Algorithm Development and Testing for Four Legged League Robot Soccer Passing

Please help yourself to some
delicious muffins and/or some coffee

The University of Newcastle
AUSTRALIA

Algorithm Development and Testing for Four Legged League Robot Soccer Passing

Special thanks to
Prof. Rick Middleton & Dr. Michael Quinlan

The University of Newcastle
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How to teach your doggy passing

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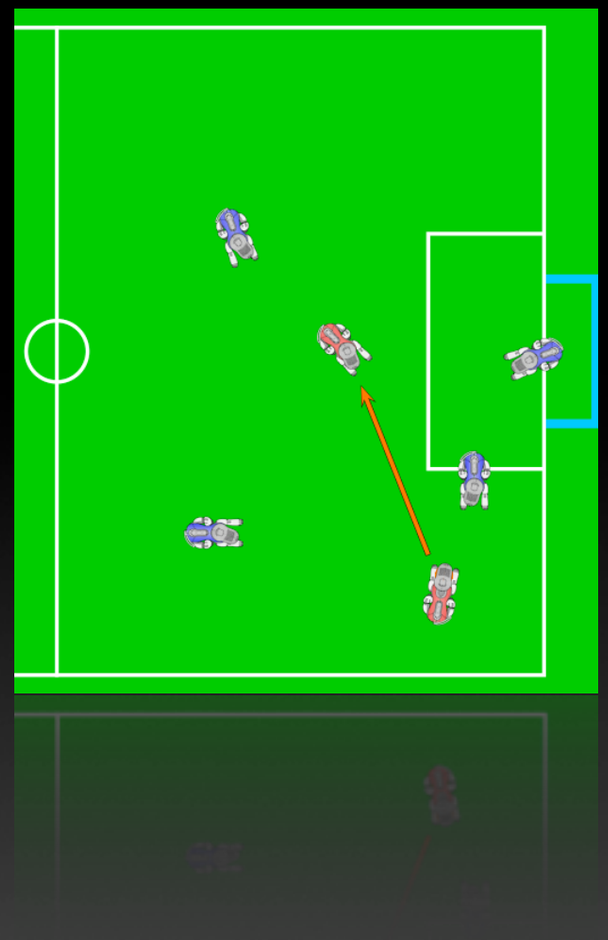
CDSC

Institut für IFAT Automatisierungstechnik

Otto-von-Guericke-Universität Magdeburg

1. Outlines and Objectives



1. Outlines and Objectives

2. Introduction to the NUbots

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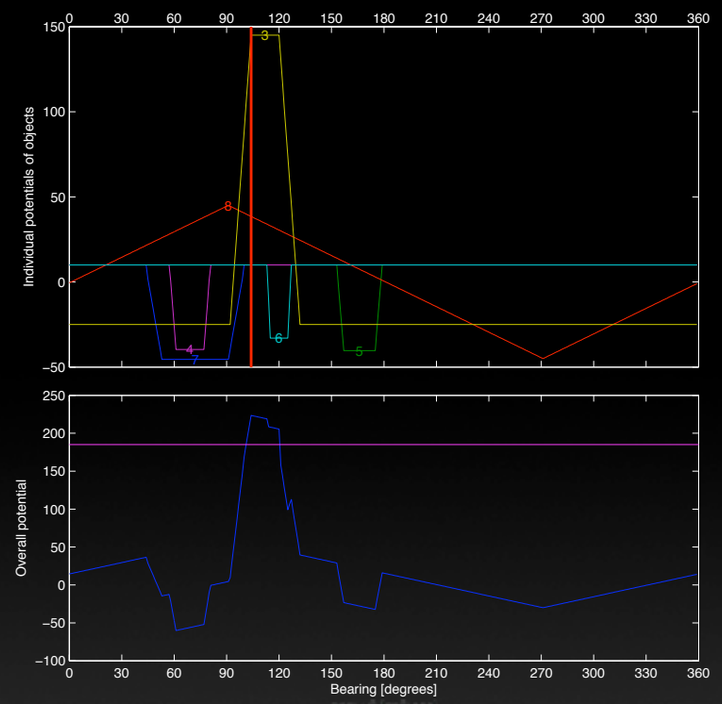
3. Passing algorithm design



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4. Implementation

```
# calculate pass receiver
if max_att > 0: # we found a winner

  min_d = 1000.0; receiver = -1;
  pass_range = l_mod(range(pass_ang-35,pass_ang+36

  for i in xrange(n):
    if ( team_th[i] in pass_range ) and ( team_d[i
      receiver = i

  # calculate how far the ball is to go "ahead" of
  delta_ang = modpm180(pass_ang-team_th[receiver])
  d20 = fabs(delta_ang)-20 # pass more than 20 deg
  if d20 > 0: # delta > +-20 deg
    if delta_ang > 0:
      delta_ang = 20
      pass_ang -= d20
    else:
      delta_ang = -20
      pass_ang += d20

# output and return
  print "PASS: %i deg | Q: %3.3f | ID: %i | D: %i
```

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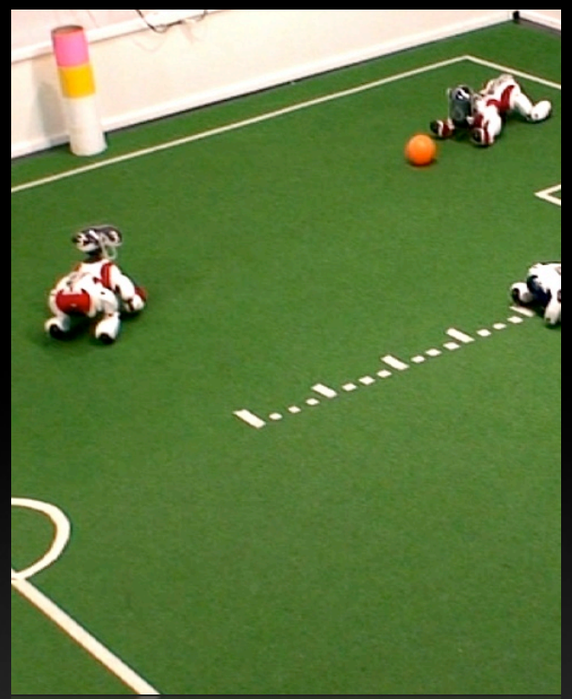
5. Demonstration and conclusion



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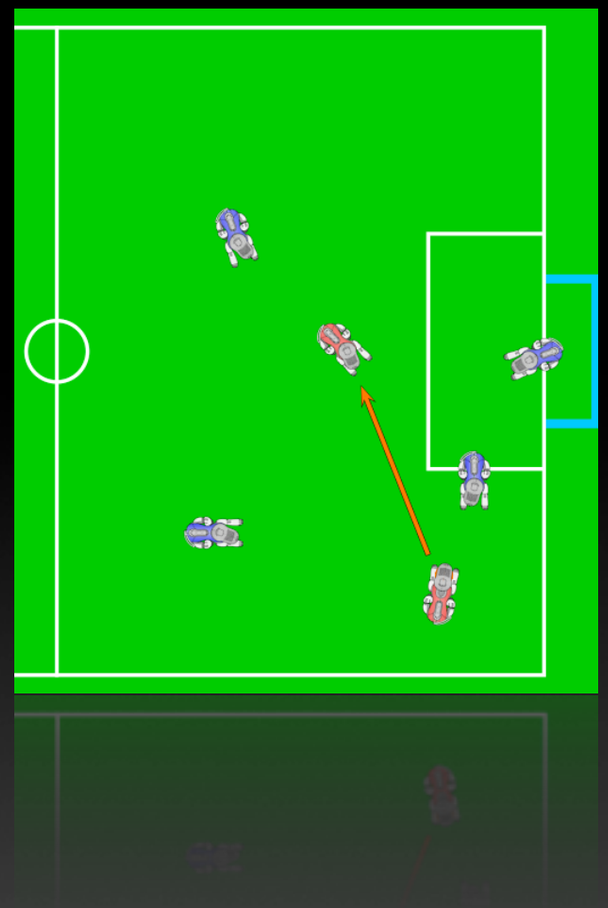

Potential advantages?

- Passing: key element in team sports

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- Would be massive advantage over other teams

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- Already used in other RoboCupSoccer leagues

Why not implemented yet?

- Lack or immaturity of certain low level skills

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- Insufficient precision in localisation

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- Insufficient precision in localisation
- Other features & behaviour of primary concern

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Some basic Four Legged League rules

- Field: 5.40m x 3.60m, 4 coloured beacons

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- 4 players per team (Red Team & Blue Team)

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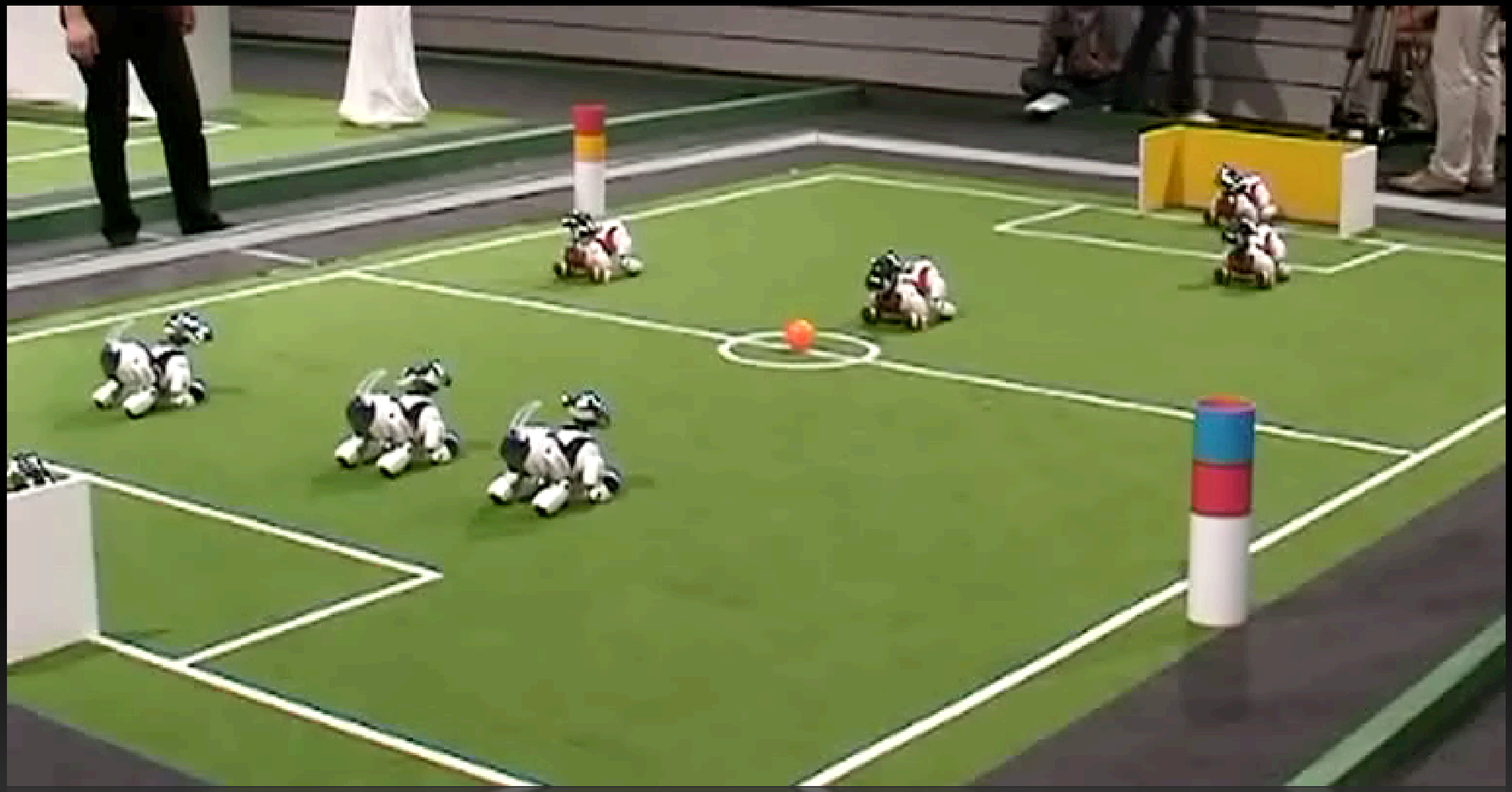
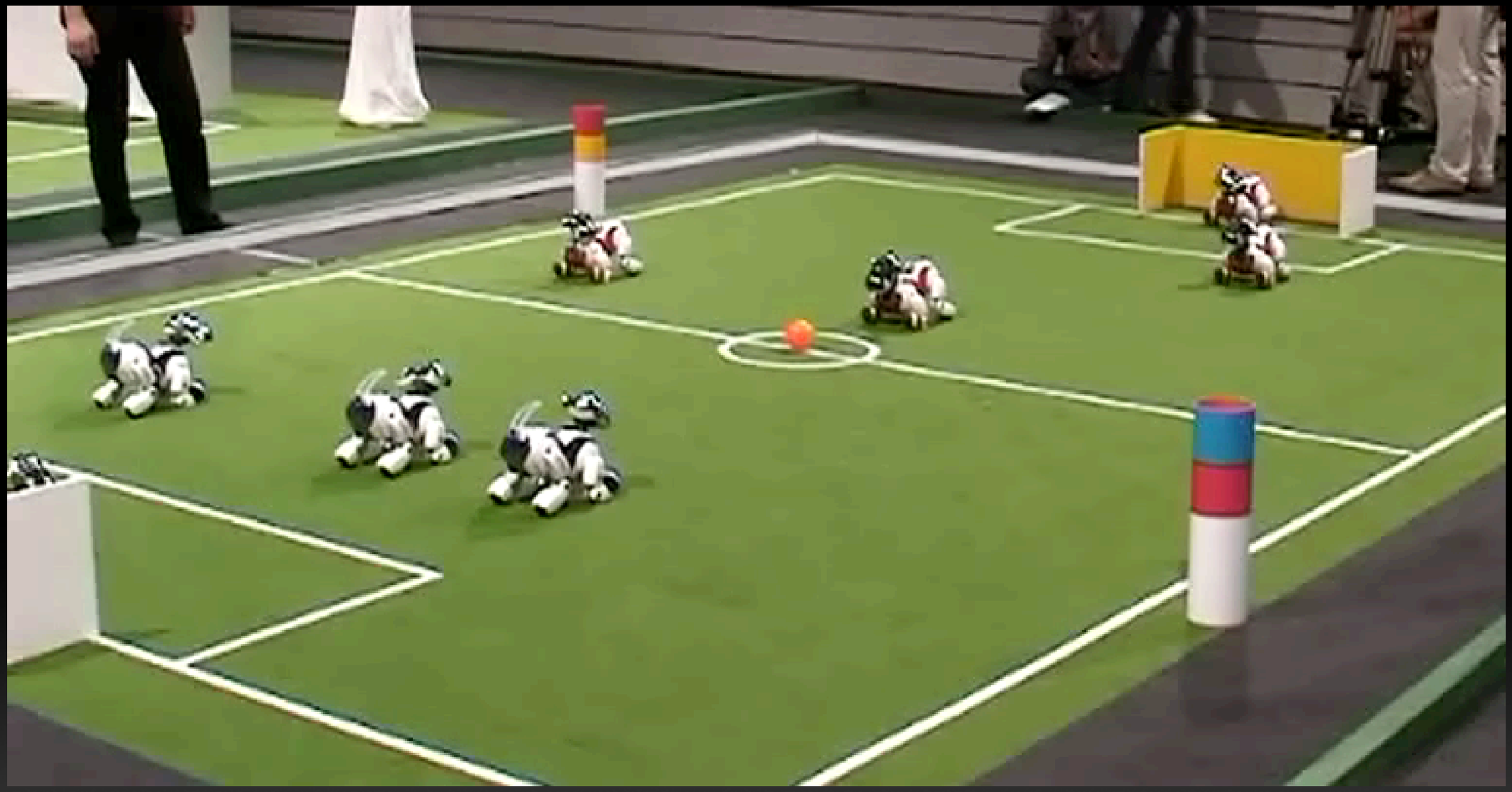
  - Team bandwidth usage exceeding 500 kbit/s



