

# Multi-touch Interface for Controlling Multiple Mobile Robots

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JST, ERATO, IGARASHI Design UI Project

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A decorative wavy line in shades of light blue and green, flowing horizontally across the middle of the slide.

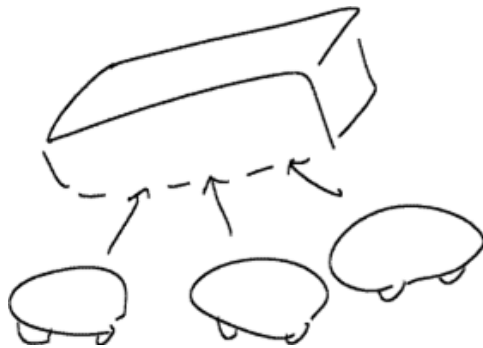
Multi-touch Interface for Controlling Multiple Mobile Robots

# **INTRODUCTION**



# Motivation

- Multiple mobile robots can do various tasks with greater efficiency.



- They also improve fault tolerance.

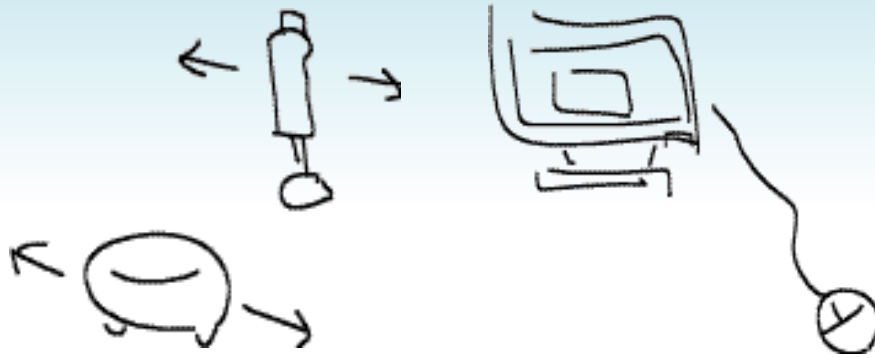




- Then, how would you like to control movements of those robots?
  - “Discussion of Challenges for User Interfaces in Human-Robot Teams” - (Driewer, F., 2007)
  - “Human control for cooperating robot teams” – (Wang, J., 2007)

