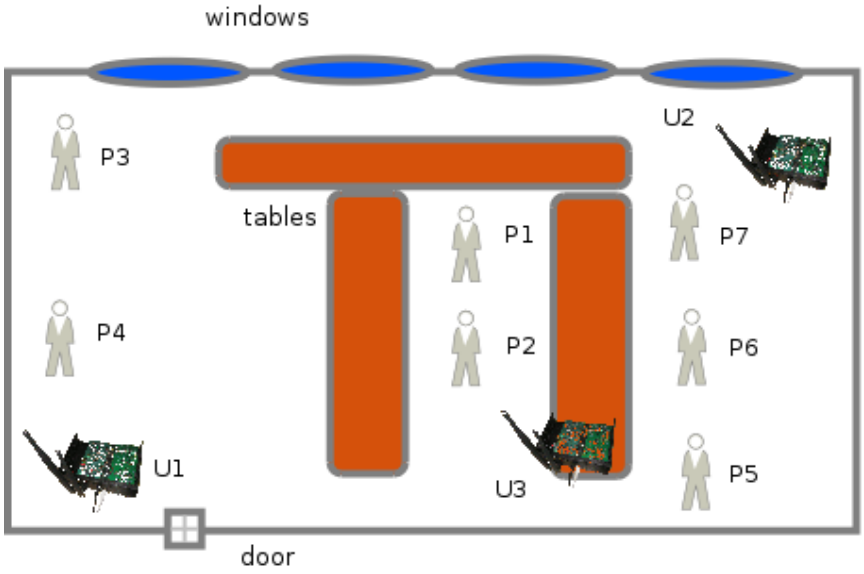
Location of a person



Situation:

- Room empty
- Person stands at P1
- Person stands at P3
- Person stands at P5

Location of a person

- 900Mhz

(b) k-NN classifier. Overall accuracy: 0.425

	Actual			
Predicted	P_1	P_3	P_5	empty
P_1	0.2	0.6	0.0	0.0
P_3	0.0	0.2	0.0	0.0
P_5	0.0	0.1	0.8	0.5
empty	0.8	0.1	0.2	0.5

Location of a person

- 2.4Ghz

(b) k-NN classifier. The overall accuracy achieved for this method is 0.6098

	Actual			
Predicted	P_1	P_3	P_5	empty
P_1	0.9	0.364	0.0	0.1
P_3	0.0	0.091	0.0	0.0
P_5	0.0	0.455	1.0	0.4
empty	0.1	0.091	0.0	0.5

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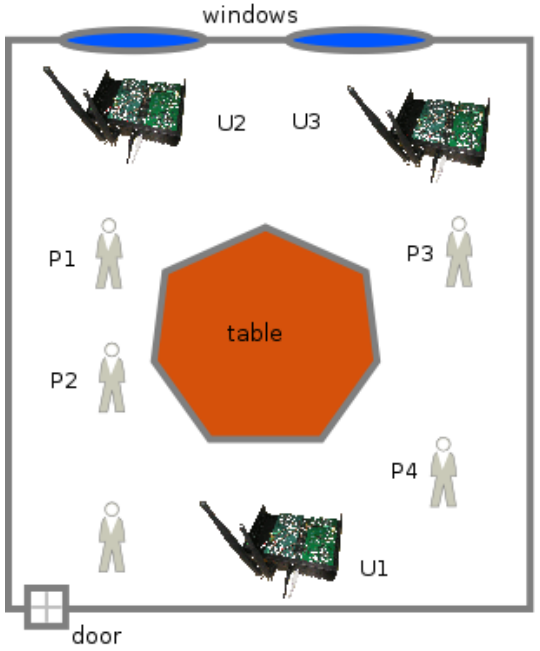
Amount of people in a room

- 900 Mhz

(b) k-NN classifier. The overall accuracy achieved for this method is 0.5712

	Actual			
Predicted	1	5	10	empty
1	0.4	0.167	0.1	0.0
5	0.1	0.167	0.1	0.0
10	0.2	0.25	0.8	0.0
empty	0.3	0.417	0.0	1.0



