

Midterm Presentation  
Frederike Dümbgen  
Semester Project LCAV  
EPFL  
29.10.2015

# **EXPERIMENTAL SETUP OF SOUND EMITTING AND PROCESSING ROBOT FOR ACOUSTIC- BASED SLAM APPLICATIONS**

# INTRODUCTION USING ECHOES FOR LOCALIZATION

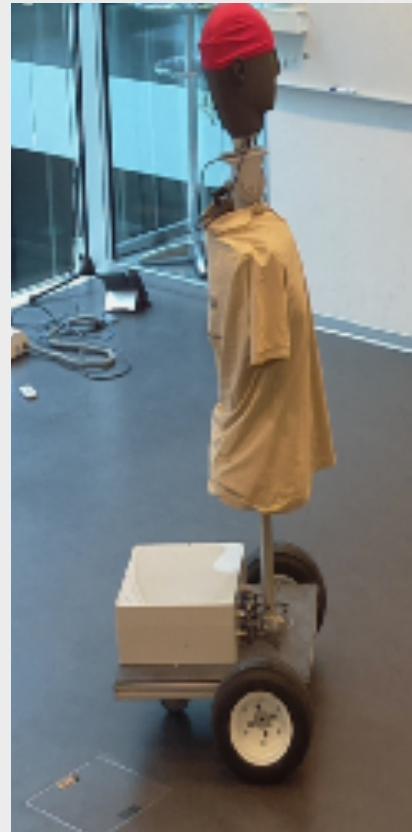


[1]

„The sense of imagery is very rich for an experienced user. One can get a sense of beauty or starkness or whatever“ [2]

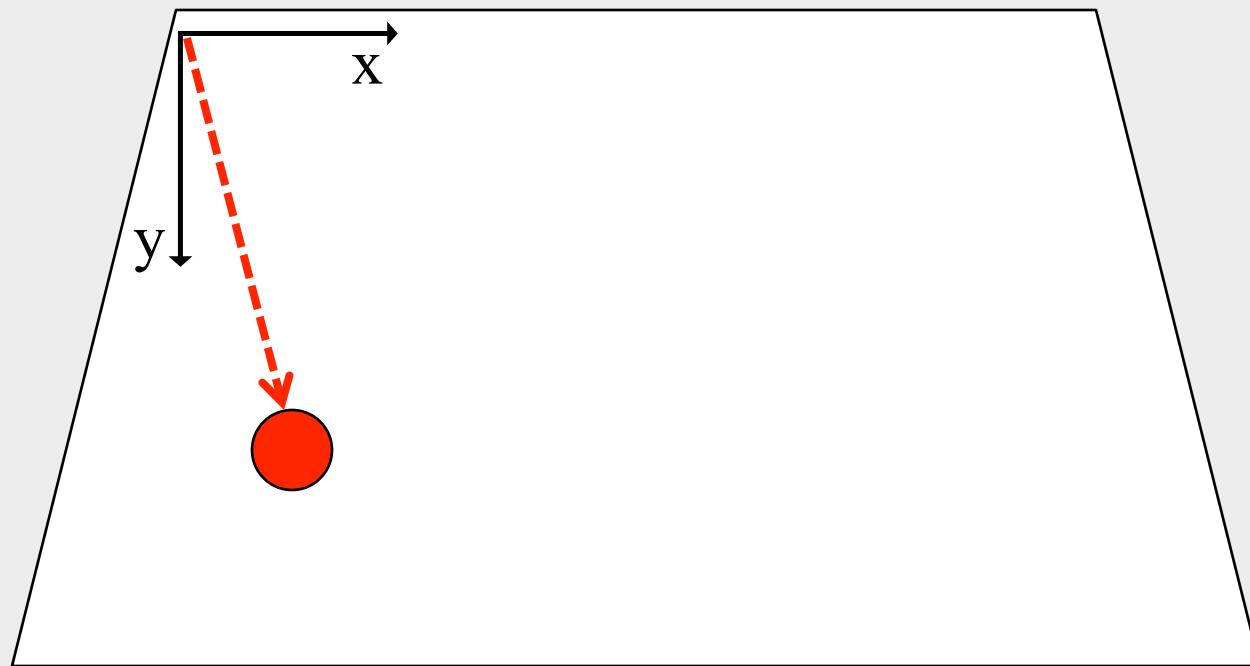
**Daniel Kish**, founder of *World Access for the blind*