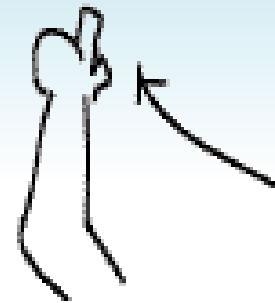


# Existing User Interfaces

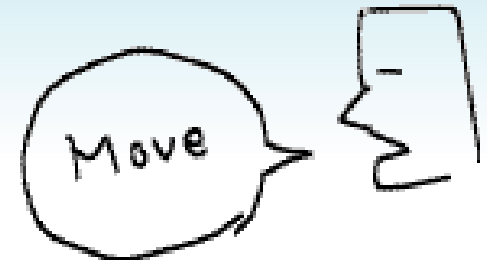


Joystick

Mouse



Gesture



Speech



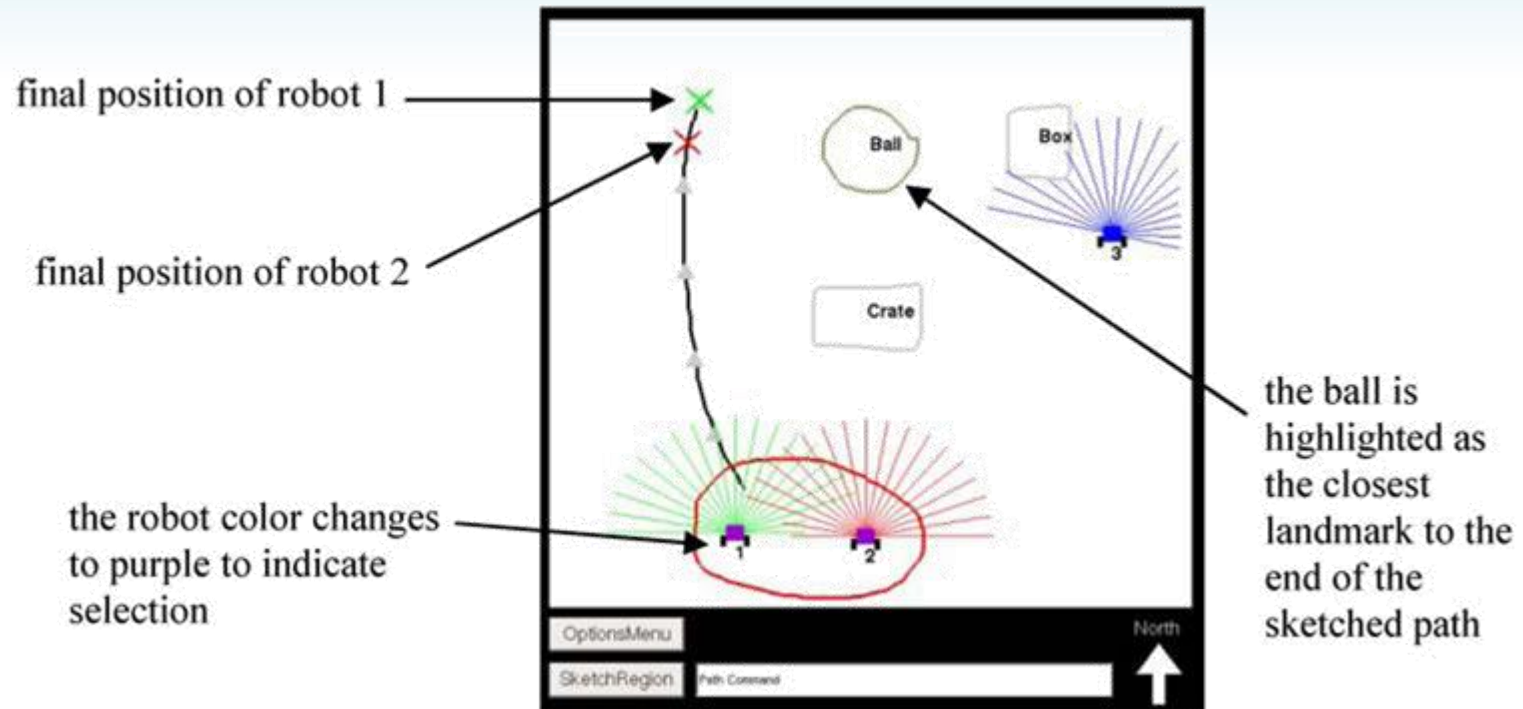
Gesture and Speech (Rogalla, 2002)



PDA and Pen (Fong, T., 2002)



# Existing User Interfaces

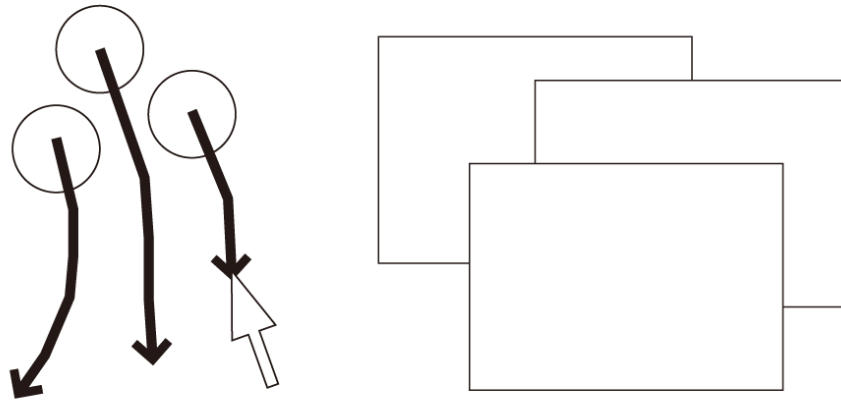


Drawing a sketch to control robots (Skubic, M., 2007)