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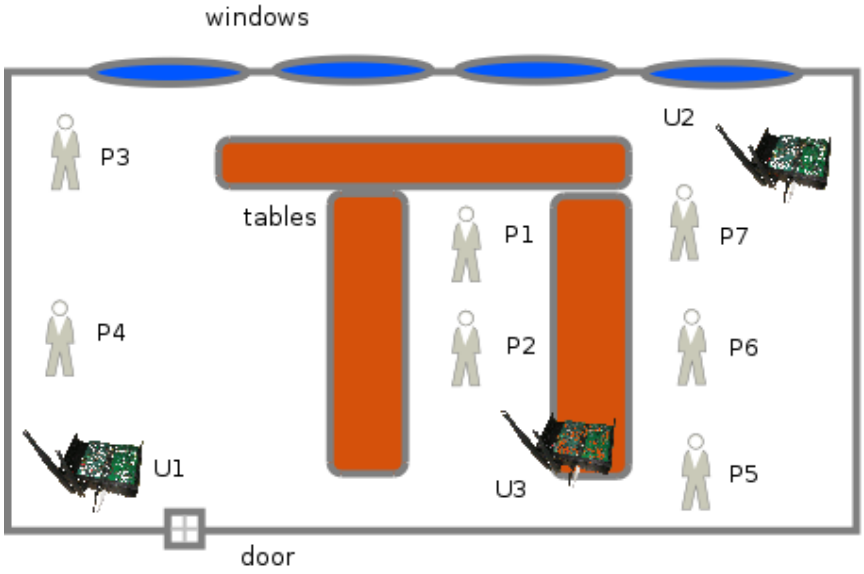
Activity of a person



Situation:

- Person sits at Position P1
- Person stands at Position P1
- Person walks between P1 and P2.

Activity of a person

- 900Mhz

(b) k-NN classifier. The overall accuracy achieved for this method is 0.6

	Actual			
	stand	sit	walk	empty
stand	0.4	0.0	0.1	0.2
sit	0.3	0.6	0.1	0.0
walk	0.1	0.0	0.6	0.0
empty	0.2	0.4	0.2	0.8

Activity of a person

- 2.4Ghz

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(b) k-NN classifier. The overall accuracy achieved for this method is 0.5238

	Actual			
	stand	sit	walk	empty
stand	0.3	0.0	0.091	0.0
sit	0.4	0.9	0.364	0.364
walk	0.2	0.0	0.545	0.273
empty	0.1	0.1	0.0	0.364

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Impact of the node count

900 Mhz 3 Nodes

(b) k-NN classifier. The overall accuracy achieved for this method is 0.8333

	Actual		
Predicted	door	presence	empty
door	1.0	0.2	0.0
presence	0.0	0.8	0.3
empty	0.0	0.0	0.7

900 Mhz 2 Nodes

(b) k-NN classifier. The overall accuracy achieved for this method is 0.5

	Actual		
Predicted	door	presence	empty
door	0.455	0.0	0.0
presence	0.182	0.308	0.2
empty	0.364	0.692	0.8

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Comparison of Classifiers

2.4 Ghz, 3 Nodes

(a) Bayes classifier. The overall accuracy achieved for this method is 0.561

	Actual			
Predicted	P_1	P_3	P_5	empty
P_1	0.9	0.273	0.0	0.1
P_3	0.0	0.091	0.0	0.0
P_5	0.0	0.273	1.0	0.6
empty	0.1	0.364	0.0	0.3

(b) k-NN classifier. The overall accuracy achieved for this method is 0.6098

	Actual			
Predicted	P_1	P_3	P_5	empty
P_1	0.9	0.364	0.0	0.1
P_3	0.0	0.091	0.0	0.0
P_5	0.0	0.455	1.0	0.4
empty	0.1	0.091	0.0	0.5

(c) Rule learner. classifier. The overall accuracy achieved for this method is 0.5366

	Actual			
Predicted	P_1	P_3	P_5	empty
P_1	0.8	0.364	0.0	0.2
P_3	0.1	0.182	0.0	0.1
P_5	0.1	0.364	1.0	0.5
empty	0.0	0.091	0.0	0.2

(d) Tree learner. classifier. The overall accuracy achieved for this method is 0.5854

	Actual			
Predicted	P_1	P_3	P_5	empty
P_1	0.9	0.455	0.0	0.3
P_3	0.0	0.364	0.0	0.1
P_5	0.1	0.0	1.0	0.5
empty	0.0	0.182	0.0	0.1

(e) C4.5 classifier. The overall accuracy achieved for this method is 0.561

	Actual			
Predicted	P_1	P_3	P_5	empty
P_1	0.9	0.455	0.0	0.3
P_3	0.0	0.273	0.0	0.2
P_5	0.1	0.273	1.0	0.4
empty	0.0	0.0	0.0	0.1

(f) Average classification accuracy achieved over all considered methods: 0.5708

	Actual			
Predicted	P_1	P_3	P_5	empty
P_1	0.88	0.382	0.0	0.2
P_3	0.02	0.2	0.0	0.08
P_5	0.06	0.273	1.0	0.48
empty	0.04	0.145	0.0	0.24

Conclusion

- Only two to three nodes are sufficiant for basic context awareness
- K-NN and bayes classifier provide good results in most cases
- A higher amount of Nodes Improves the Accurency

Further steps:

- Use more nodes
- Use existing communication
- Try different values for the training

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