Typical game play



Typical game play

Sony AIBO ERS-7

Hardware

- Input:
  Camera, infra-red senors, buttons

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- Processing:
  576 MHz CPU, 64 MB RAM, 16 MB Memory Stick

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- Output:
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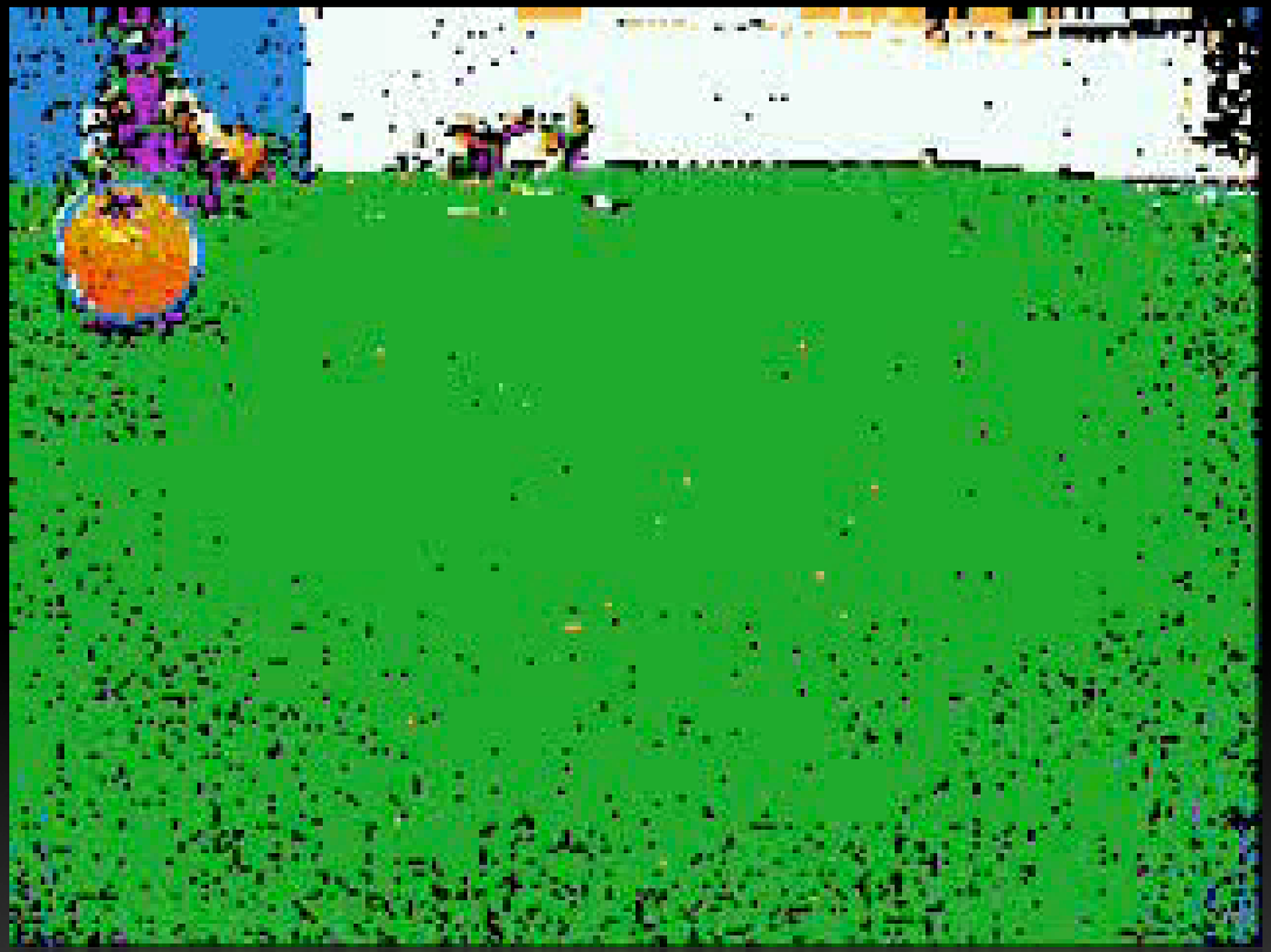
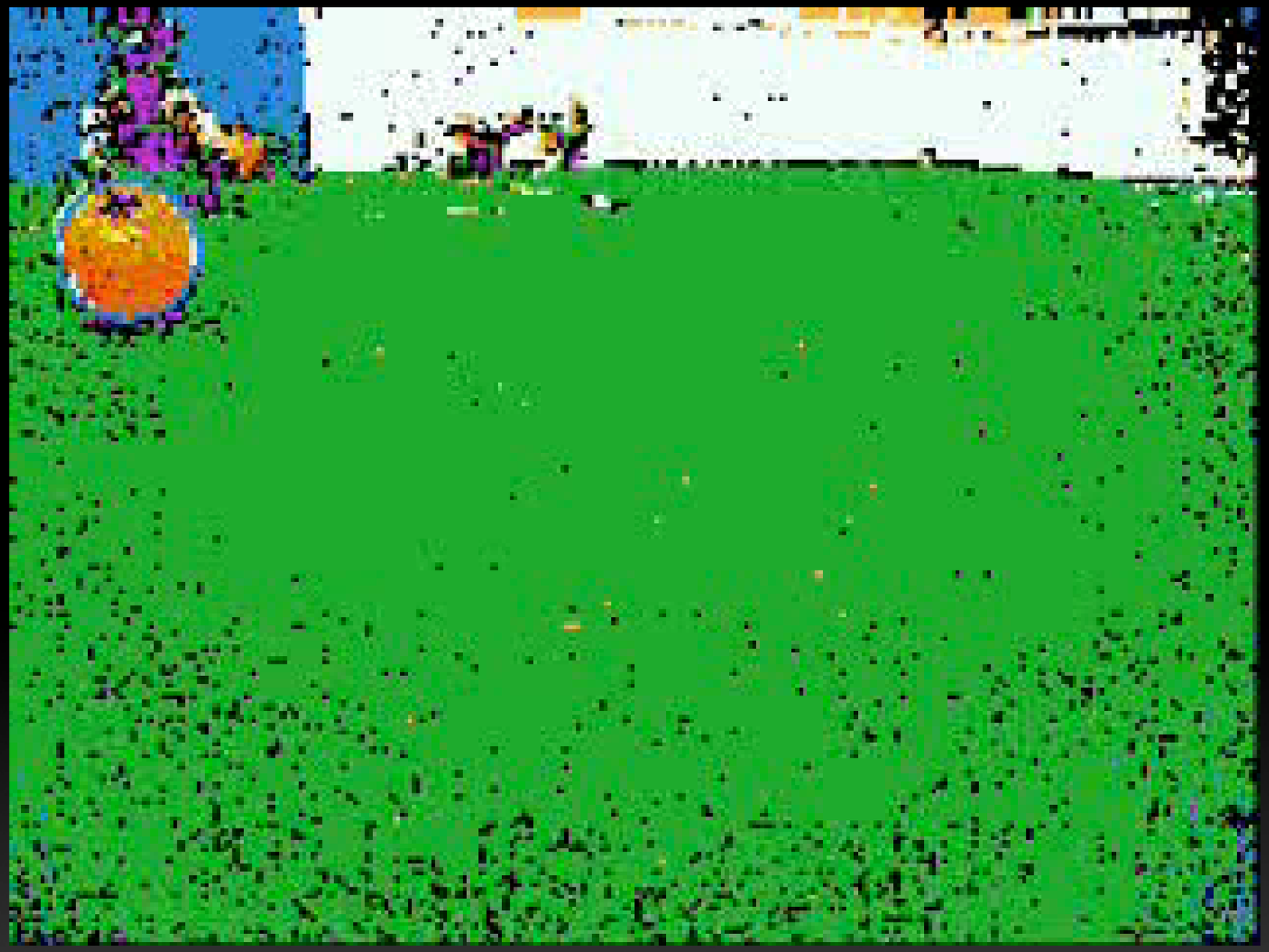
Digital Camera

AIBO Camera



What the robots see



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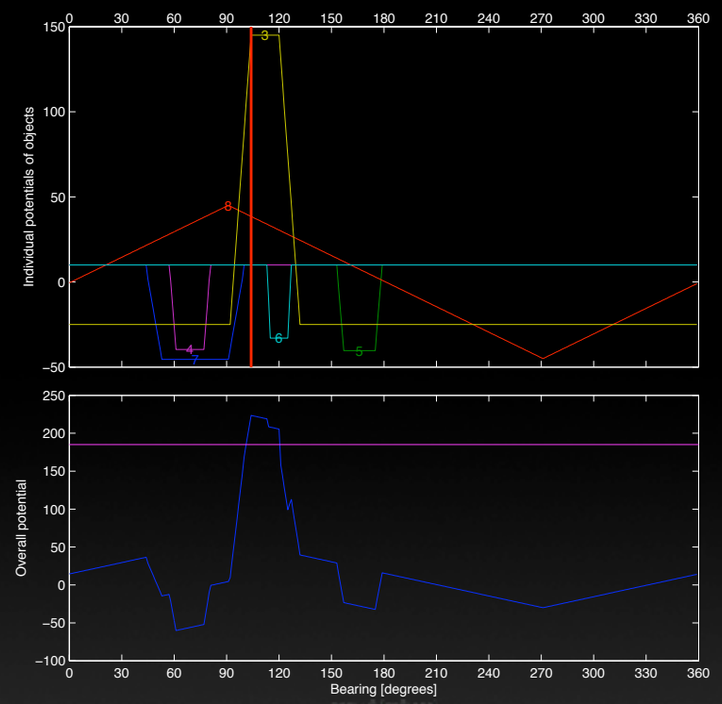

What makes a pass?

