Omnidirectional Distributed Vision System for Heterogeneous Robots

E. Menegatti, A. Scarpa, D. Masarin, E. Ros and E. Pagello

IAS-Lab
Intelligent Autonomous Systems
The University of Padua

Presentation Outline

- Motivation of the work
- Omnidirectional Distributed Vision System (ODVS)
- Future Works

Motivation of the work

To extend the limits of the sensorial horizon of the single agent

- The first step: to use omnidirectional vision
- The large field of view of omnidirectional vision systems that is not enough in highly dynamic environments
- Omnidirectional vision cannot see occluded objects or very distant objects

So:

- We want to realise a distributed vision system robust to failure of the single robots
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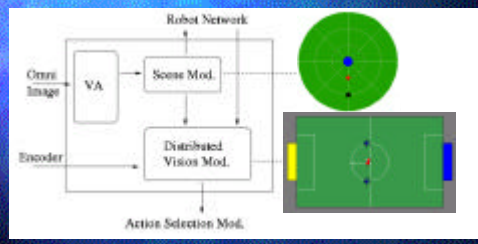
Related Works

- Stroupe et al.
  - Perspective cameras
  - Measurements made at the same instant in time
  - No tracking, just recognition
- Gutmann et al.
  - Perspective cameras
  - Laser Range Finders
  - External Global Sensor Integrator
  - Agent uses external information only for unseen objects

Omnidirectional Distributed Vision System (ODVS)

- Every robot shares its measures
- Every robot fuses received measures
- Robot syncronised with NTP
- Robot localised only with omnidirectional vision
- Works with different Vision sensors:
  - different accuracies,
  - different frame rates,

Single Sensor



Perception Module

Single Measures

- A 2D Gaussian is associated to every measure
- The Gaussian represents the probability that the object is actually located at that point
- Gaussian widths are determined experimentally for every single robot
- Measure is transformed in the absolute frame of the field
- A time stamp is associated at every measure

Fusing Multiple Observations

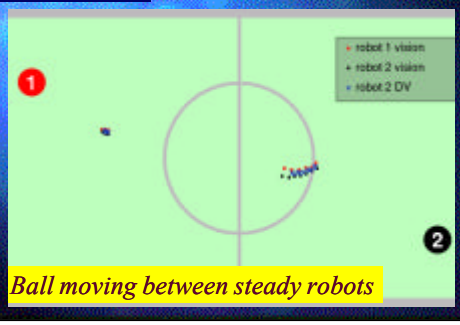
- Measures come from:
  - the vision system of the single robot
  - the vision system of the teammates
- They are processed in the same way:
  - They are stored in 'tracks'
  - They are fused with a Kalman filter by combining the two Gaussians
  - Multi-modal distribution allowed

3dplot combinazione di gaussiane

Tracks management

- When a track is not updated the associated variance increase
- Over certain threshold track deleted
- Real position assumed to be the one of smallest variance

Experiment (1)



Ball moving between steady robots

Measures from Different Robots

Problems:

1. sharing the same spatial frame of reference
2. sharing the same temporal frame of reference
3. Trusting teammates
4. Managing 'old' measurements

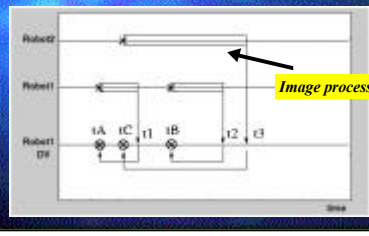
Adopted solutions:

1. Robust self-localisation
2. Internal clock syncronised via Network Time Protocol (NTP)
3. Variance of measures from teammates are doubled
4. The state of the object is recalculated

Old Measurements

- Old measurements cannot be thrown away

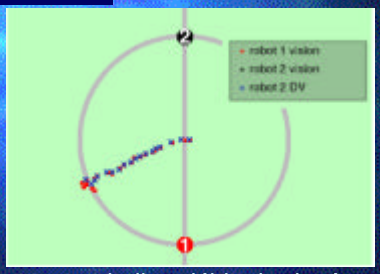
E.g. Very slow vision system reporting very accurate measurements



Experiment (2)

Ball moving between steady robots

Experiment (3)



Moving ball and 'blind robot'

Conclusions

- We implemented an Omnidirectional Distributed Vision System
- The system is robust to failure of the single robots
- The system exploits:
  - the heterogenity of the sensors
  - The redundancy of the observations
- We presented experiments in real game scenarios
- The measure fusion system is very general and can accept any measure represented as a Gaussian distribution:
  - At the moment we are working with a system that is fusing omnidirectional vision data with acoustic data from a microphonic array sensor

Advertising!

See you in Padua at RoboCup2003!

RoboCup

www.robocup2003.org

Artisti Veneti 2003