# INTRODUCTION USING ECHOES FOR LOCALIZATION



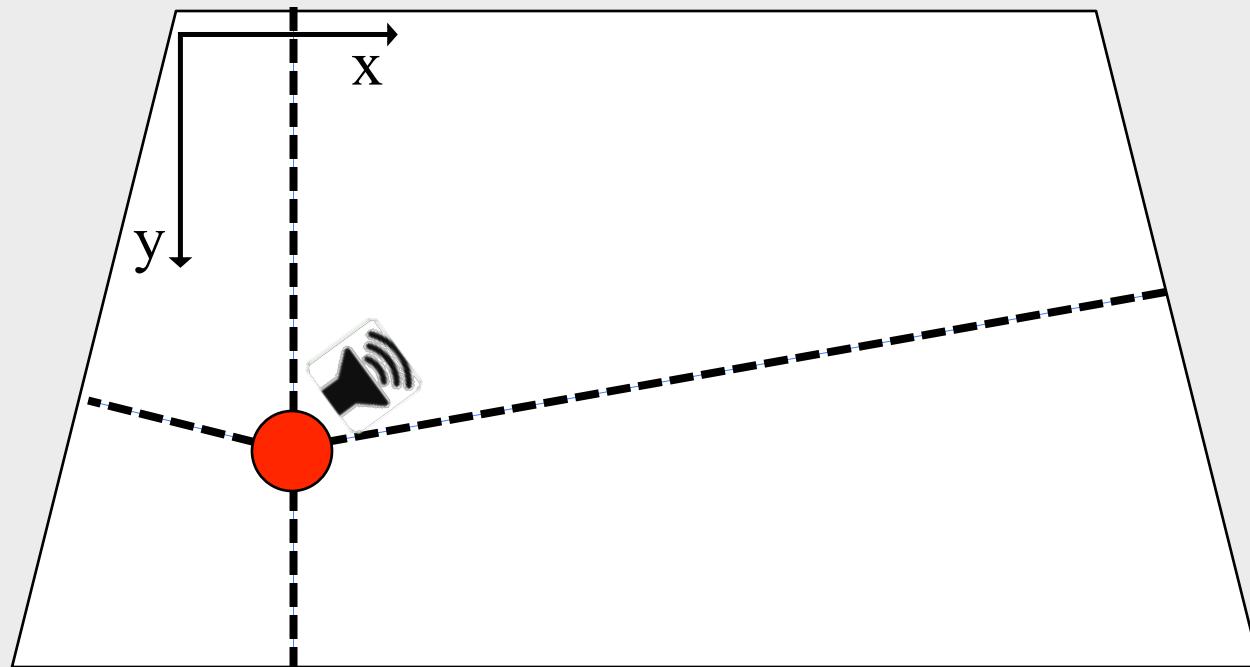
# INTRODUCTION

## ACOUSTIC-BASED SLAM



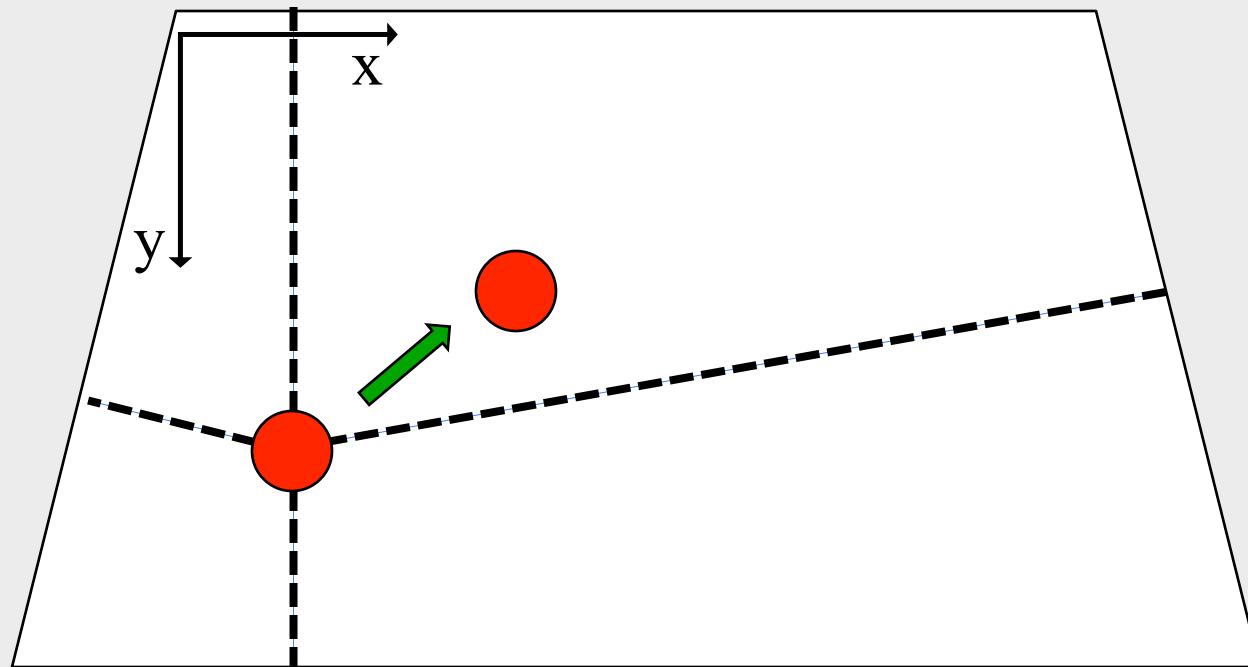
# INTRODUCTION

## ACOUSTIC-BASED SLAM



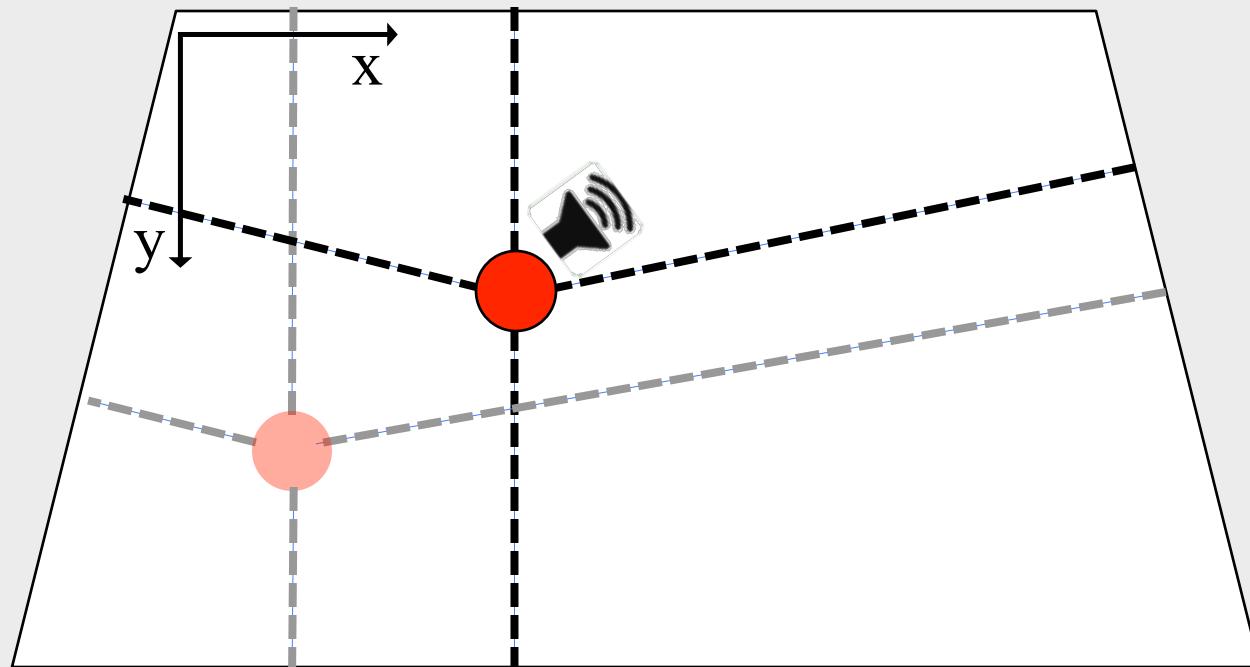
# INTRODUCTION

## ACOUSTIC-BASED SLAM



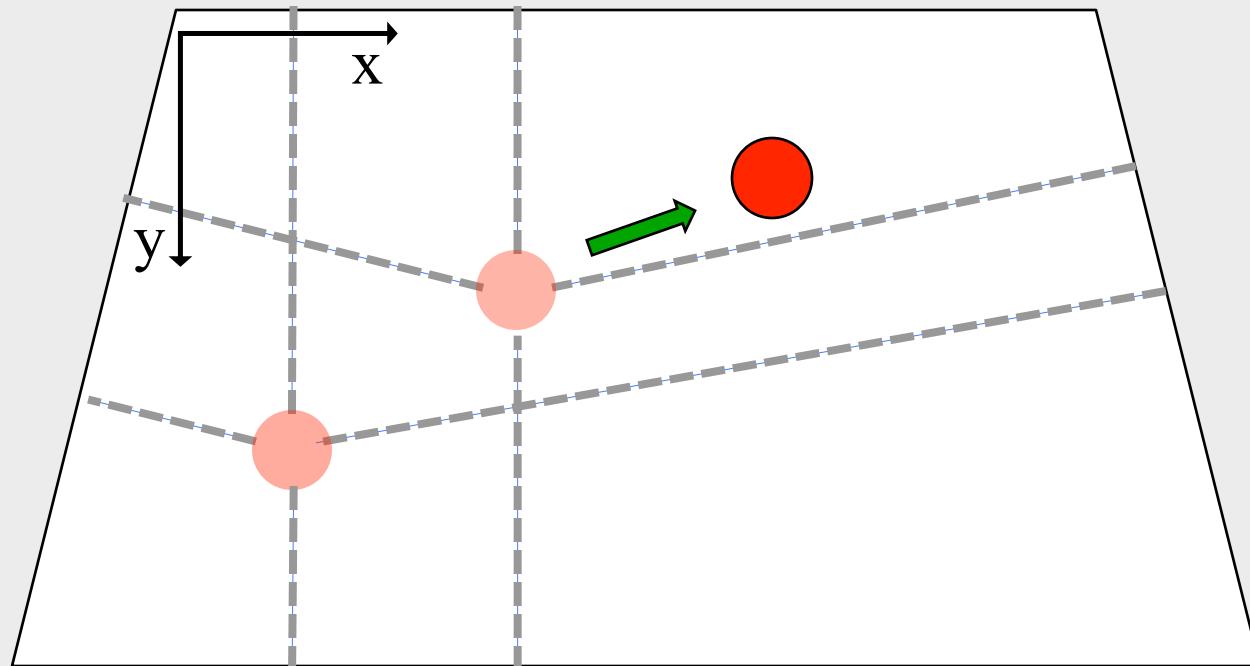