- Pass should be an overall benefit to the team

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- Receiver must not be hidden behind opponent
- Pass must go to (or in front of) receiver

What makes a good pass?

- Receiver should be clear of opponents

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- Ball should go in rough direction of goal

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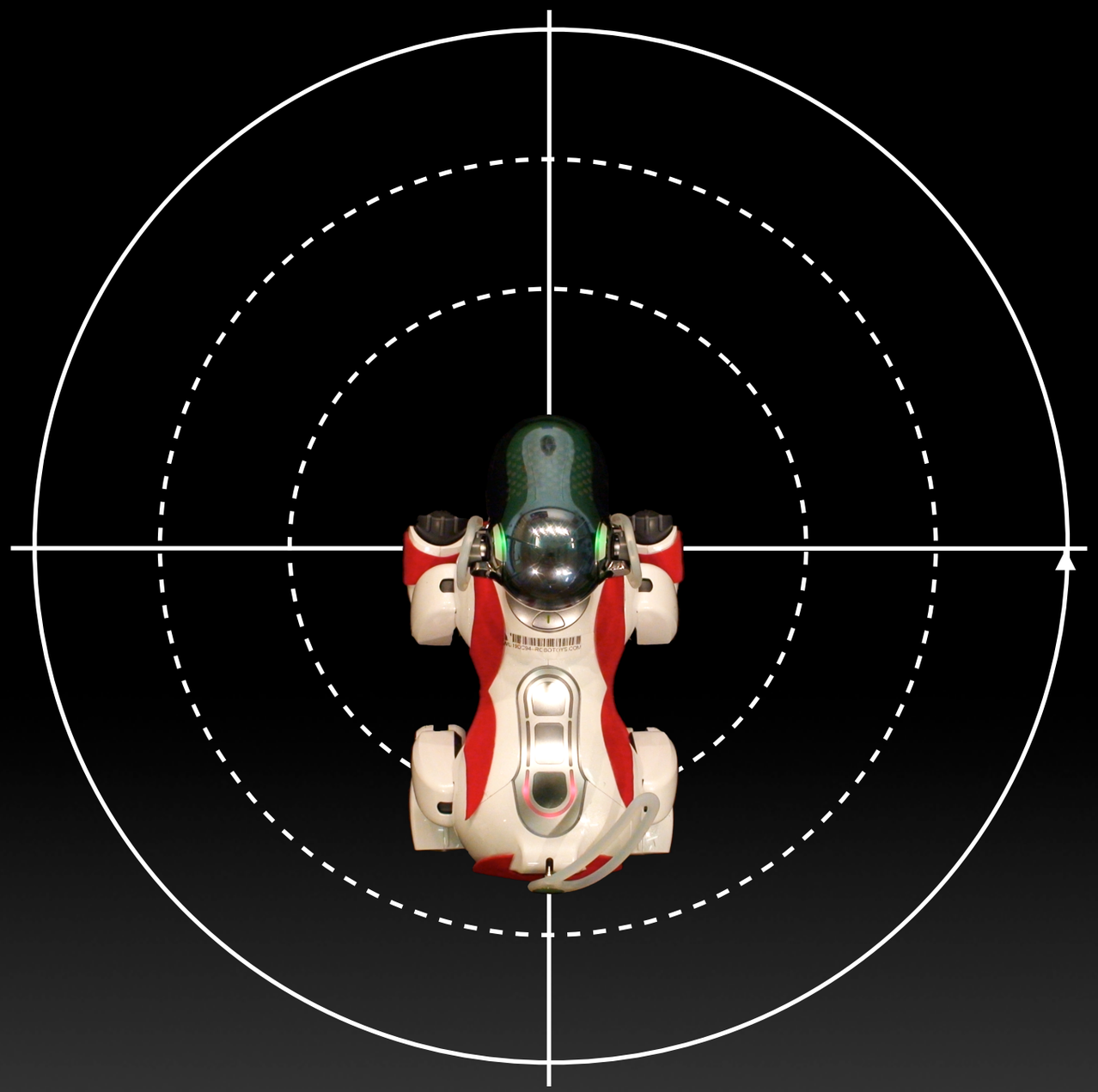
- Receiver neither too close, nor too far
- Ball should go in rough direction of goal
- Ball shouldn’t cross field in front of own goal

What direction to kick the ball in?

Potential field

Potential field



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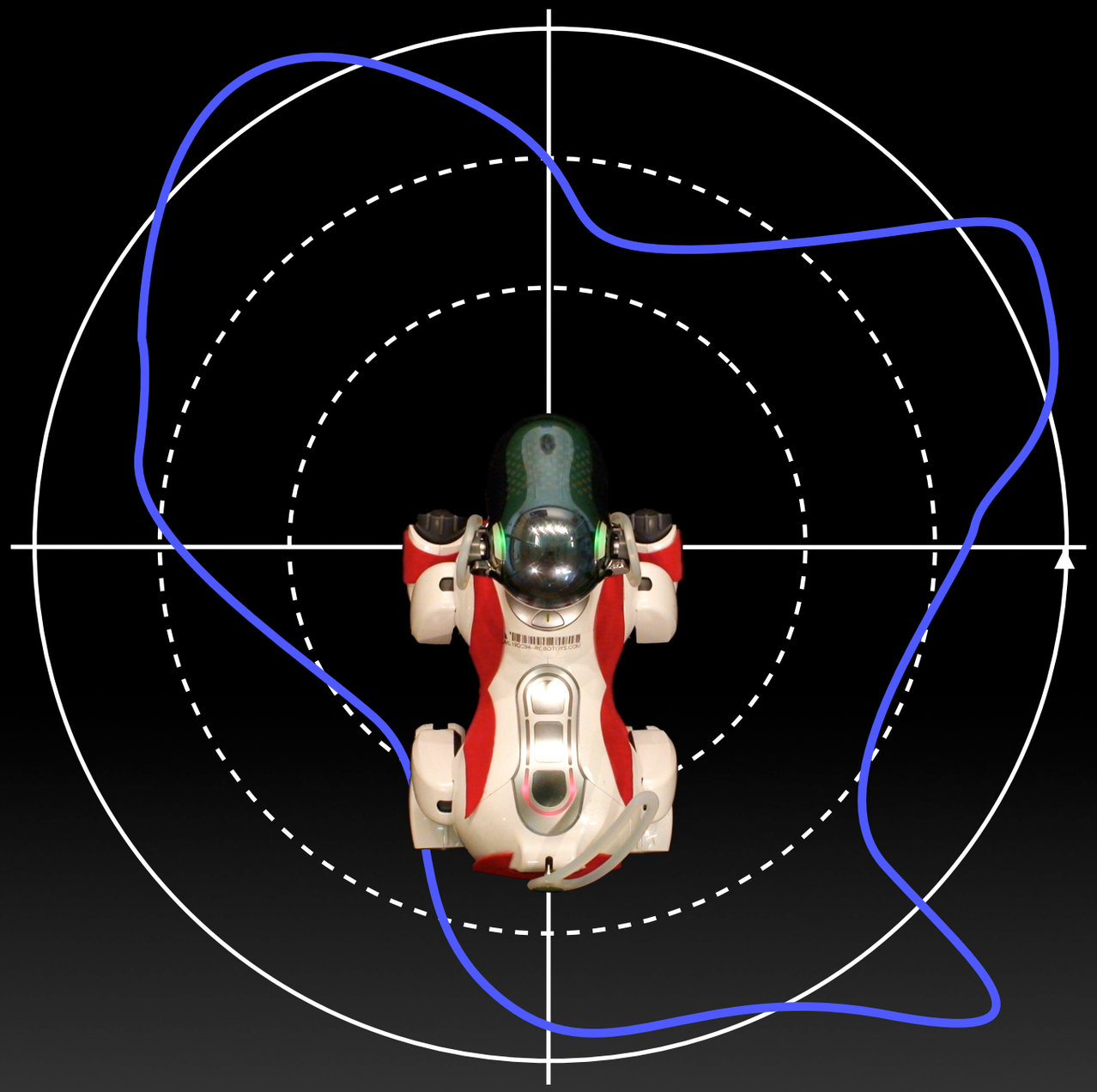

Potential field

- High potential = good direction for passing

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- Potential field: superposition of indiv. potentials

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  - Team mates

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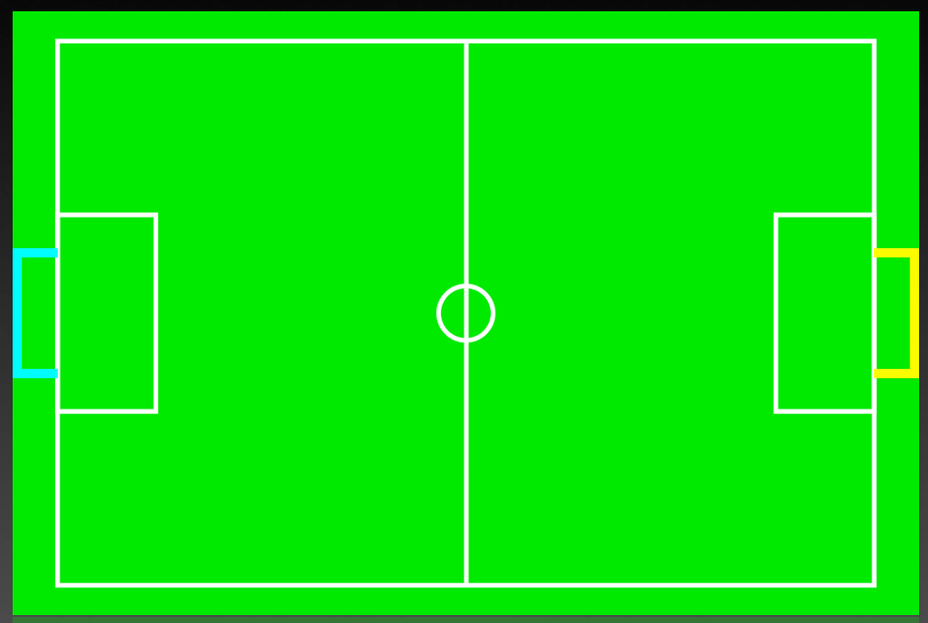

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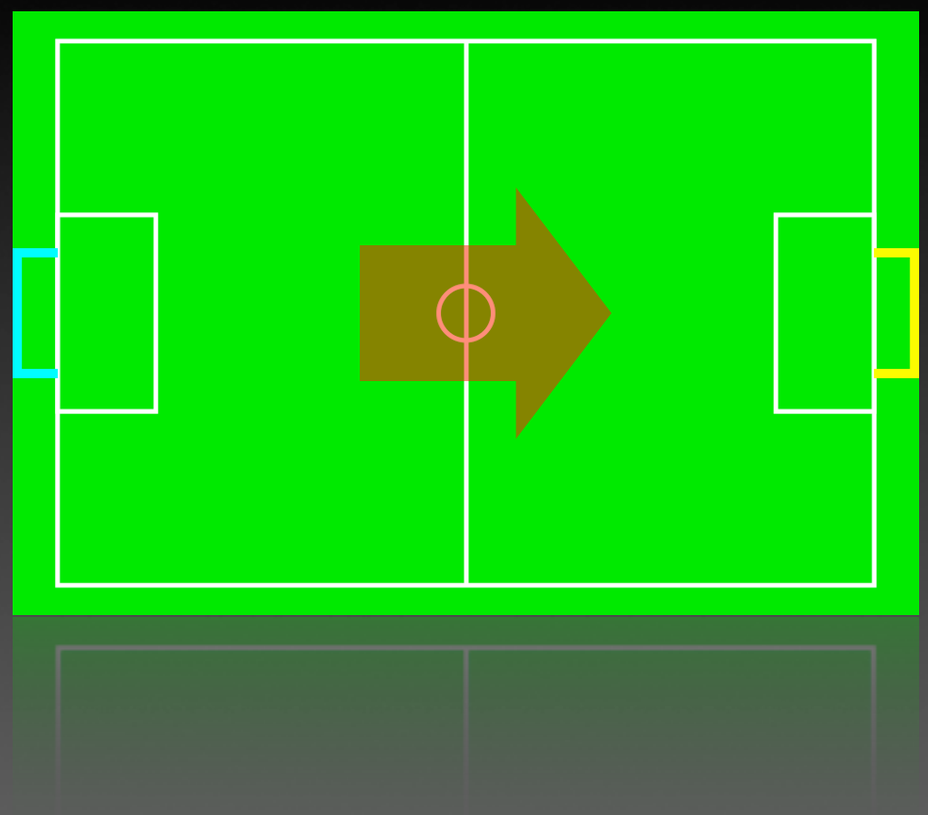

