

Vision in RoboCup Soccer:

Using Vision for Collision Avoidance and Recovery



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SUNFEST '01
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What is RoboCup Soccer?

- 3 on 3 — 1 goalie, 2 players per team
- 2-meter by 3-meter field
- Legged league — use Sony Aibo robots
- Sensors include
 - > Camera (we use low res. camera)
 - > Infrared range finder
 - > Microphones (and speakers for sound communication)
 - > Accelerometers
 - > Touch sensors on head, back and feet

Existing Detection Abilities

- Blob detection — can detect 4 largest blobs of each color (all objects color-coded)
- Determination of distance to object based on size of blob
- Detection of up to one player at a time from each team

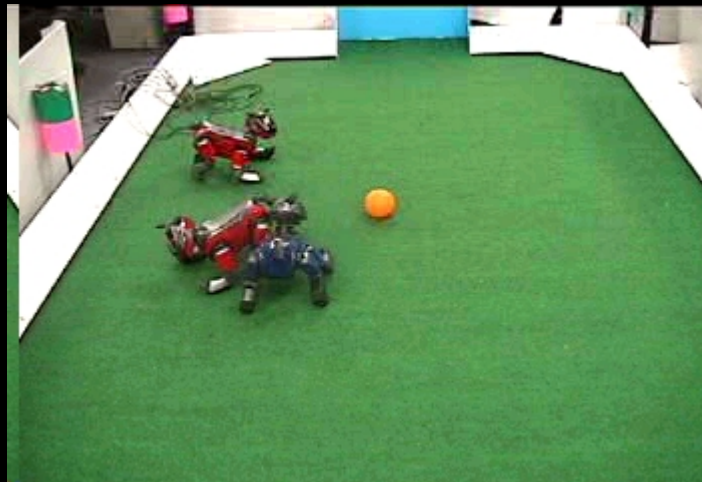
Detection Advancements:

The Ball

- Use readings from infrared range finder when ball seems to be obstructed
- Update relative position based on movement of self
- Determination of ball's relative velocity
- Use ball's velocity to determine if you're stuck
 - > If stuck, back up and try another route to ball

Collision Recovery

- Back up, then either:
 - > Sidestep in direction that keeps ball between self and goal, or
 - > Rotate to face ball



Detection Advancements:

Other



Players

- Use infrared range finder when within 40 cm
- Ability to store positions of all other players
- Algorithm to determine which blobs are part of the same player
- Update relative positions based on movement of self

Reacting to Other Players

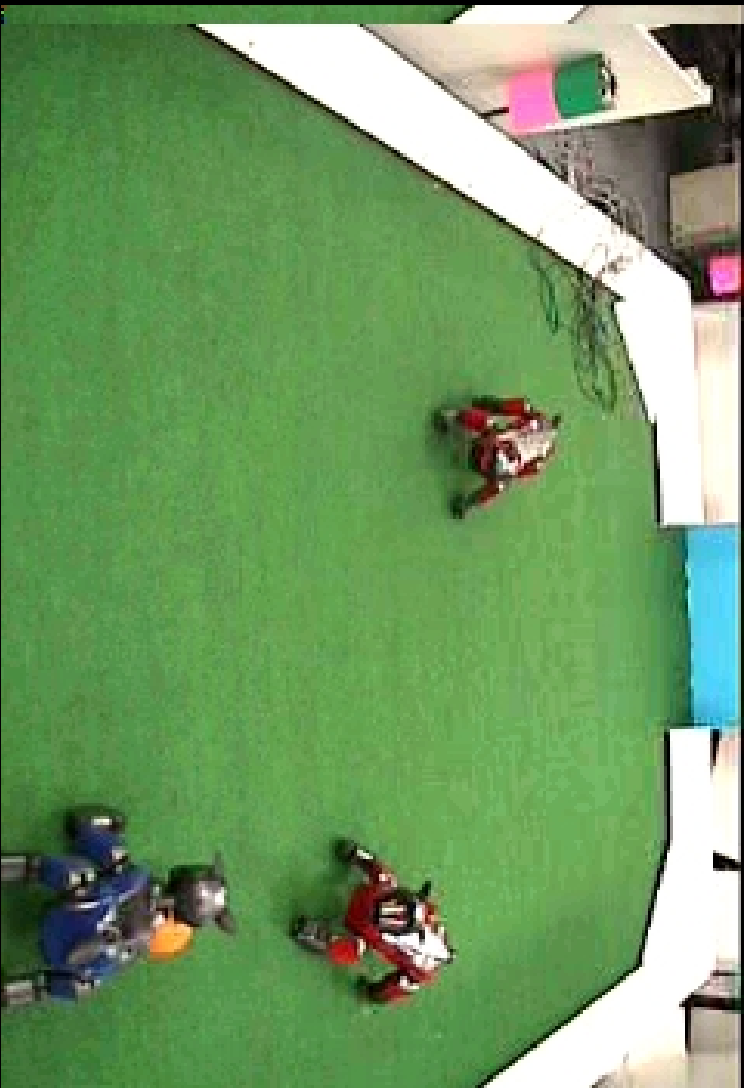
- Objective: ability to dribble ball past other players
- Technique: artificial potential fields
 - > Goal exerts attractive force
 - > Other players exert repulsive force
 - > Calculate total force vector, and travel in that direction
- Simple computations allow real-time planning and avoidance of moving obstacles

Modifications to Theoretical Model

- Obstacles' repulsive force degrades relatively slowly with distance
- Repulsive force multiplied by $\cos(\text{angle to obstacle} - \text{angle to goal})$
- Robot not permitted to travel backwards

- With stationary obstacles, works well
- With moving obstacles, less consistent

Avoiding Stationary Obstacles



Further Work

- More accurate determinations of object distances, possibly by using high res. camera
- Fine-tuning of avoidance algorithm
- Different goalie actions based on ball velocity
- More coordination between teammates

Conclusions:

How we're Using Vision for Collision Avoidance and Recovery

- Track ball velocity relative to self
 - > If not getting closer, probably stuck
 - > Back up and try another route
- Avoidance of other players using artificial potential fields method

Acknowledgements

Thanks to:

Professor Jim Ostrowski

Sachin Chitta

Aveek Das