## Problems

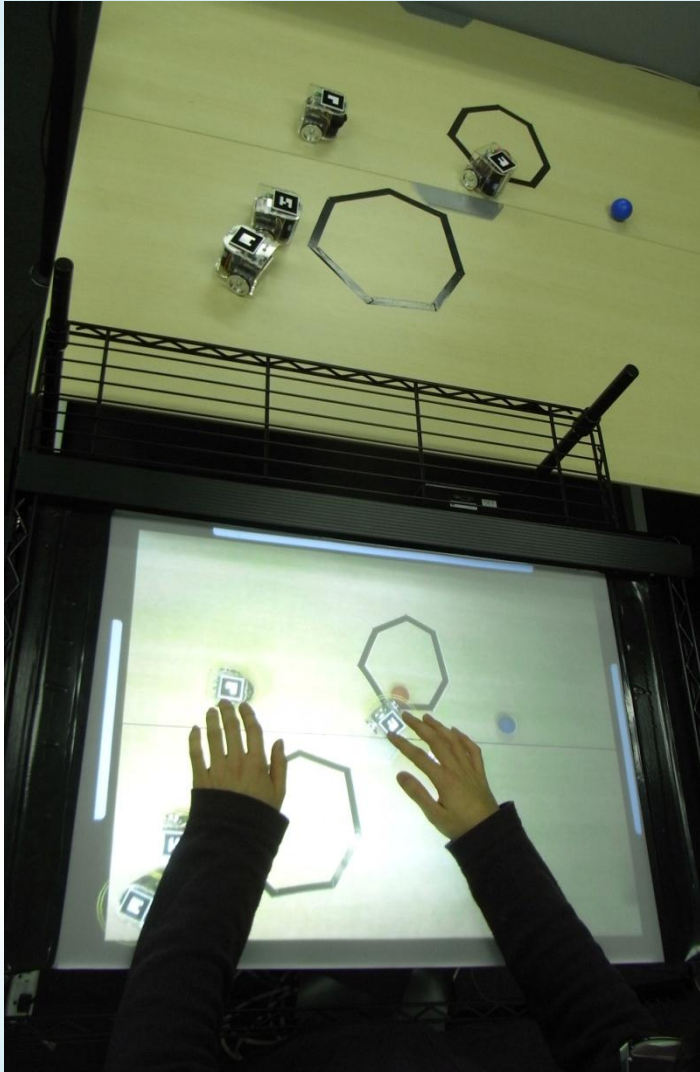
- Draw similar paths? Switch among many views?



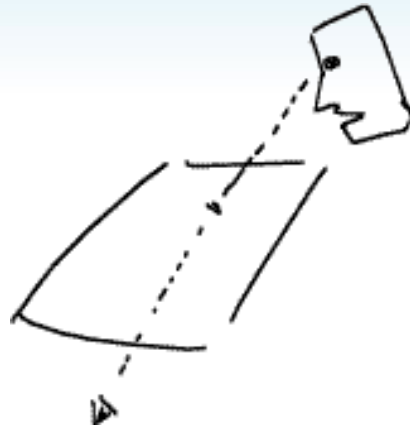
- How can we combine these interfaces with autonomous approaches?