# INTRODUCTION

## ACOUSTIC-BASED SLAM



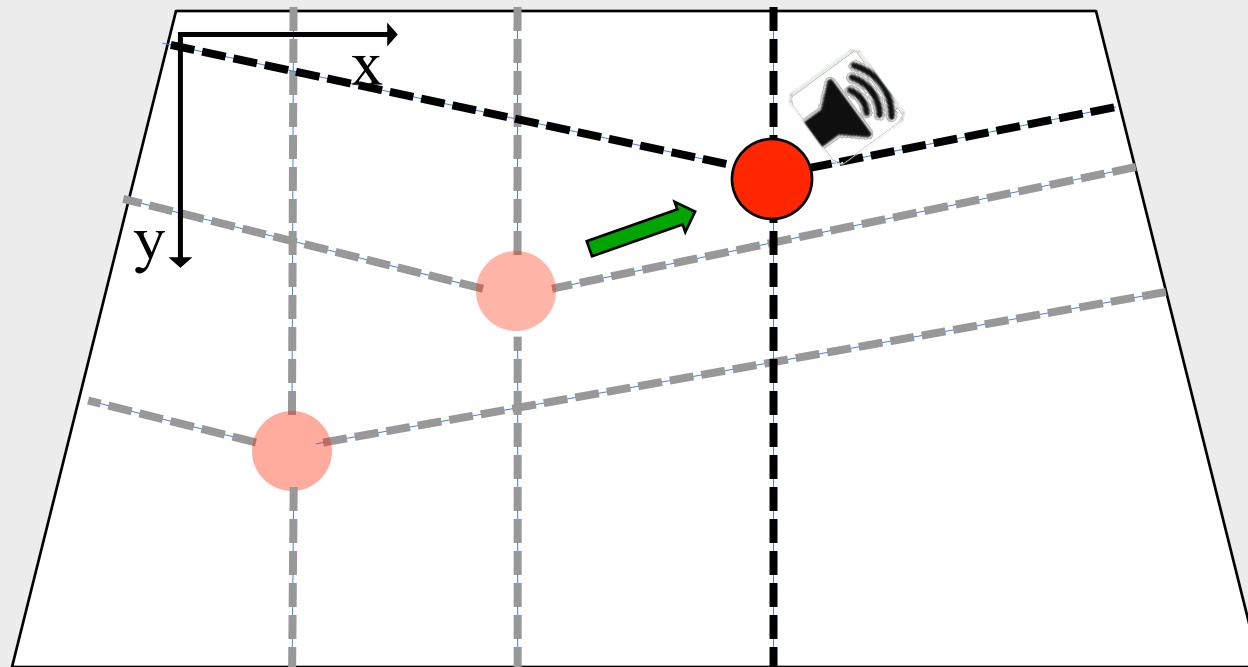
# INTRODUCTION

## ACOUSTIC-BASED SLAM



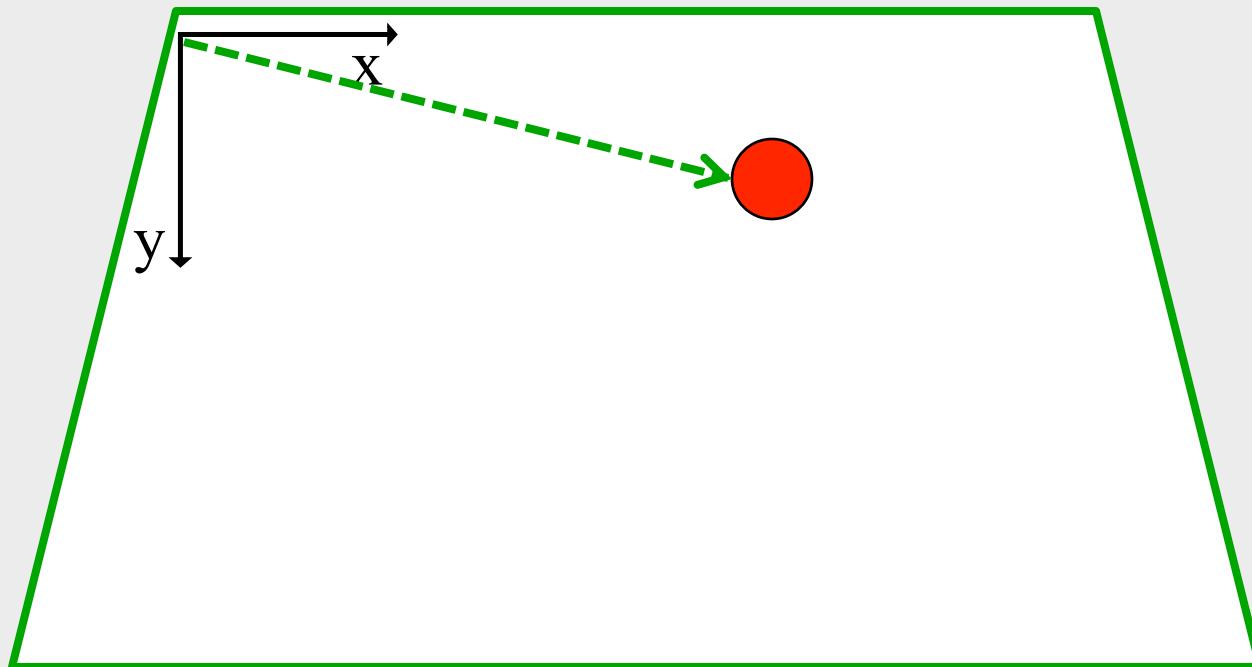
# INTRODUCTION

## ACOUSTIC-BASED SLAM



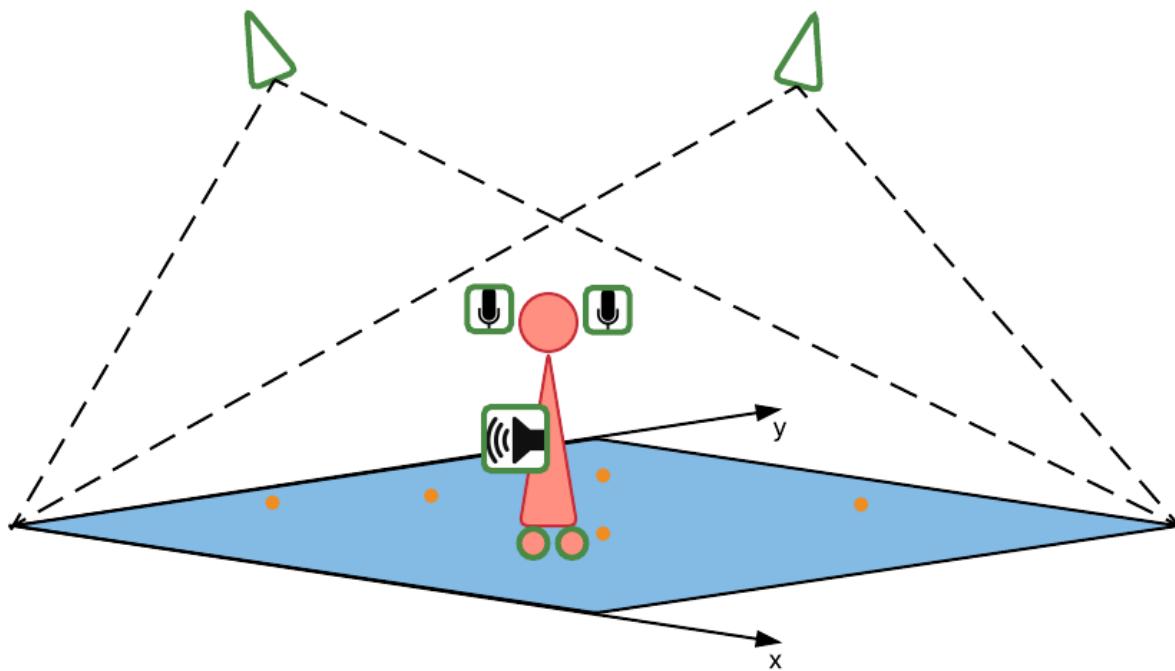