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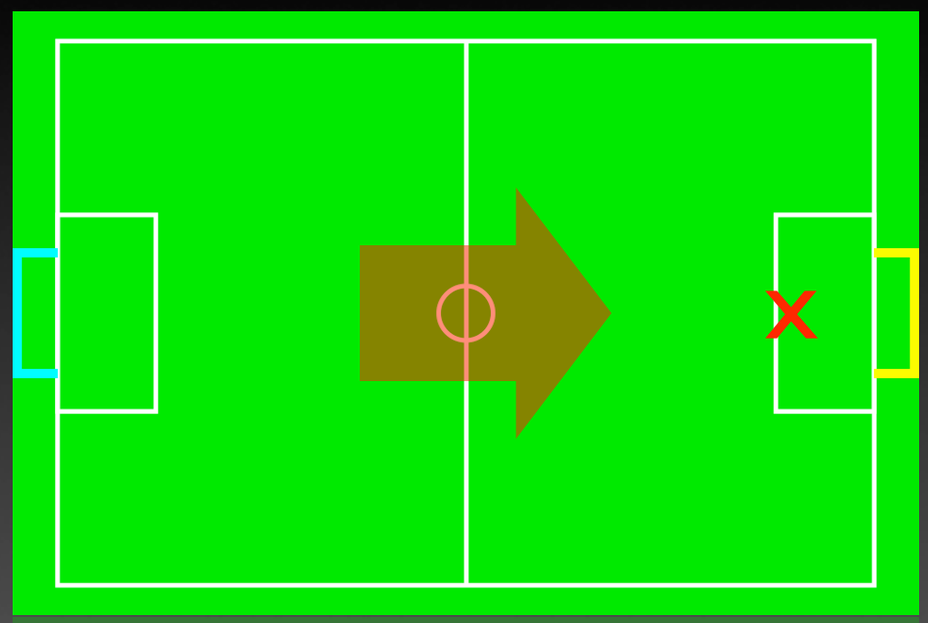
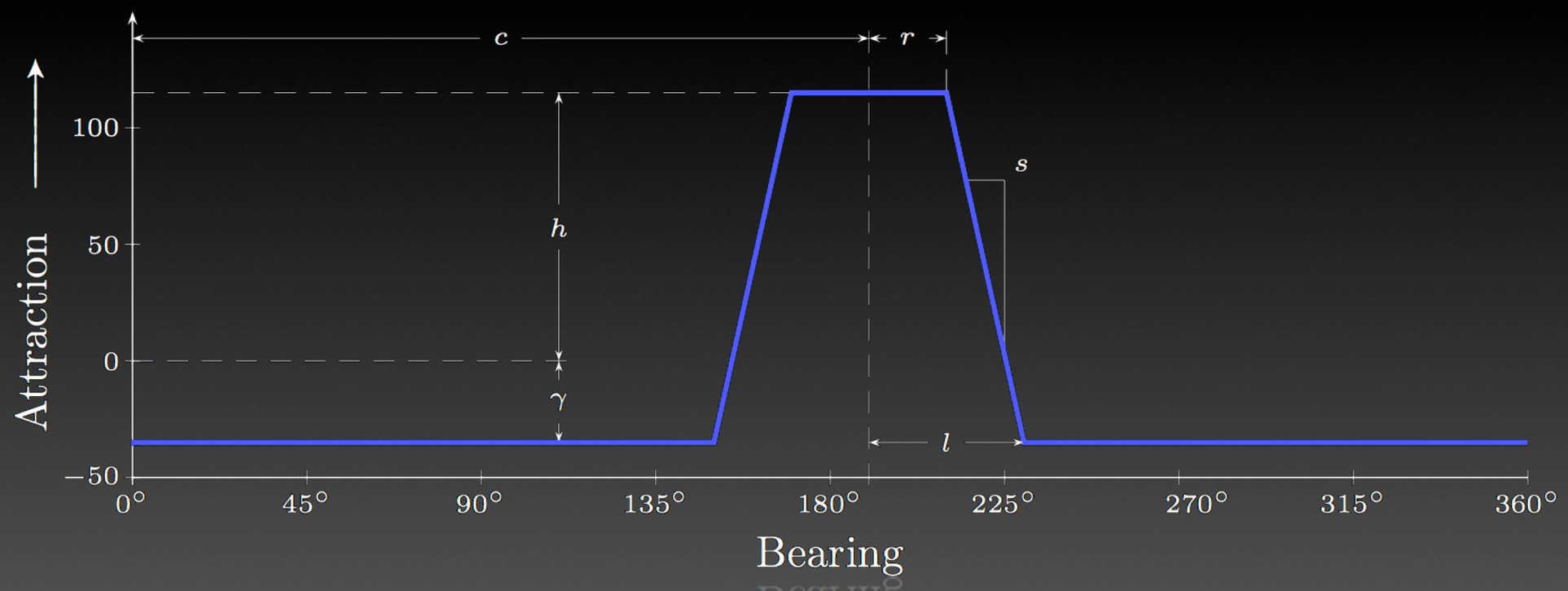
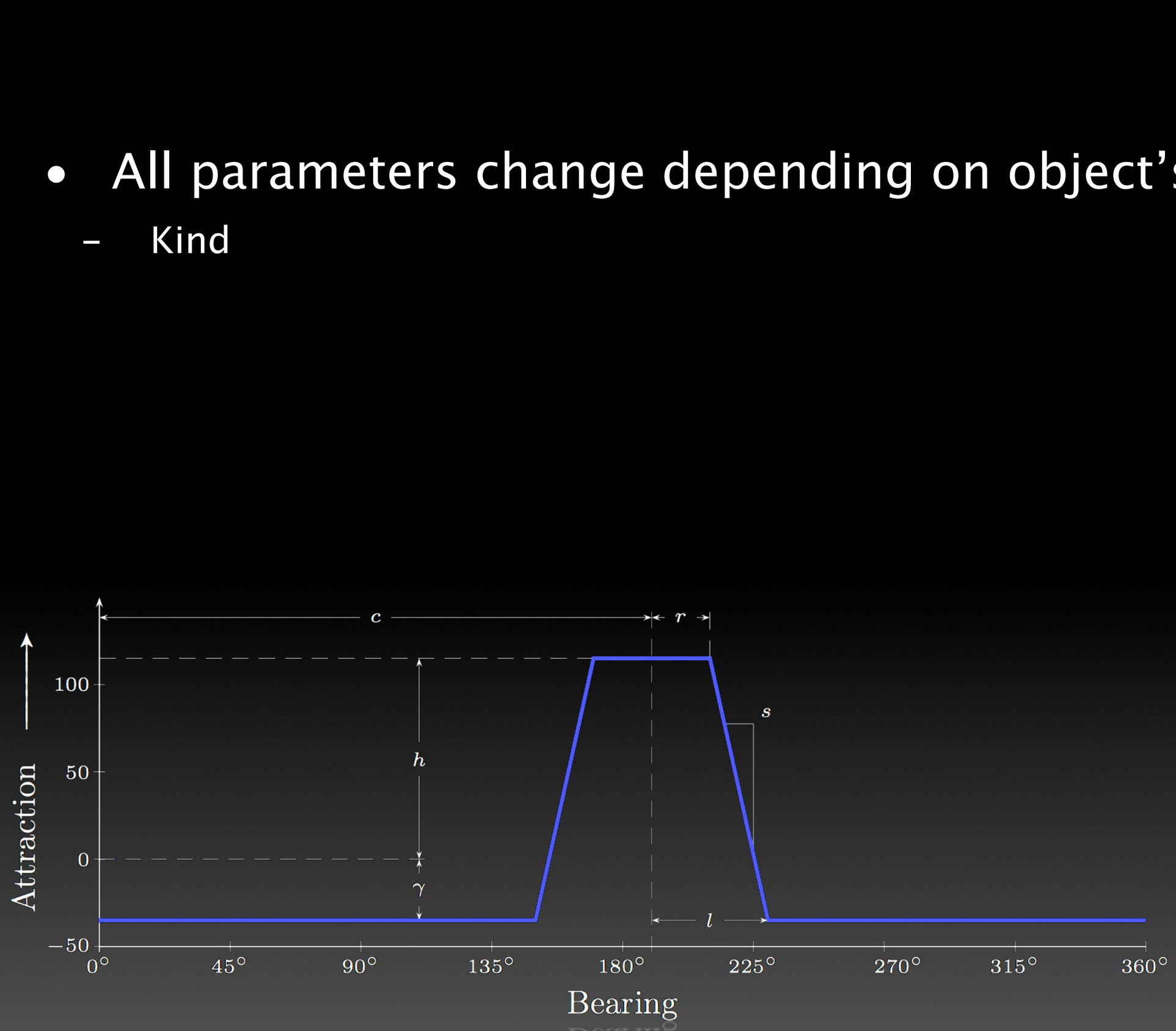


Potential created by an object

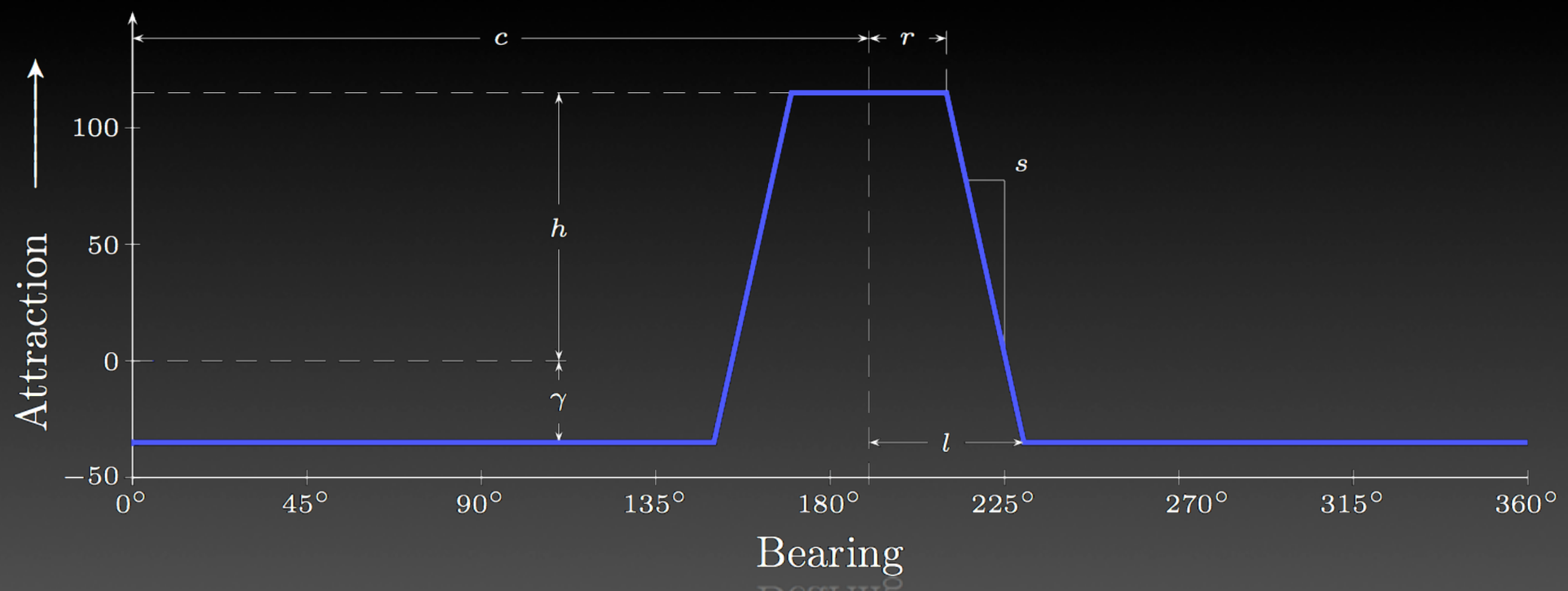
- All parameters change depending on object's