# My Approach



God's view of the environment



Two hands' intuitive operation

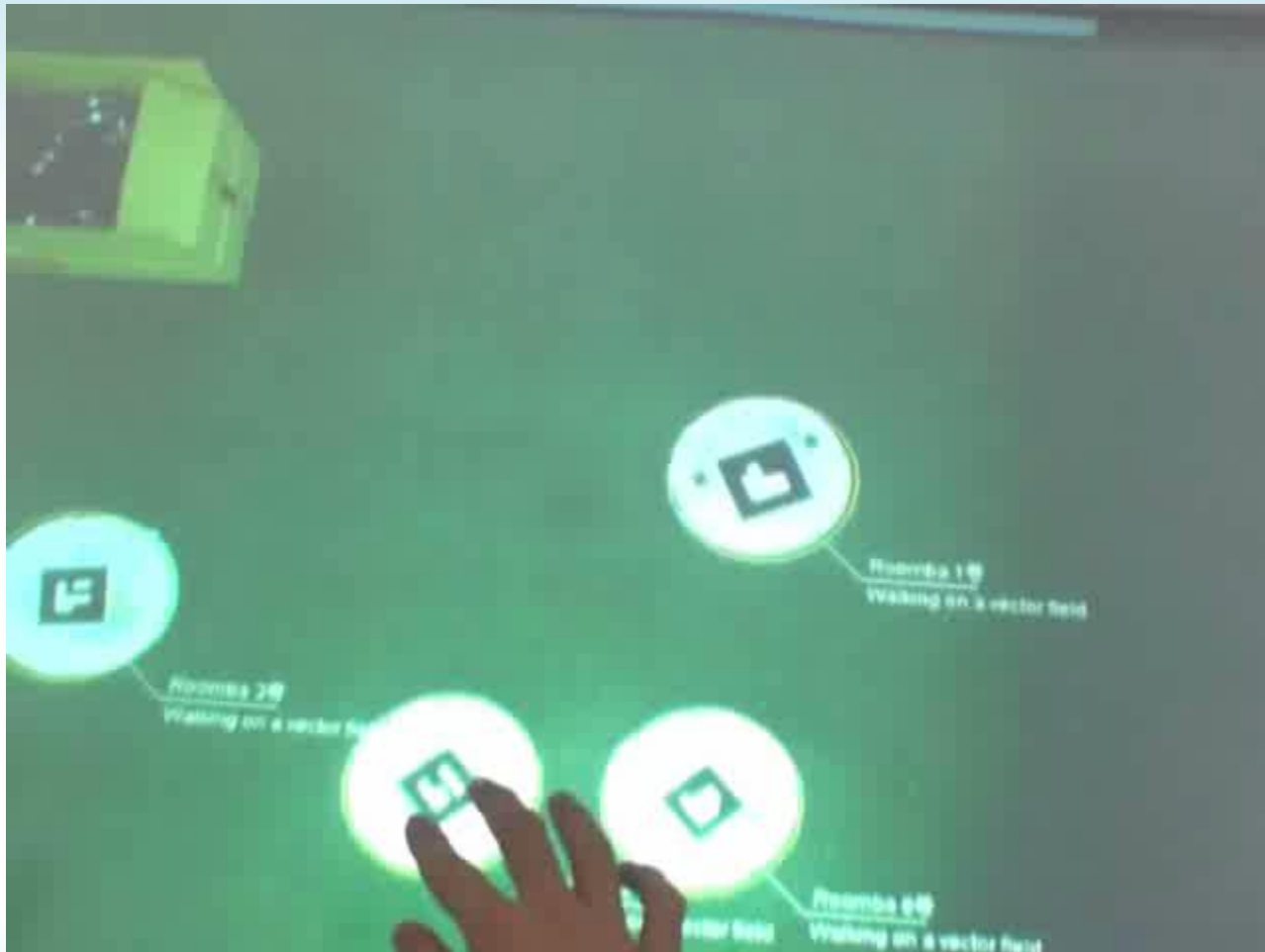


Direct manipulation of raw data  
for navigating robots





# Vector Field Operation



Draw a stream, drift robots!

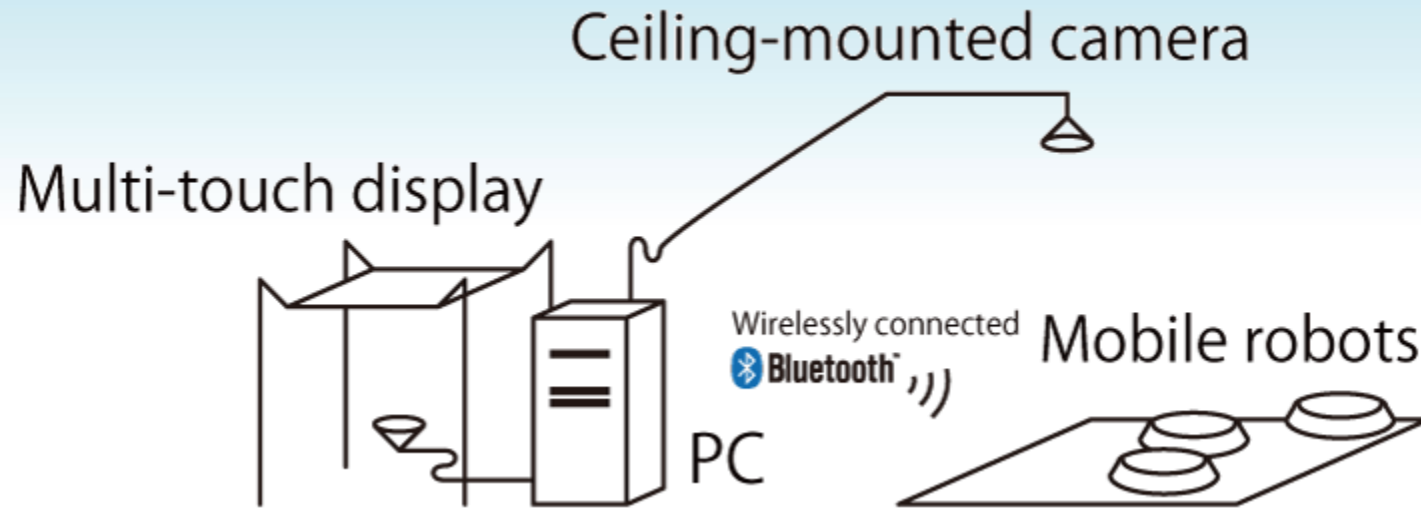
A decorative wavy line in shades of light blue and green, spanning the width of the slide and positioned above the text.