# INTRODUCTION

## ACOUSTIC-BASED SLAM



# PROJECT DESCRIPTION OVERVIEW

## Physical setup



## Algorithms

Visual localization  
ground truth

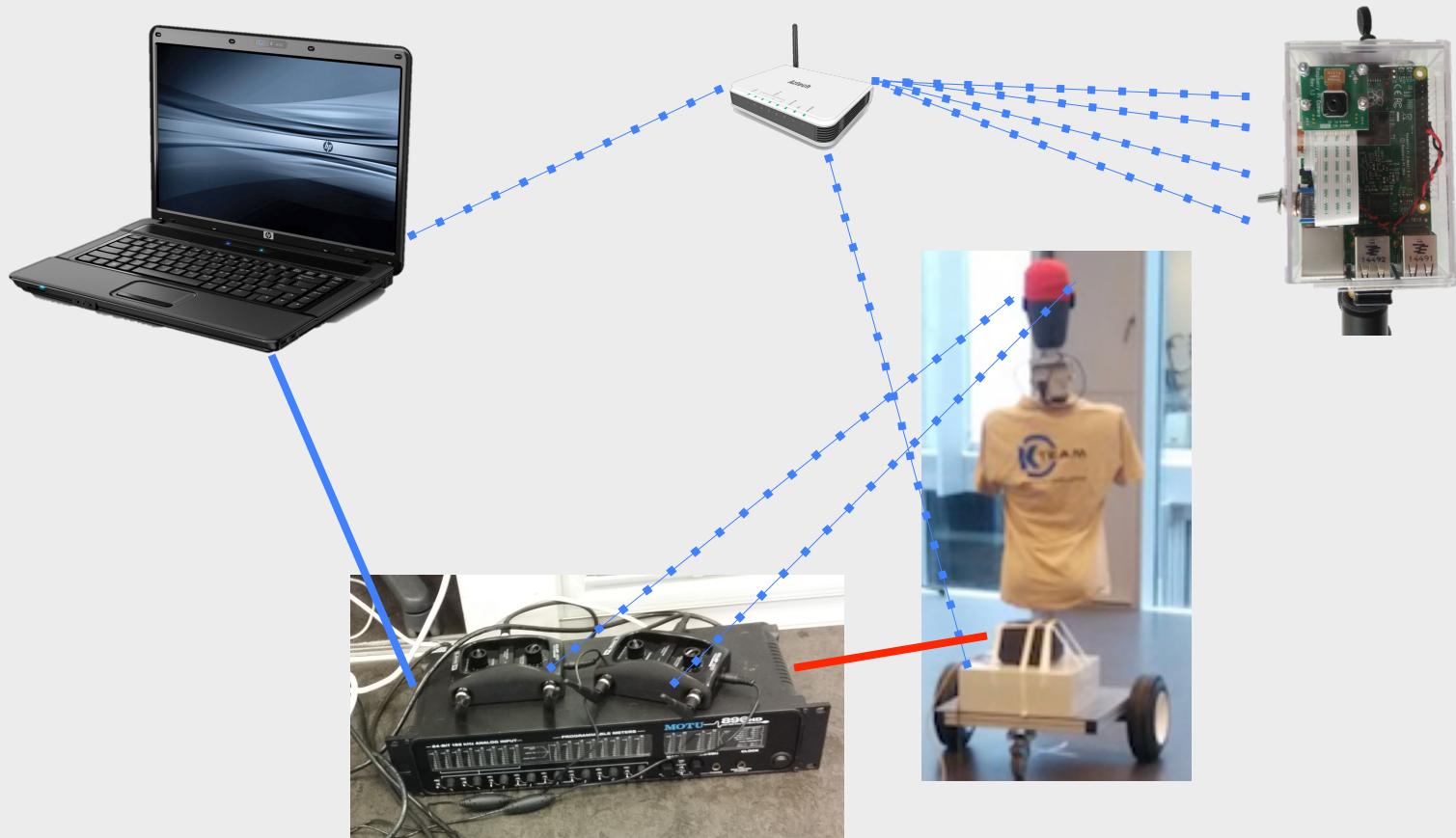
Odometry  
position guess



Sound processing  
new algorithm

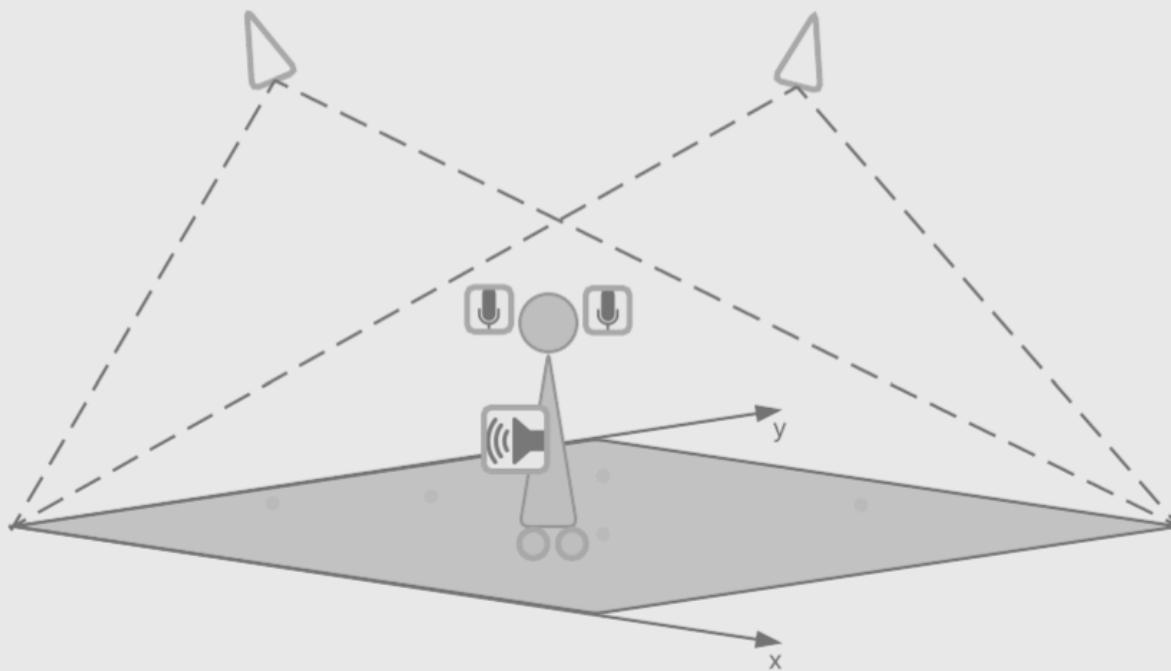