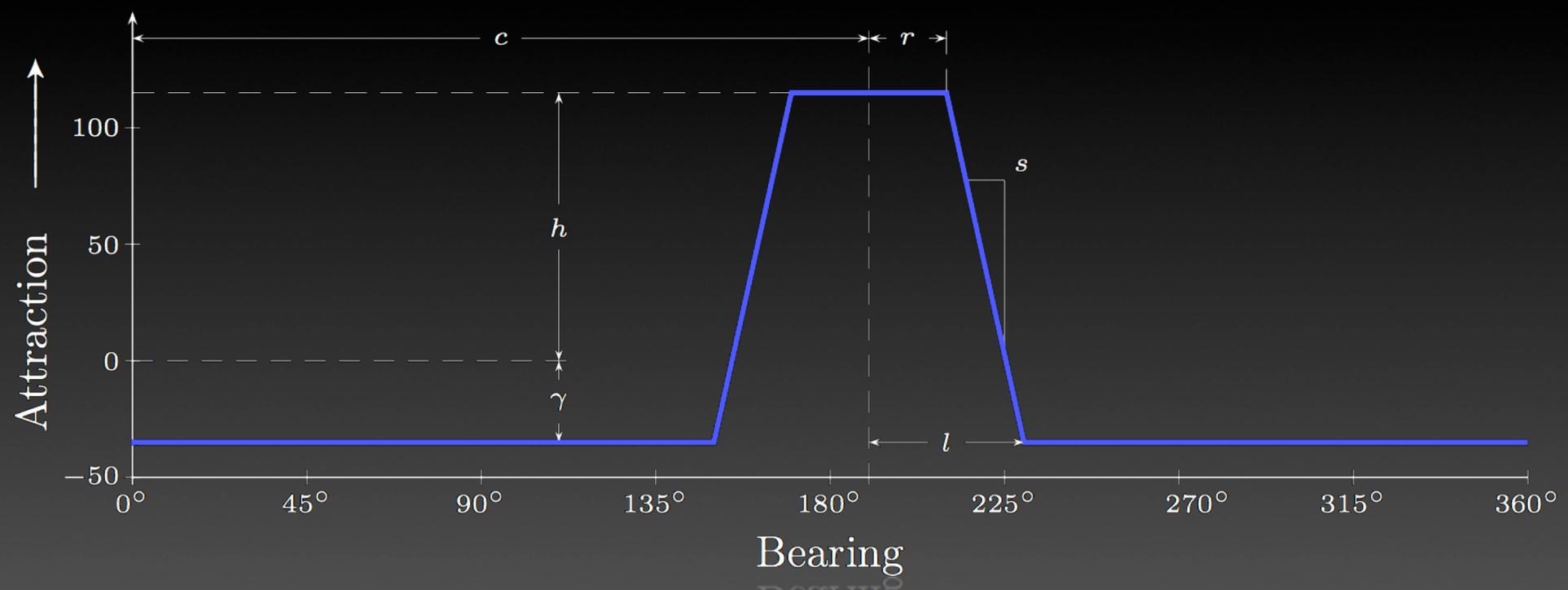
- All parameters change depending on object's
  - Kind



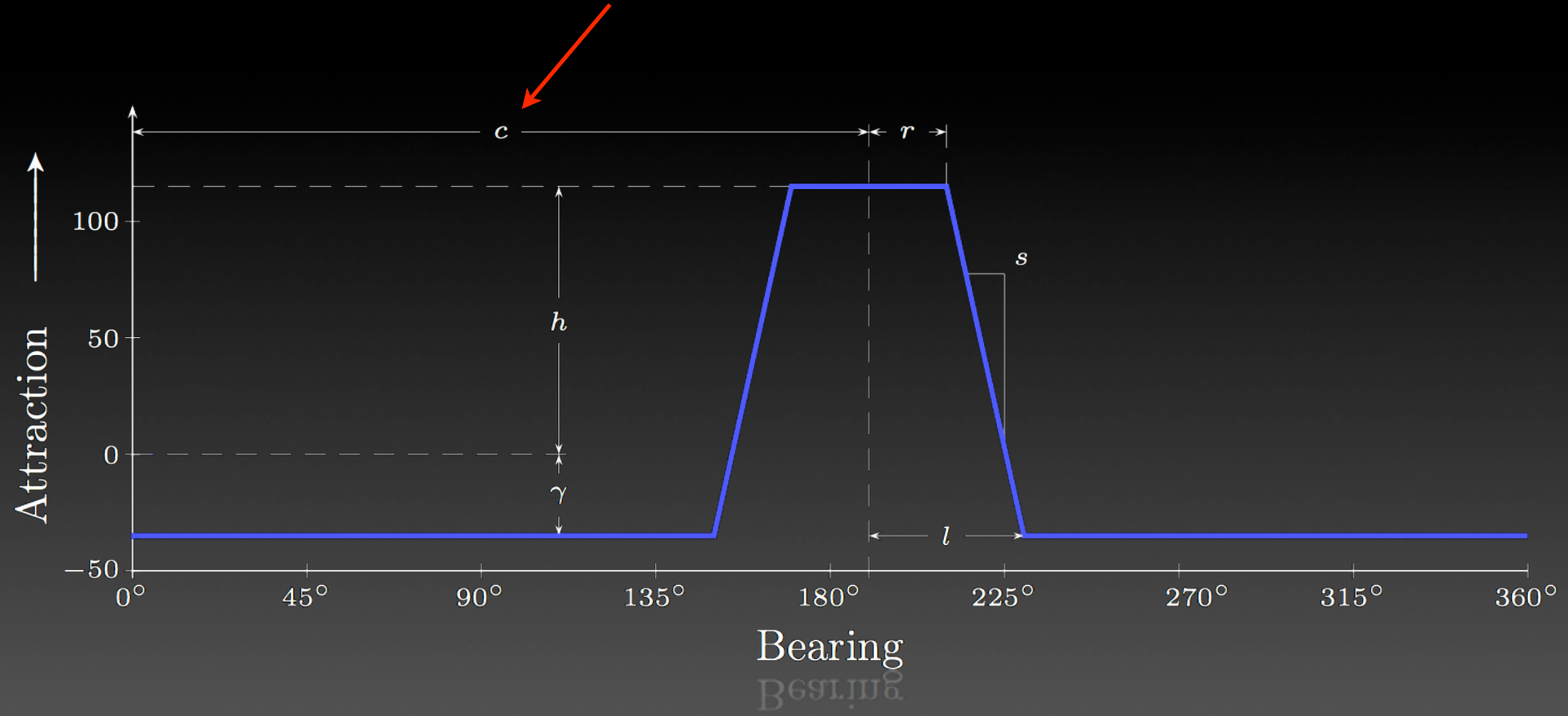
- All parameters change depending on object's
  - Kind
  - Distance



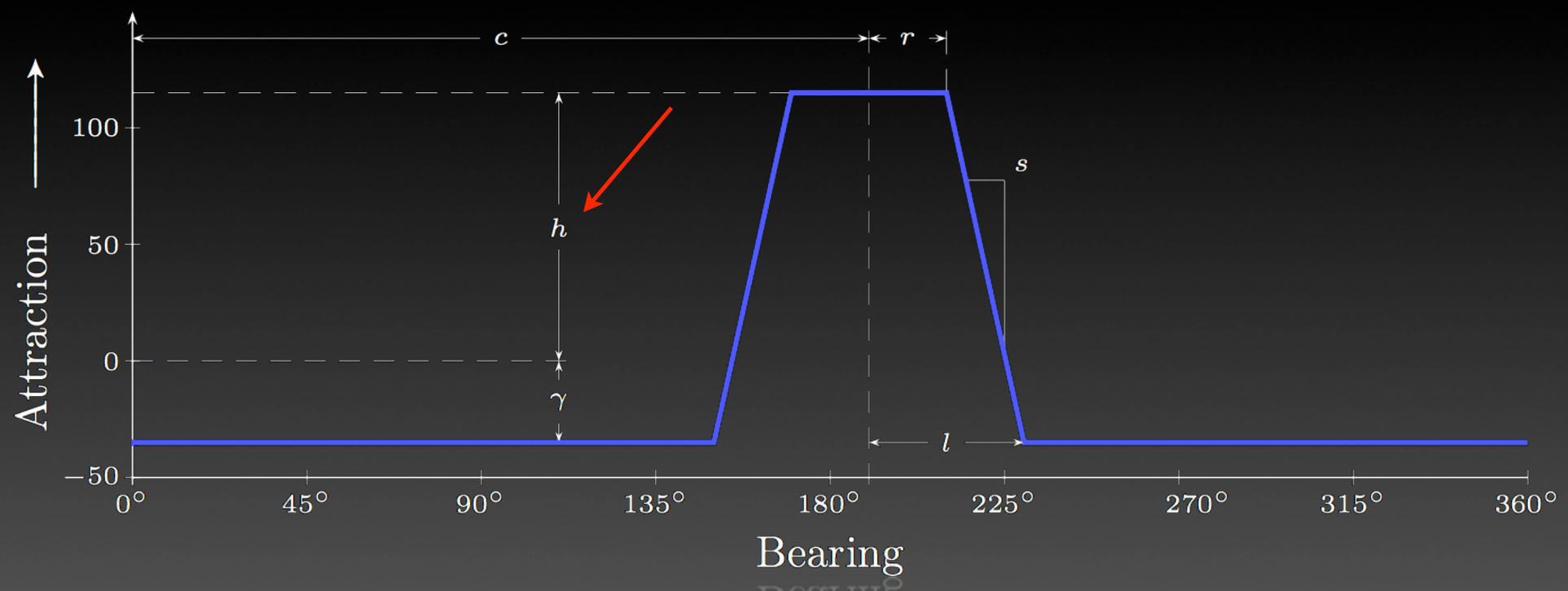
- All parameters change depending on object's
  - Kind
  - Distance
  - Bearing