Multi-touch Interface for Controlling Multiple Mobile Robots

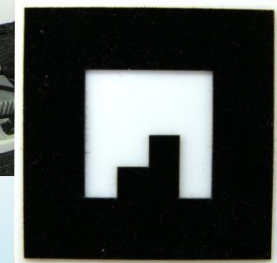
# **VECTOR FIELD OPERATION**



# Hardware Setup

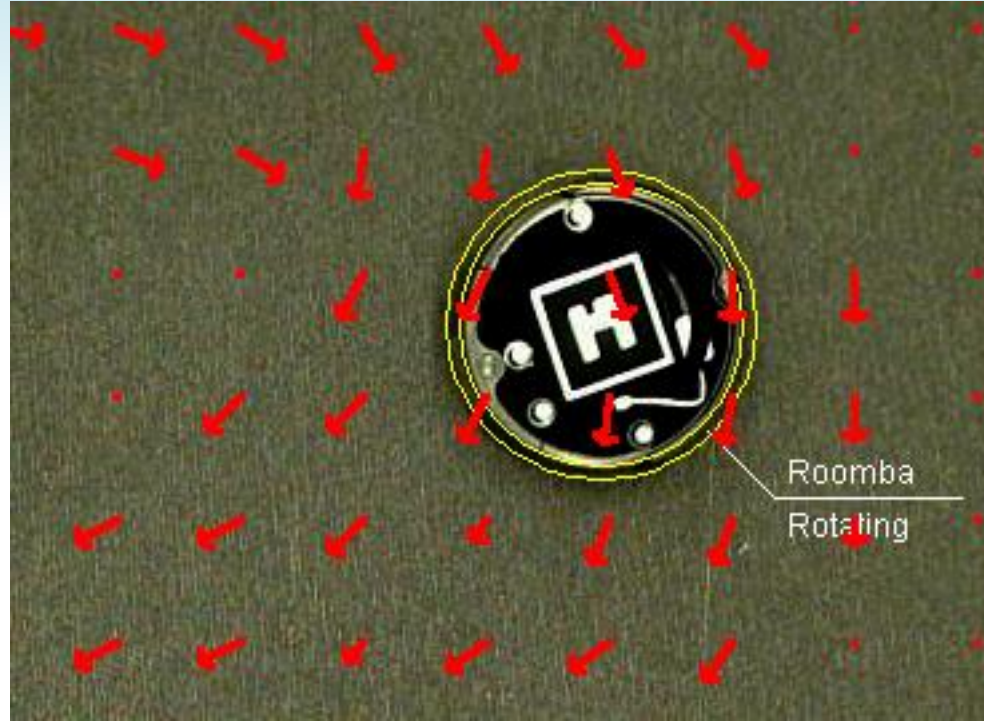


with





## Vector Field on the View



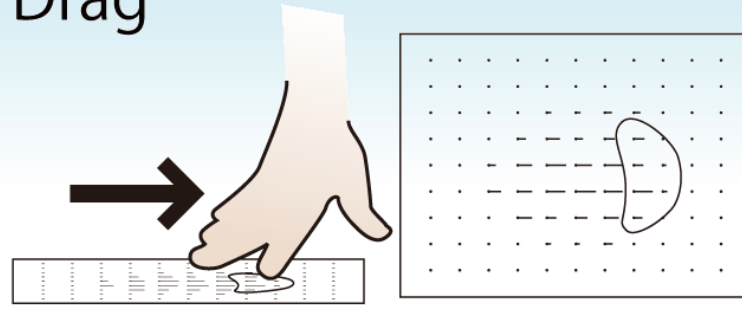
- The view is divided into grids.
- Each grids have 2D vector information.
- Whole grids construct a 2D vector (flow) field.