# PROJECT DESCRIPTION

## PHYSICAL SETUP



# PROJECT DESCRIPTION OVERVIEW

## Physical setup



## Algorithms

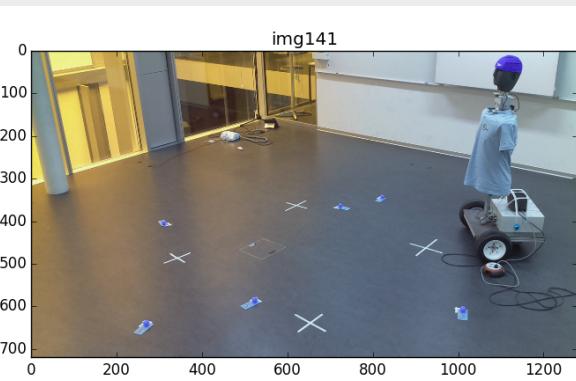
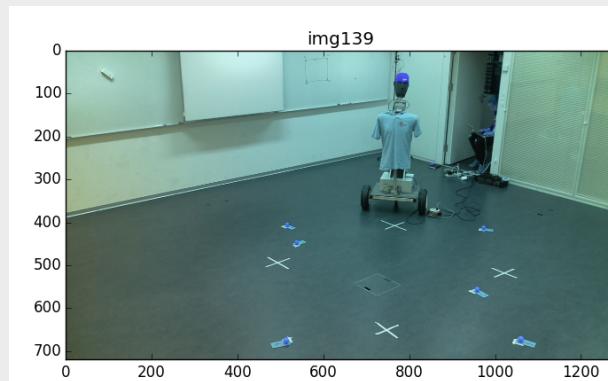
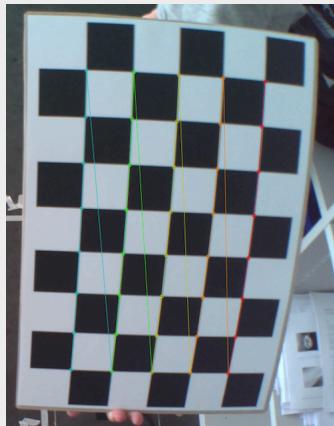
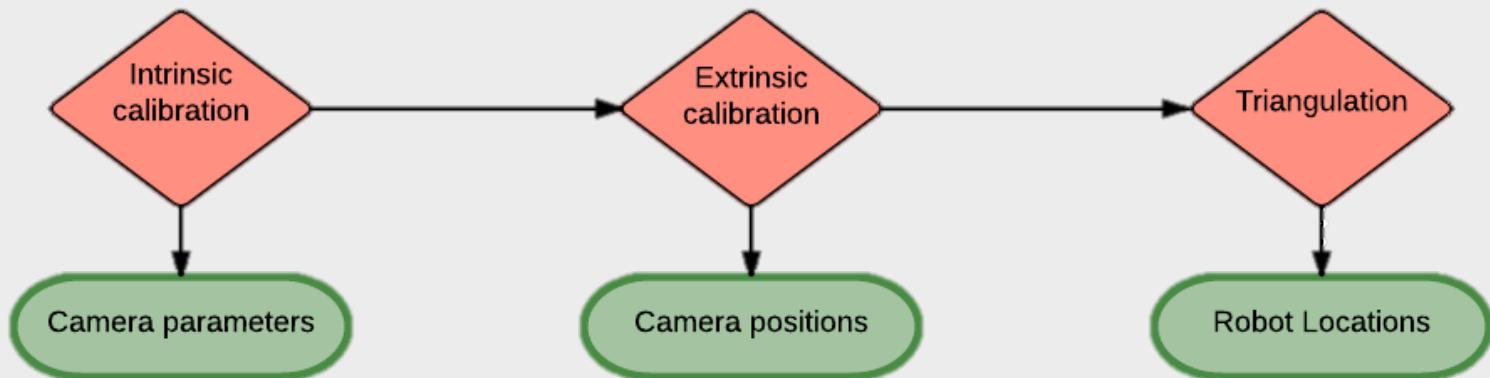
**Visual localization**  
ground truth