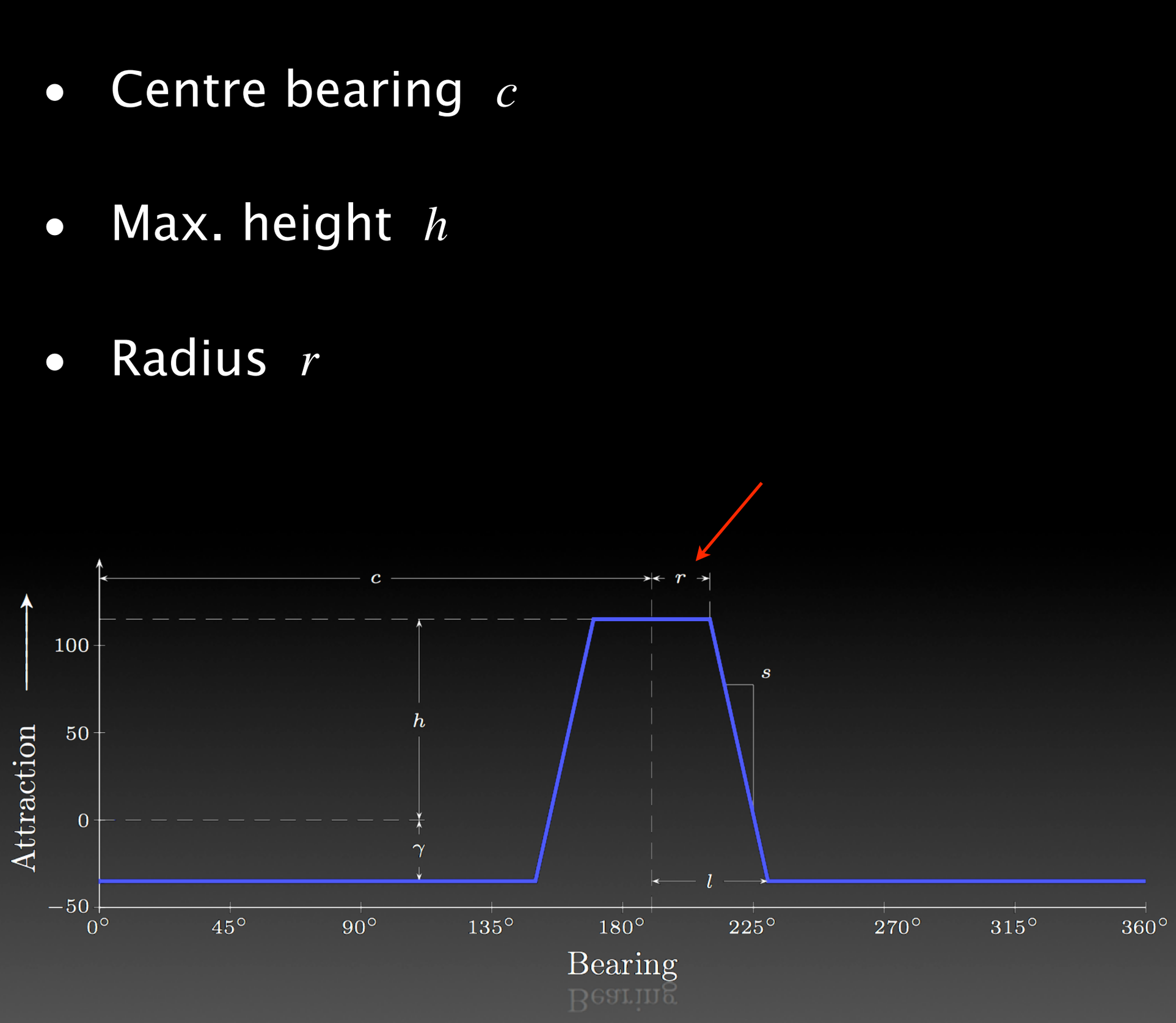
- Centre bearing c



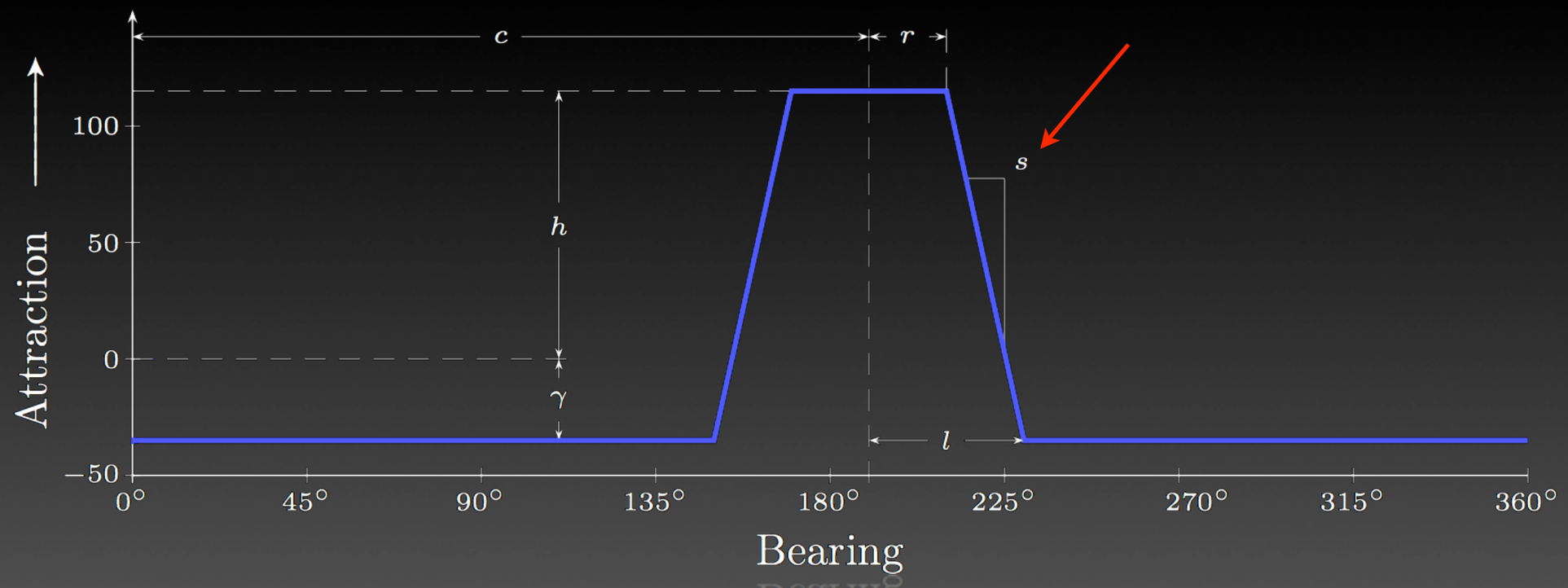
- Centre bearing c
- Max. height h



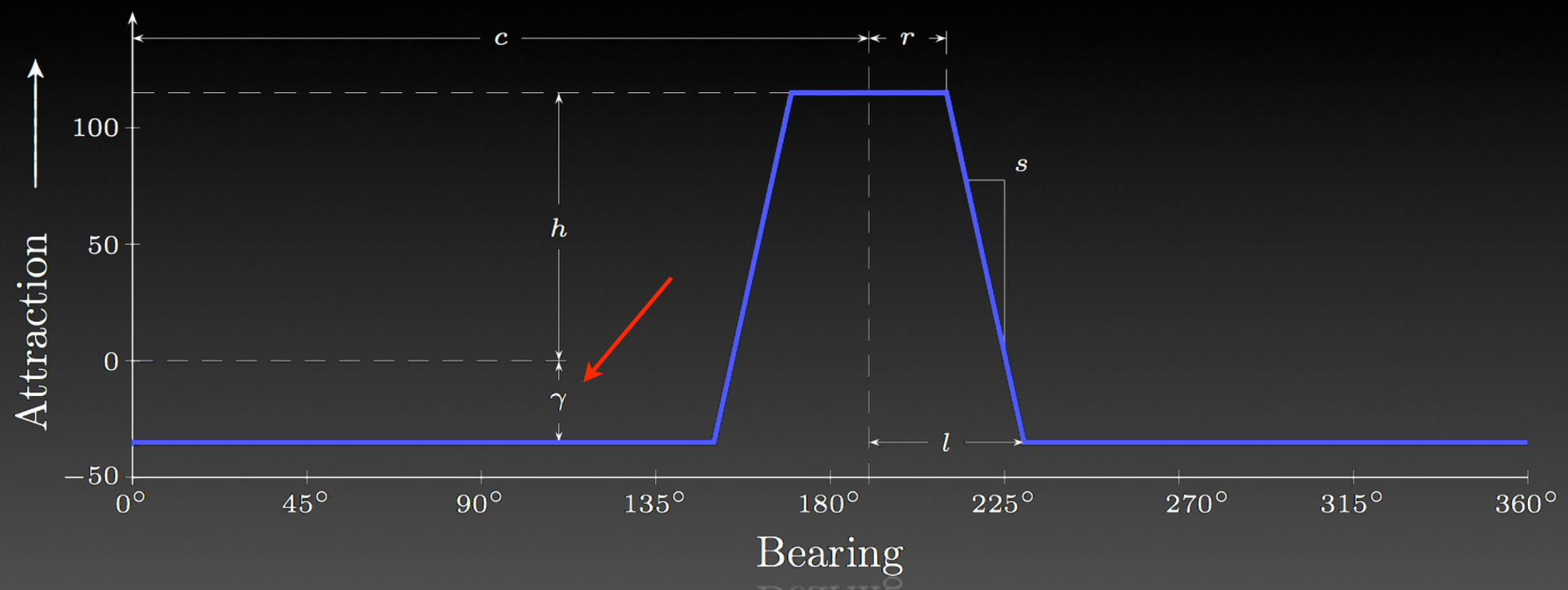
- Centre bearing c
- Max. height h
- Radius r



- Centre bearing c
- Max. height h
- Radius r
- Slope s



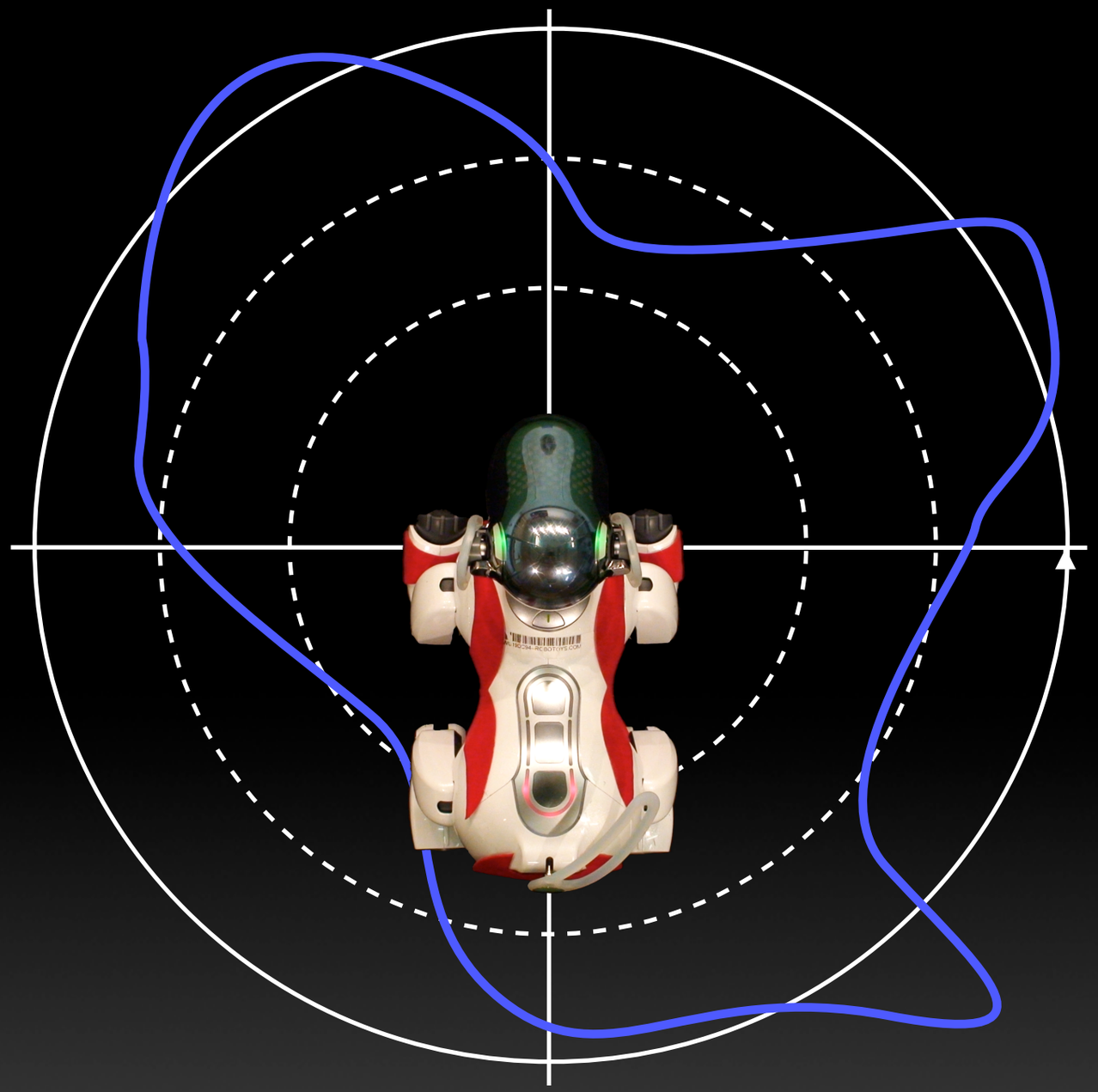
- Centre bearing c
- Max. height h
- Radius r
- Slope s
- Cut-off γ