# Available Operations on the Vector Field

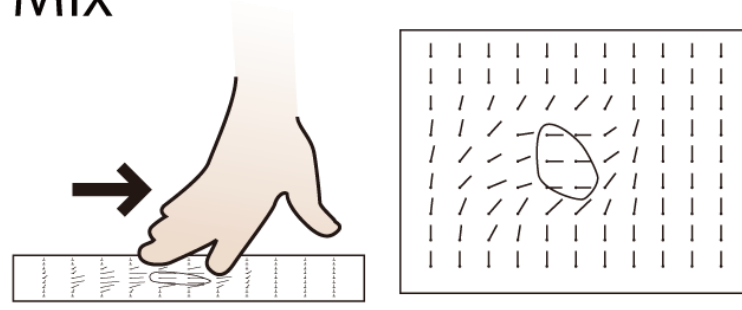
To move robots,

Drag



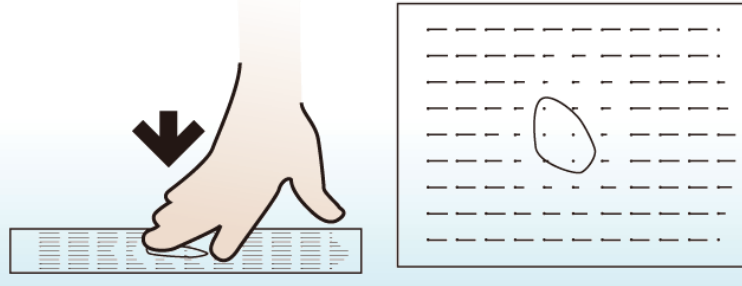
To fix movements,

Mix

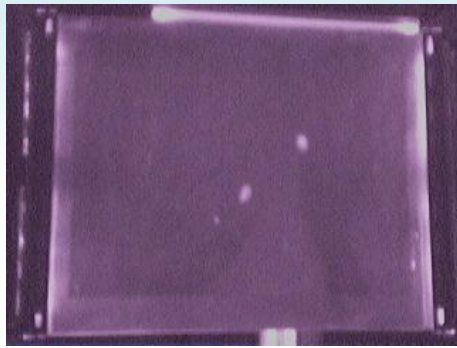


To stop robots,

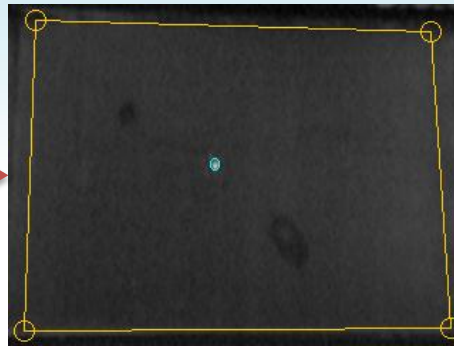
Hold



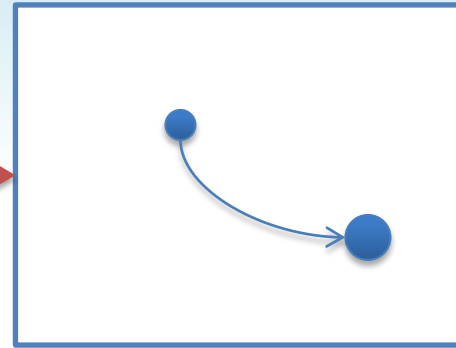
# Implementation of the Vector Field



Capture



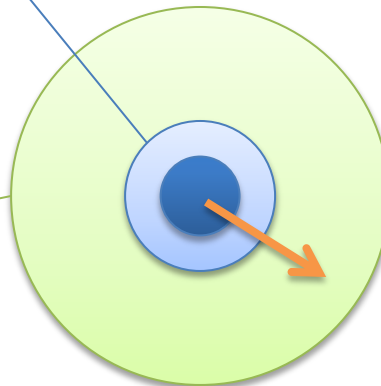
Calibrate



Track motion

Vectors are overwritten completely in **blue** area

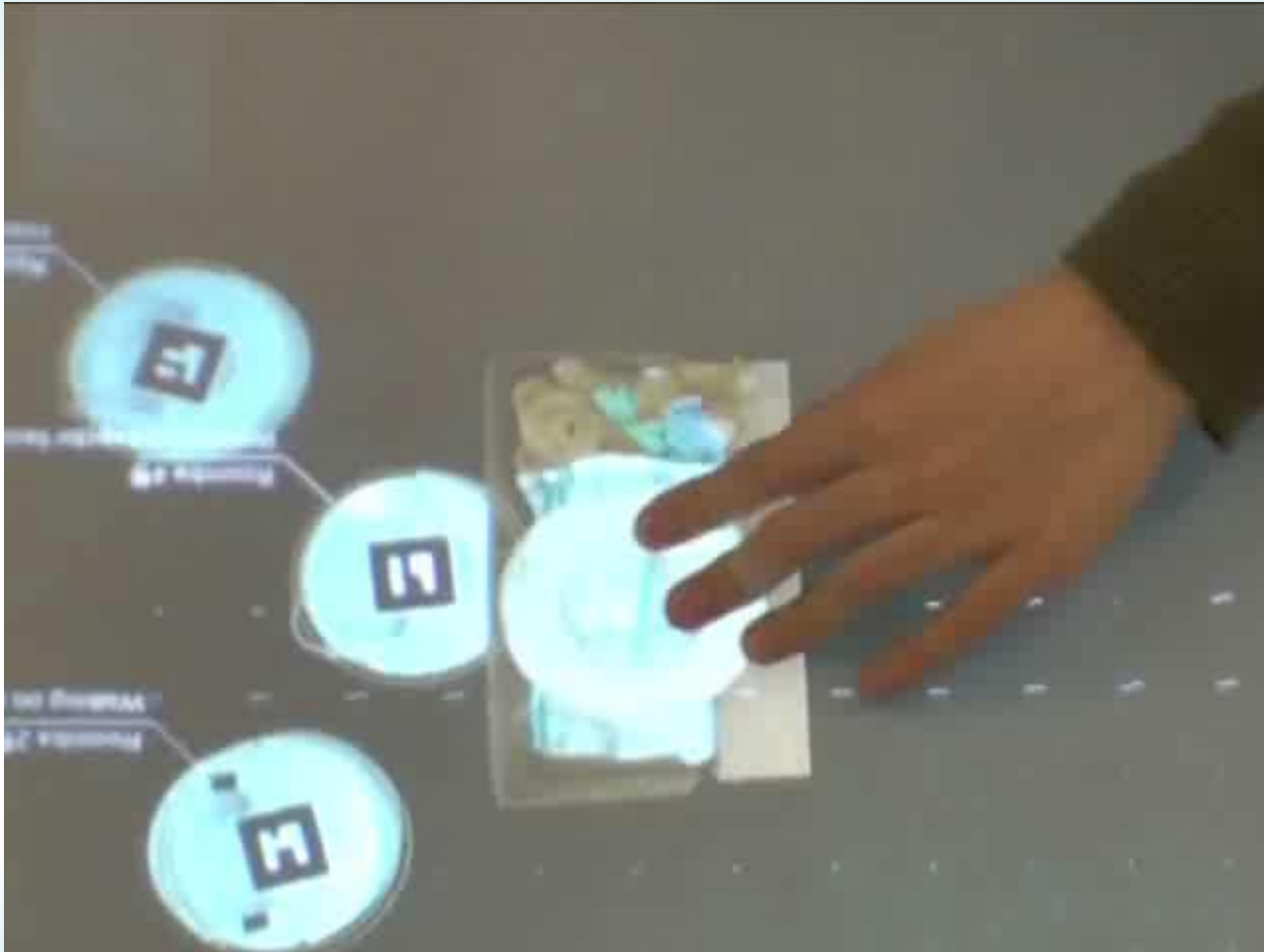
Vectors are overwritten 0-100% in **green** area, in proportion to the distance from the center