**Odometry**  
position guess



**Sound processing**  
new algorithm

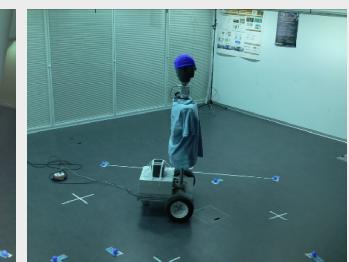
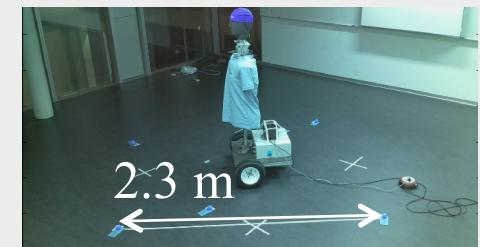
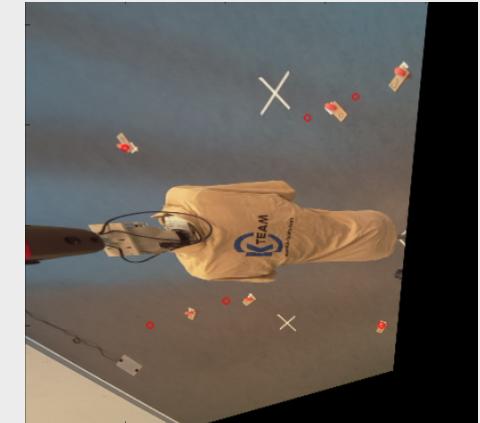
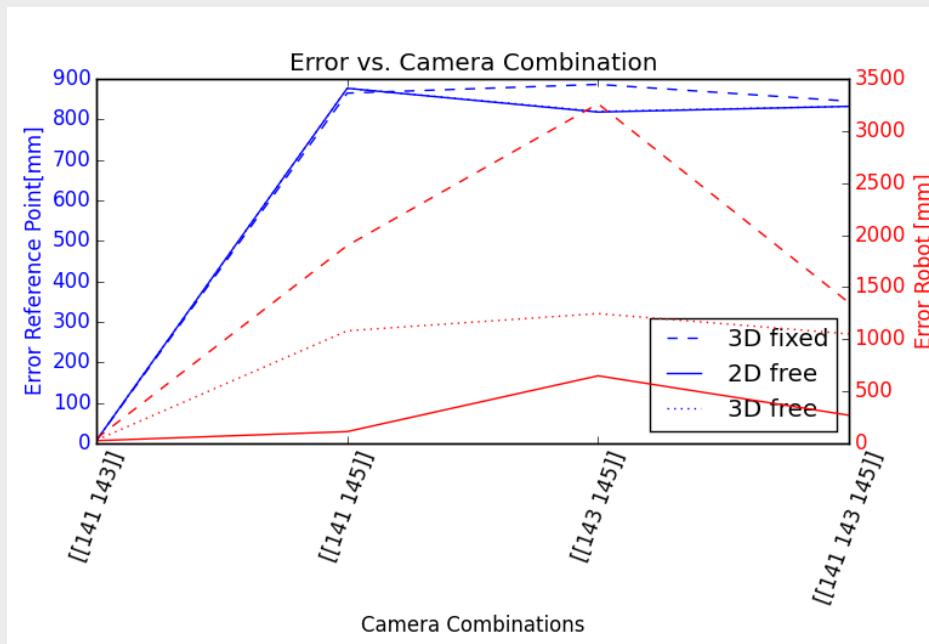
# VISUAL LOCALIZATION IMPLEMENTATION



# VISUAL LOCALIZATION

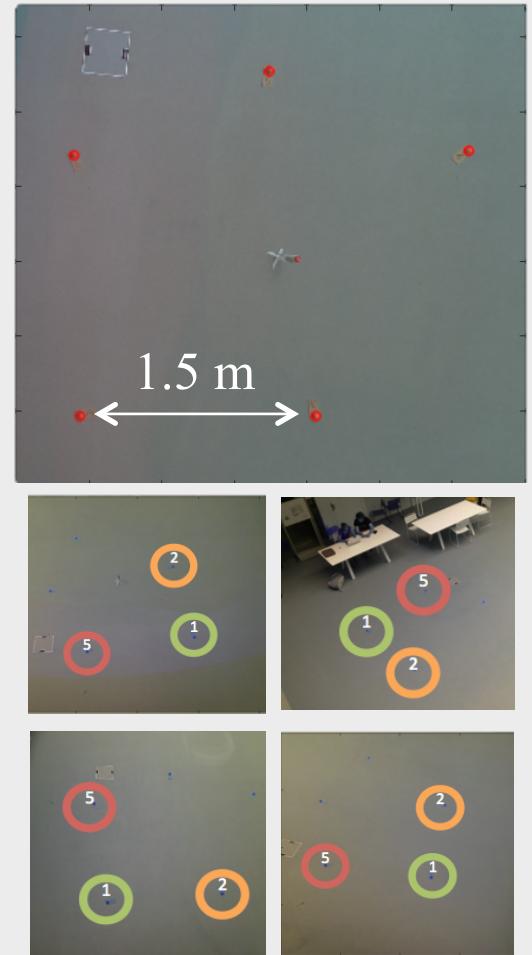
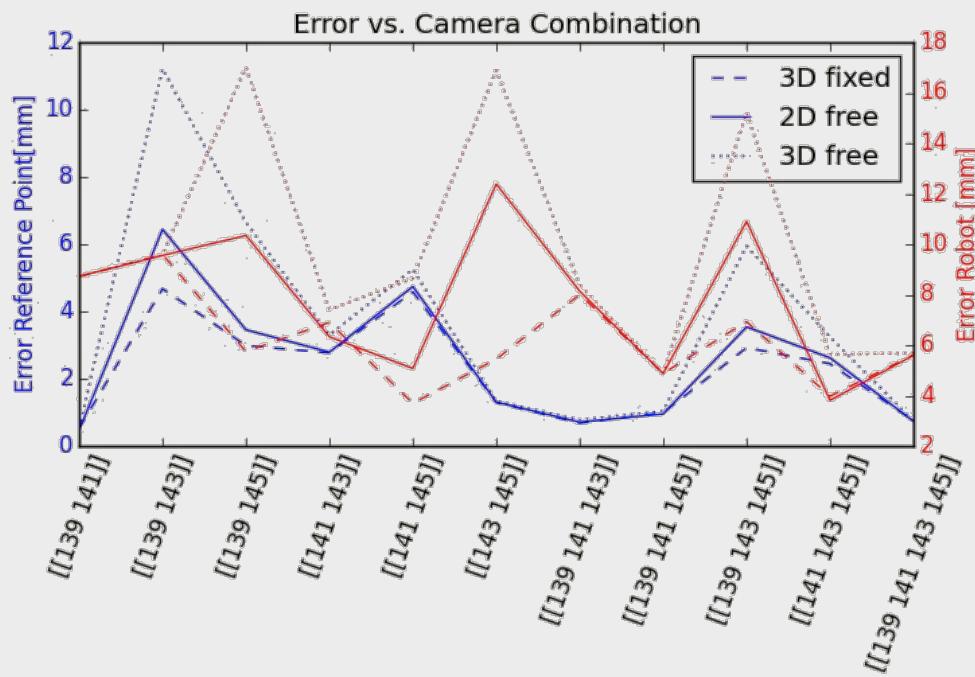
## EXPERIMENTAL RESULTS