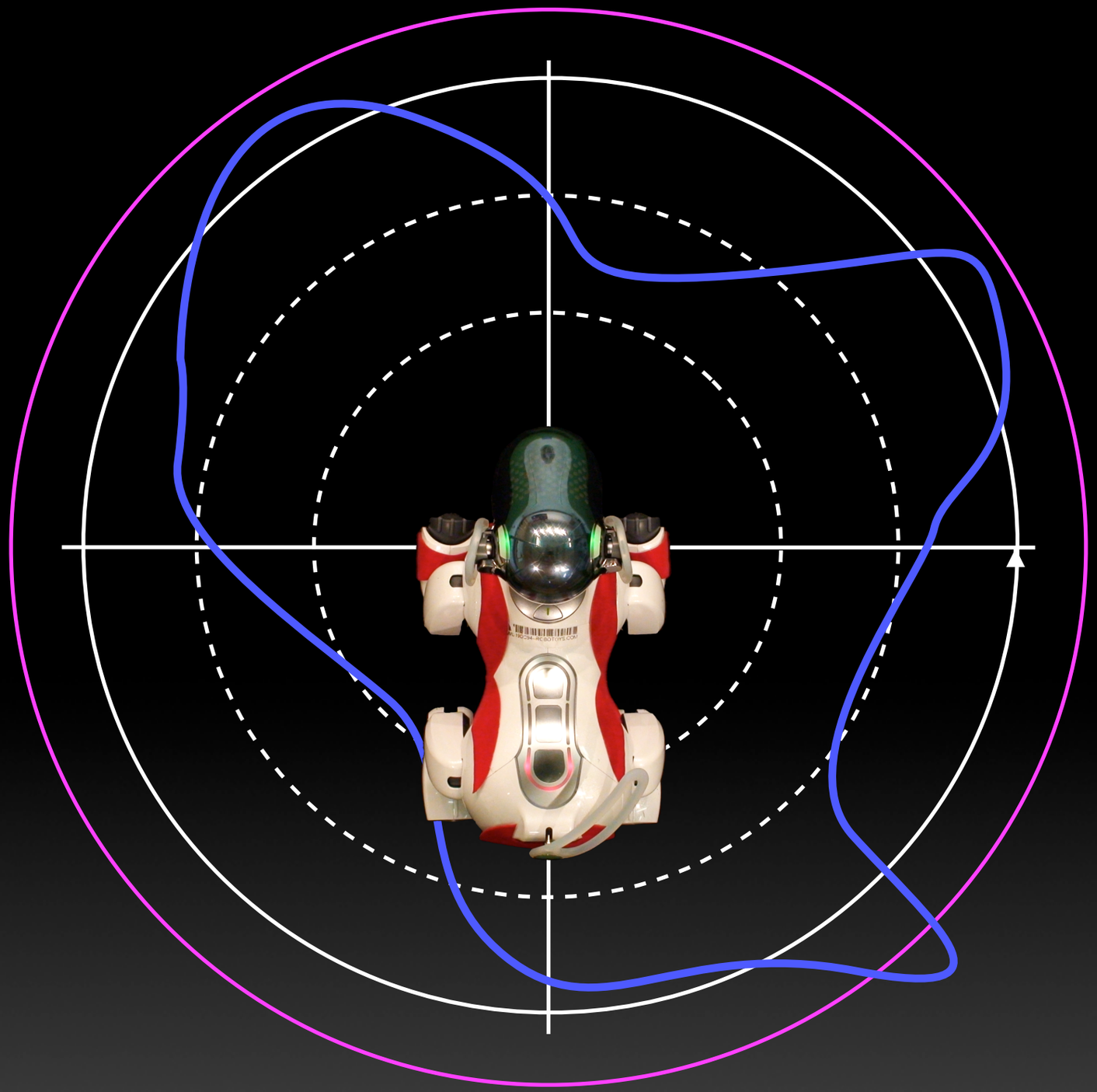
When is a pass triggered?

Potential field

Potential field



Potential field



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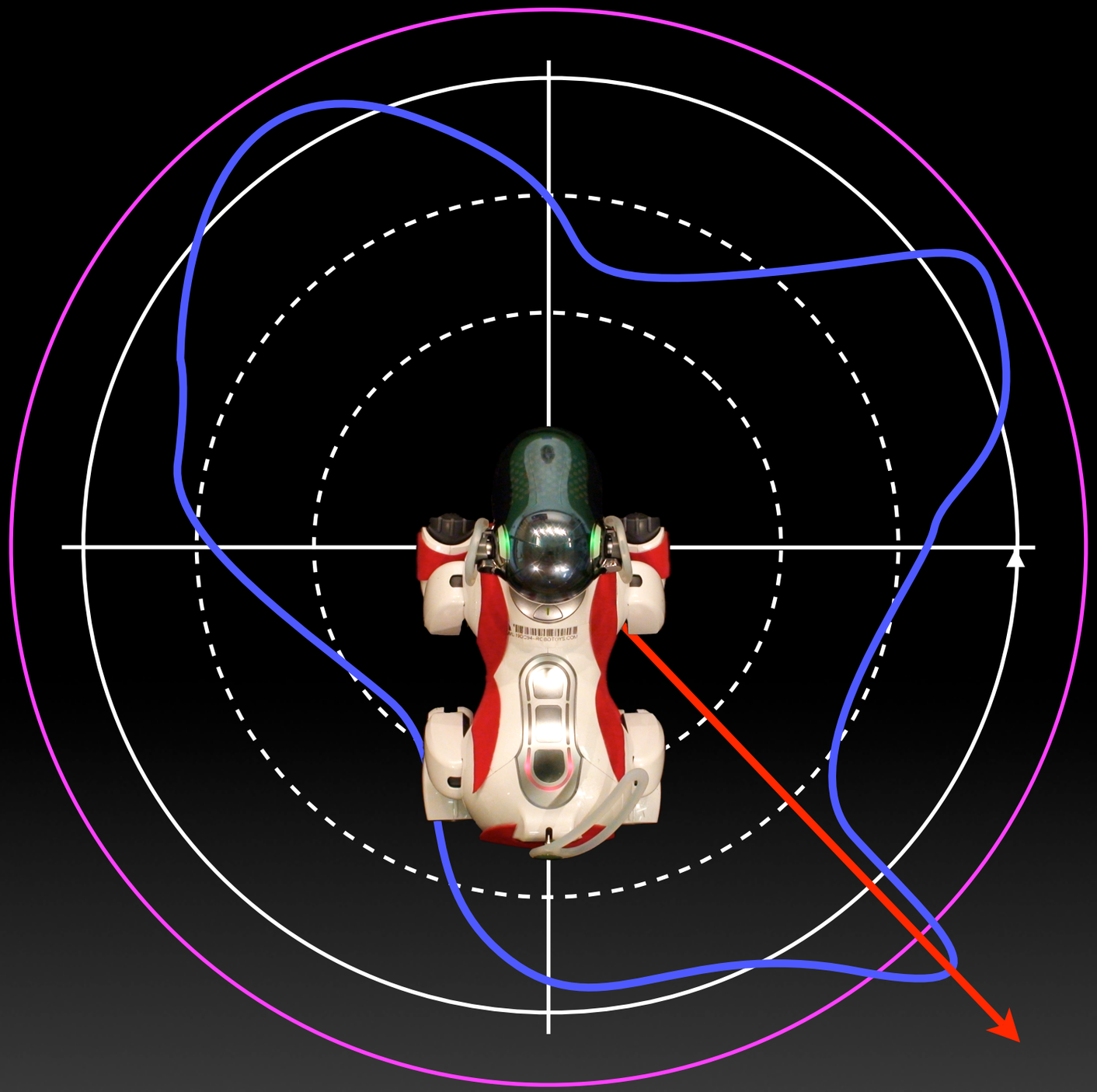

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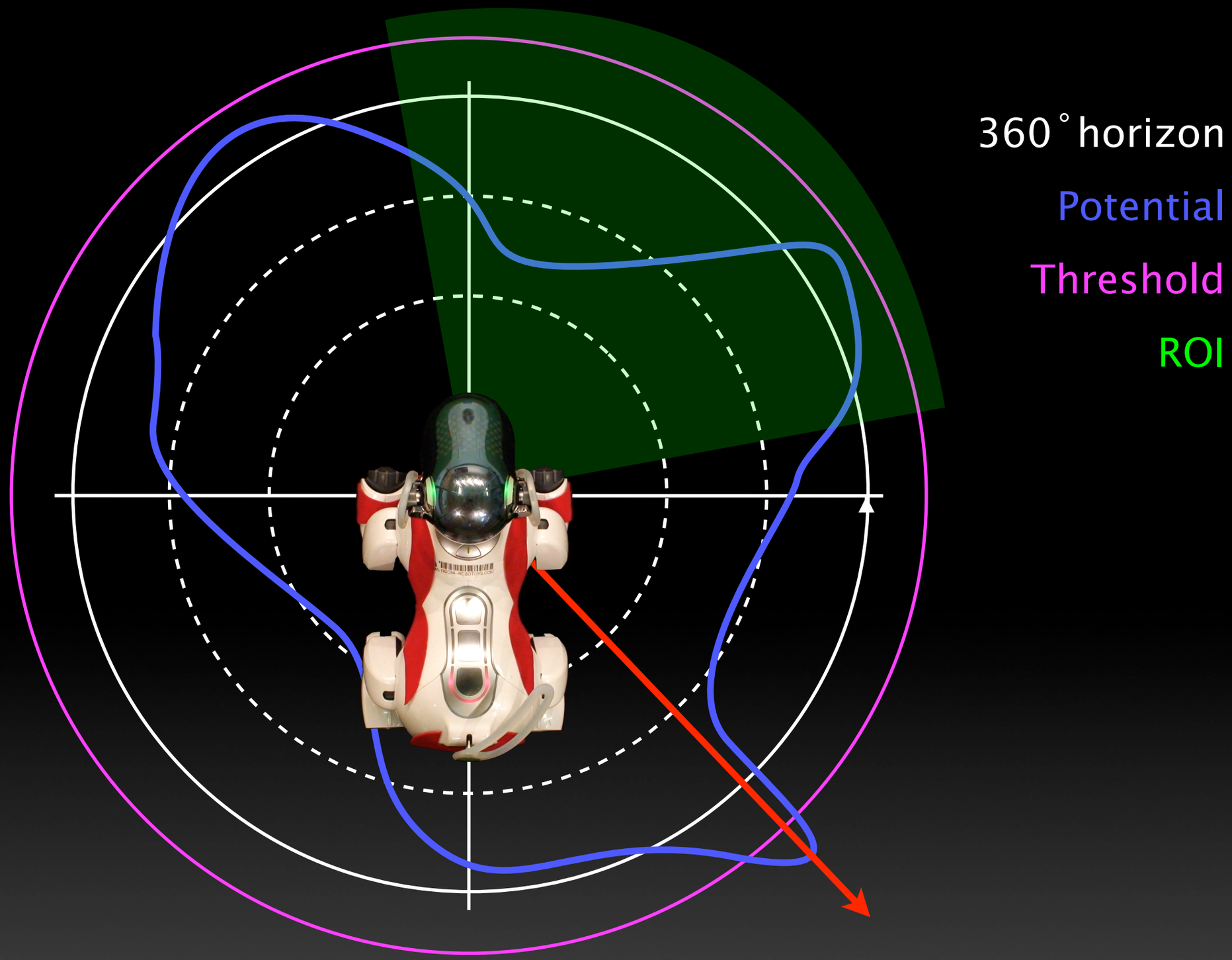