Motion vector affects the field



“So, what can we do?”





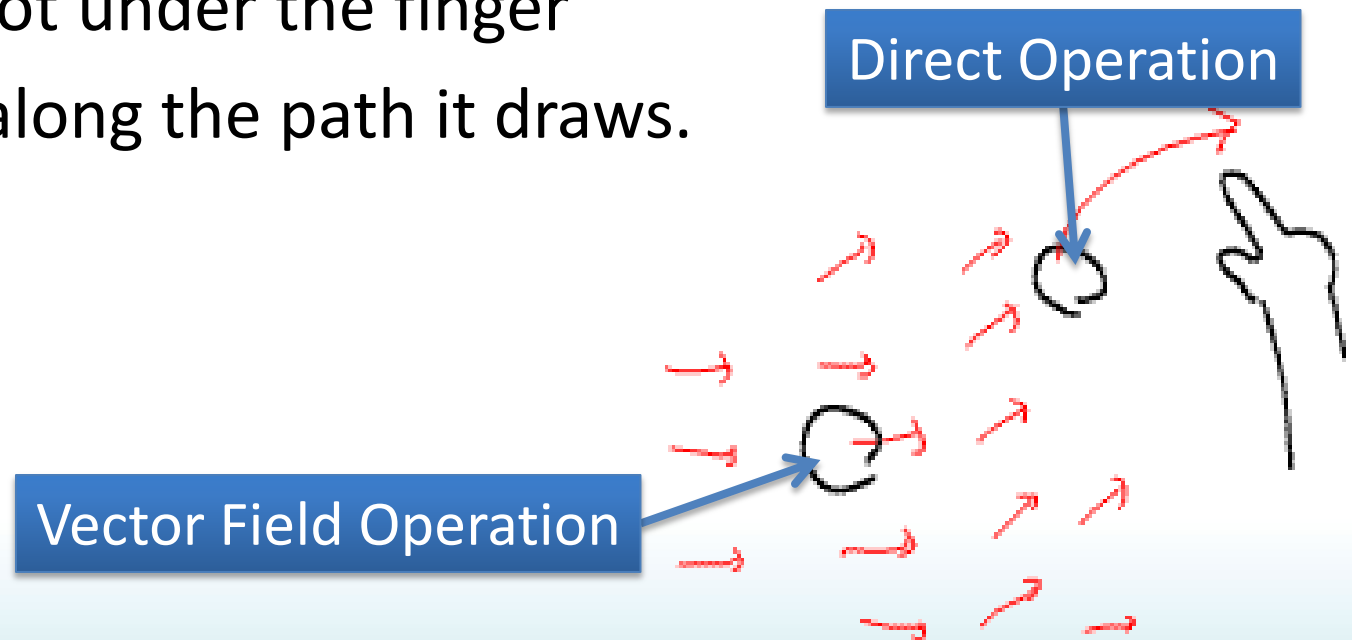
## Next Step...