- ◆ Good accuracy in 2D ( $<3$  cm) and height ( $<2$  cm) for **some** camera combinations
- ◆ Very big variance between and within 4 cameras  
**needs more investigation**

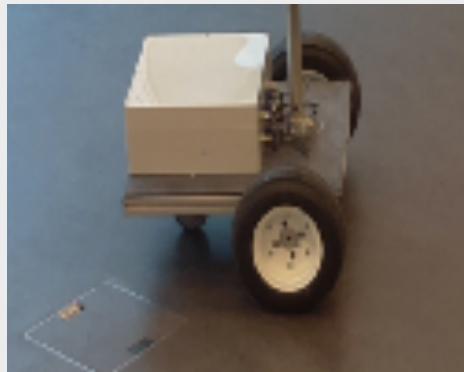


# VISUAL LOCALIZATION COMPARISON ATRIUM

- Very good accuracy in 2D (<1 cm) and height (<5mm) for **all** camera combinations



# ODOMETRY EXPERIMENTAL RESULTS



## Parameters:

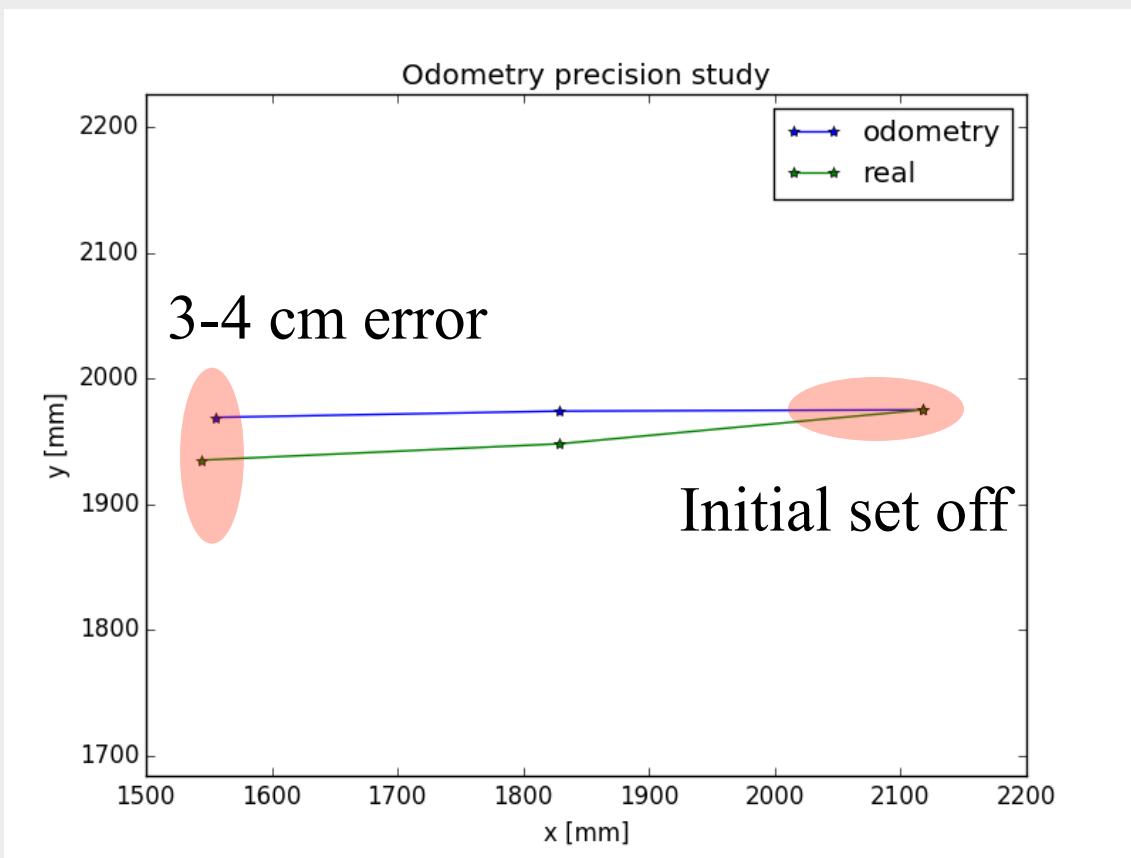
R=15cm

D=71cm

N=512x47 counts/rev

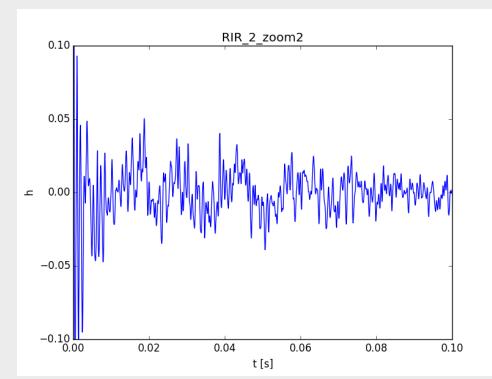
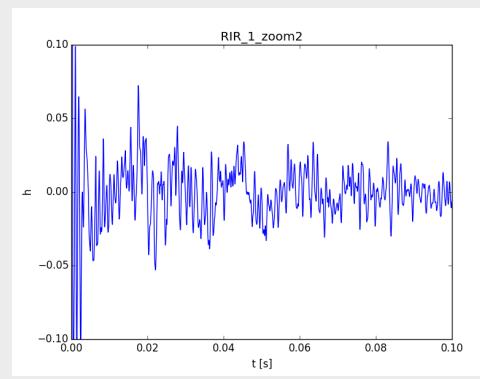
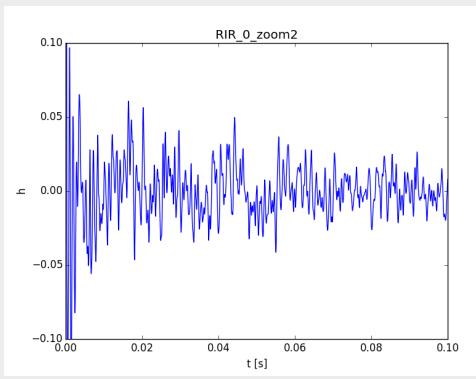
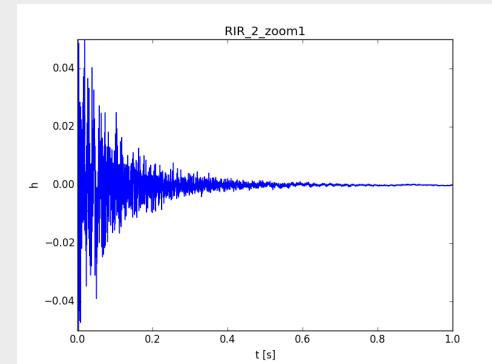
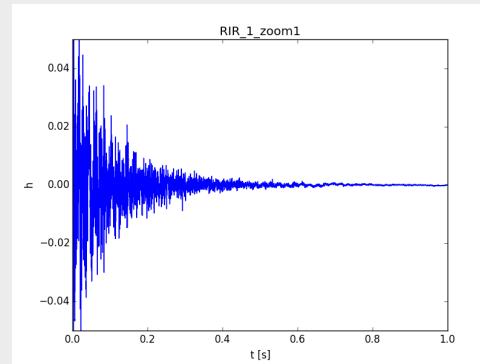
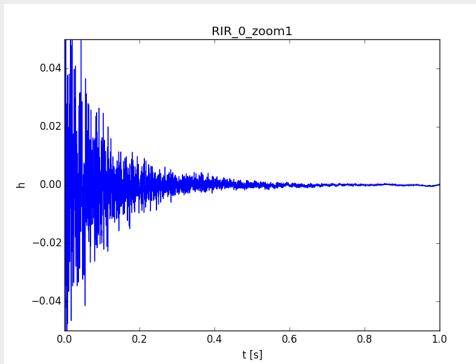
$(x_0, y_0, \theta_0)$