- A user test
- Integration of other user interfaces



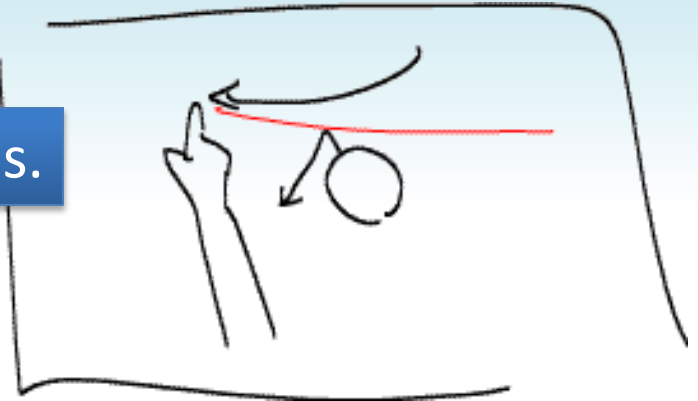
## Combination with Direct Operation

- Based on Vector Field Operation
- When fingers are in the robot icon, Direct Operation starts.
  - The robot under the finger moves along the path it draws.

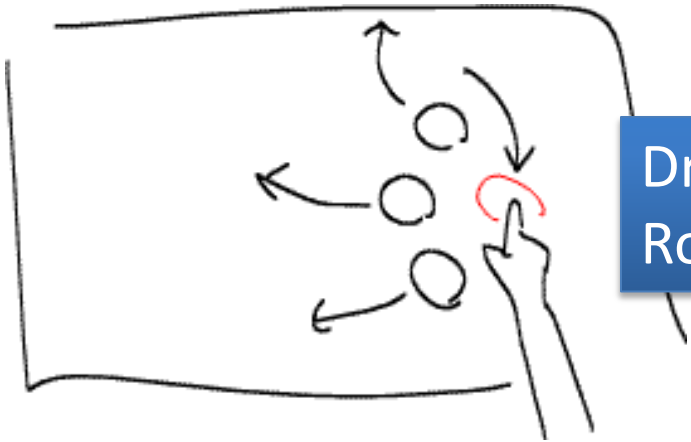


# Extensions of Vector Field Operation

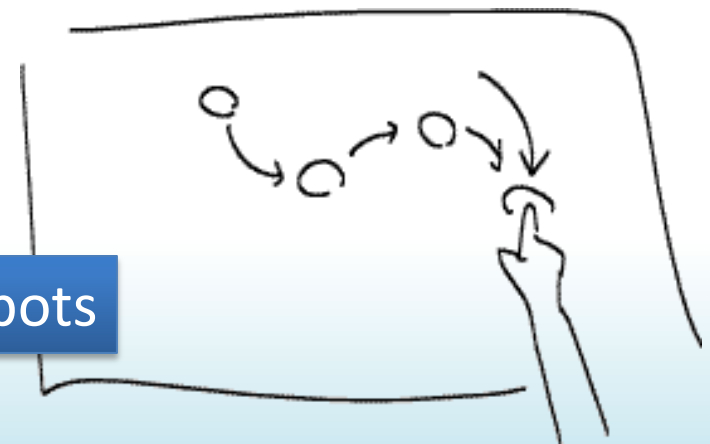
Draw or clear virtual walls.



Draggable virtual dog icons.  
Robots as sheeps run away!



Bind relative positions of robots





## Integration with Autonomous Algorithms

- With Virtual Force Field (Borenstein, J., 1989)
- Etc.?



# Extensions of Visualization

Visualization of the Vector Field  
with particle-animation



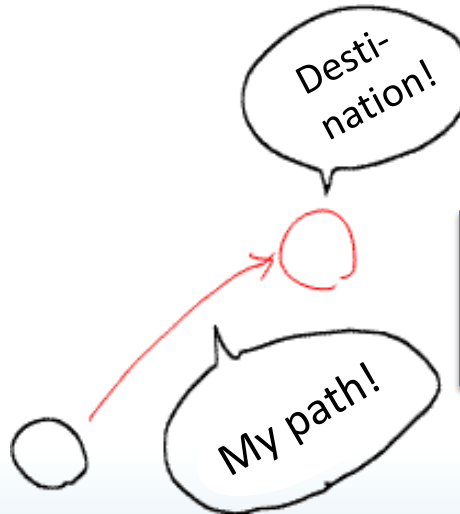
I can't move!



Error displays  
like time out

Desti-  
nation!

My path!



Path calculation  
and visualization



## Summary

- We developed a multi-touch interface for controlling multiple mobile robots simultaneously.
- Our interface has capability to be integrated with other operating methods, including autonomous ways.