$\Delta_{\text{left},k}, \Delta_{\text{right},k}$  ( $k=0, \dots$ )



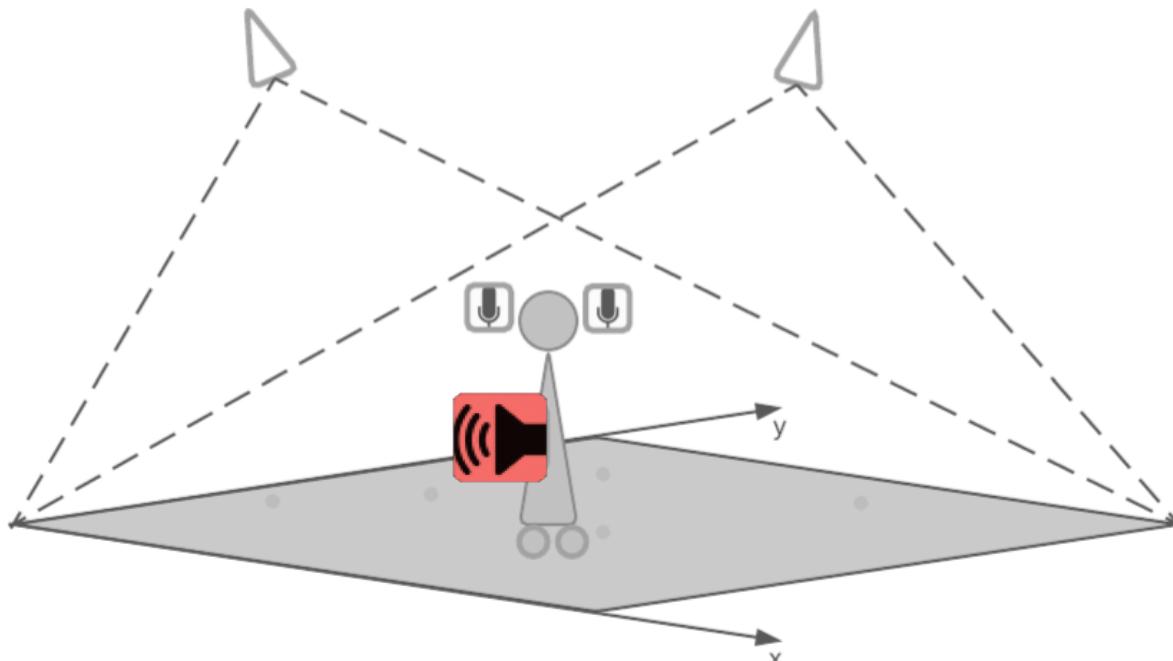
# ACOUSTICS

## EXPERIMENTAL RESULTS



# SUMMARY AND OUTLOOK

## Physical setup



## Algorithms

Visual localization  
ground truth

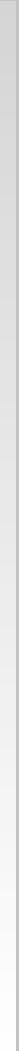
Odometry  
position guess

Sound processing  
new algorithm

+ Finalization Instructions online

# REFERENCES

- [1] <http://www.trailblazercoaching.com/2156/blind-batman/>
- [2] William Kremer: *Human echolocation: Using tongue-clicks to navigate the world.* 12.09.2012. [www.bbc.com/news/magazine-19524962](http://www.bbc.com/news/magazine-19524962)
- [3] *The boy who sees without eyes,* 30.05.2012  
<https://www.youtube.com/watch?v=TeFRkAYb1uk>



**THANK YOU**