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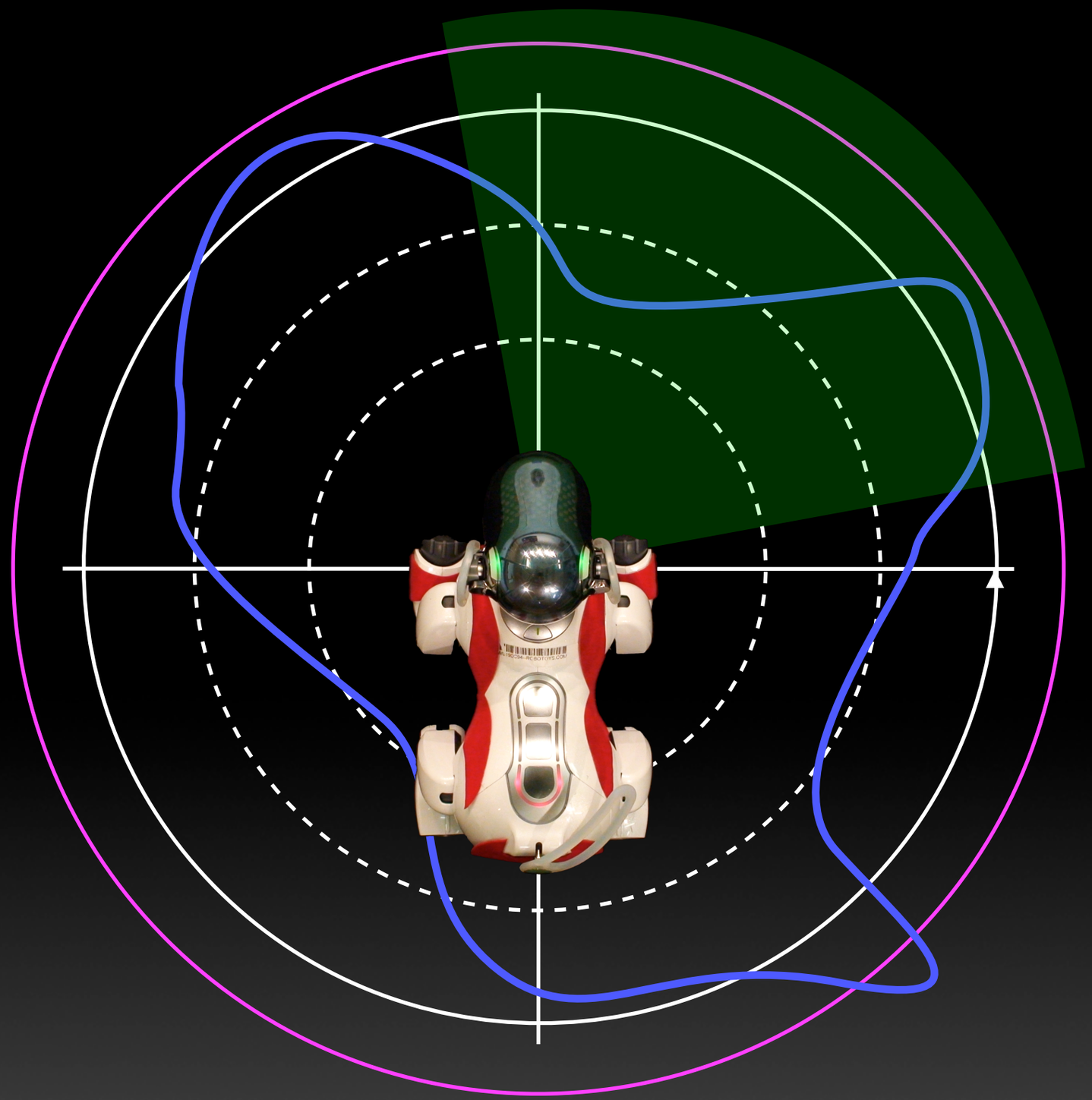
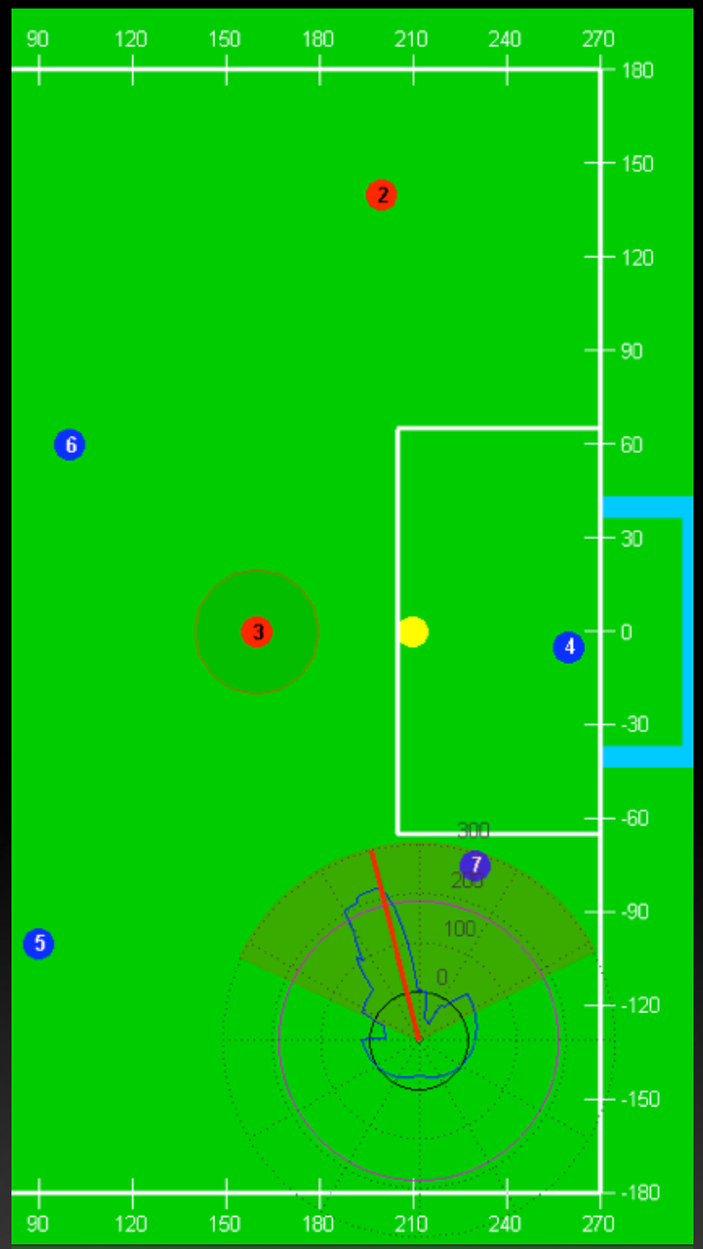


Potential field

Demonstration

Offence


90
120
150
180
210
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270
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90
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30
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-180
2
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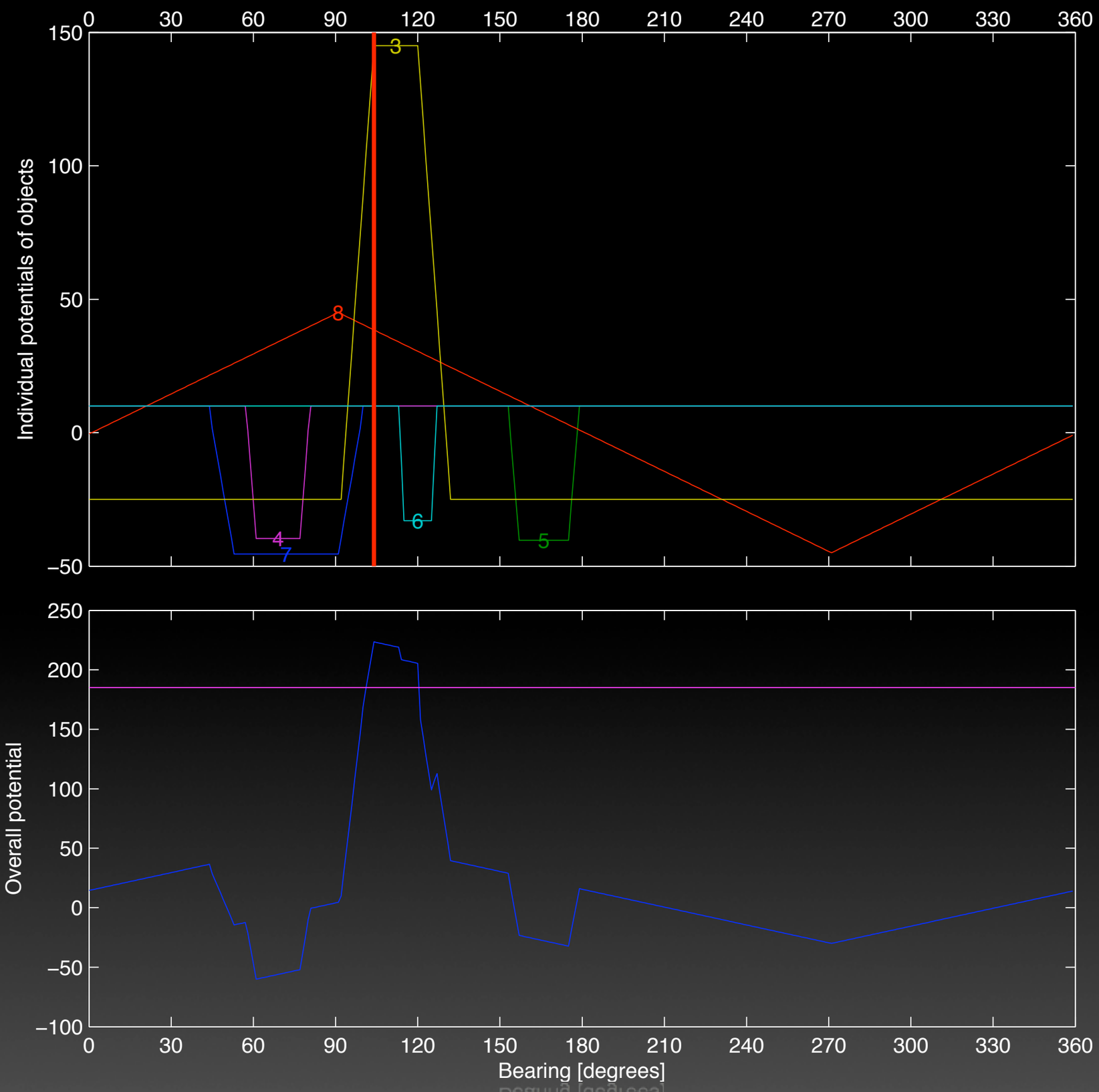
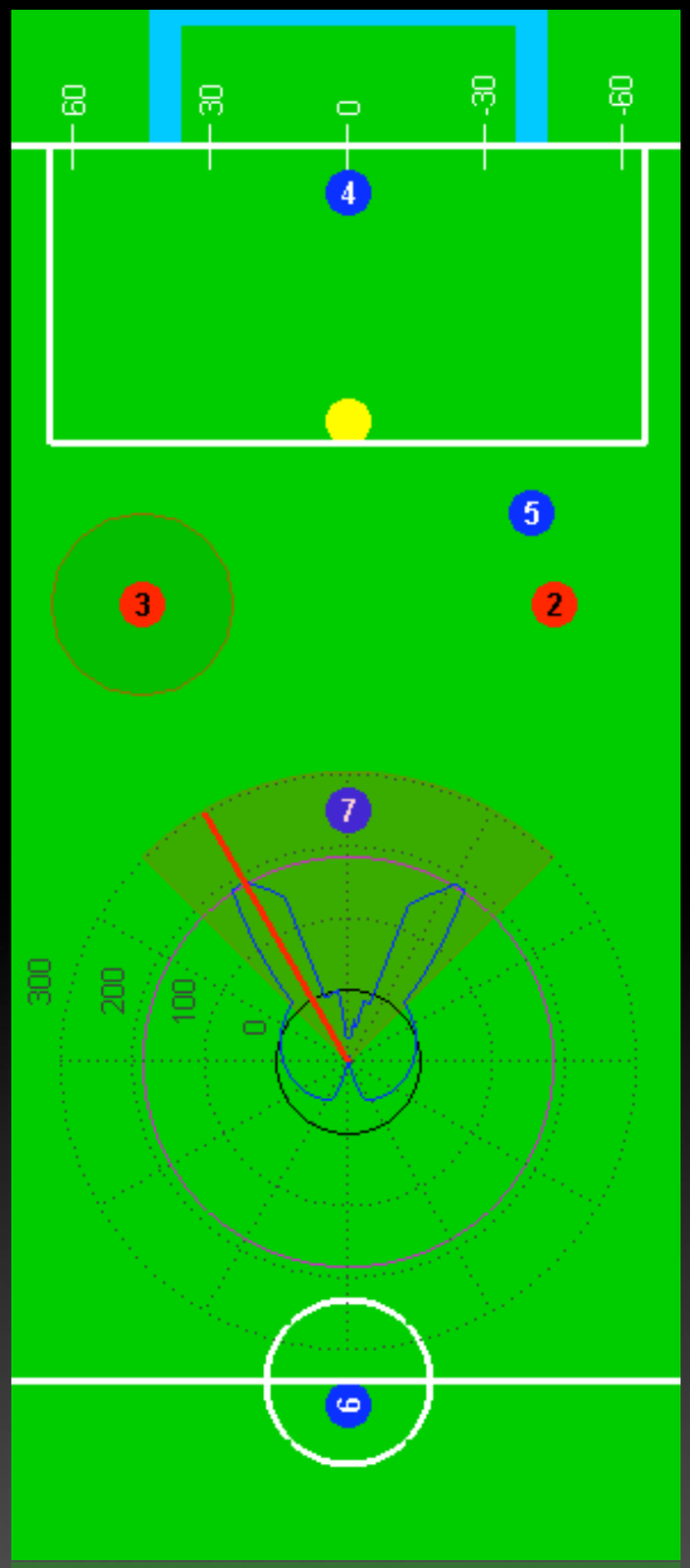
300
200
100
0


Individual potentials of objects
0
30
60
90
120
150
180
210
240
270
300
330
360
150
100
50
0
−50
3
8
6
4
7
5
Overall potential
250
200
150
100
50
0
−50
−100
Bearing [degrees]

Midfield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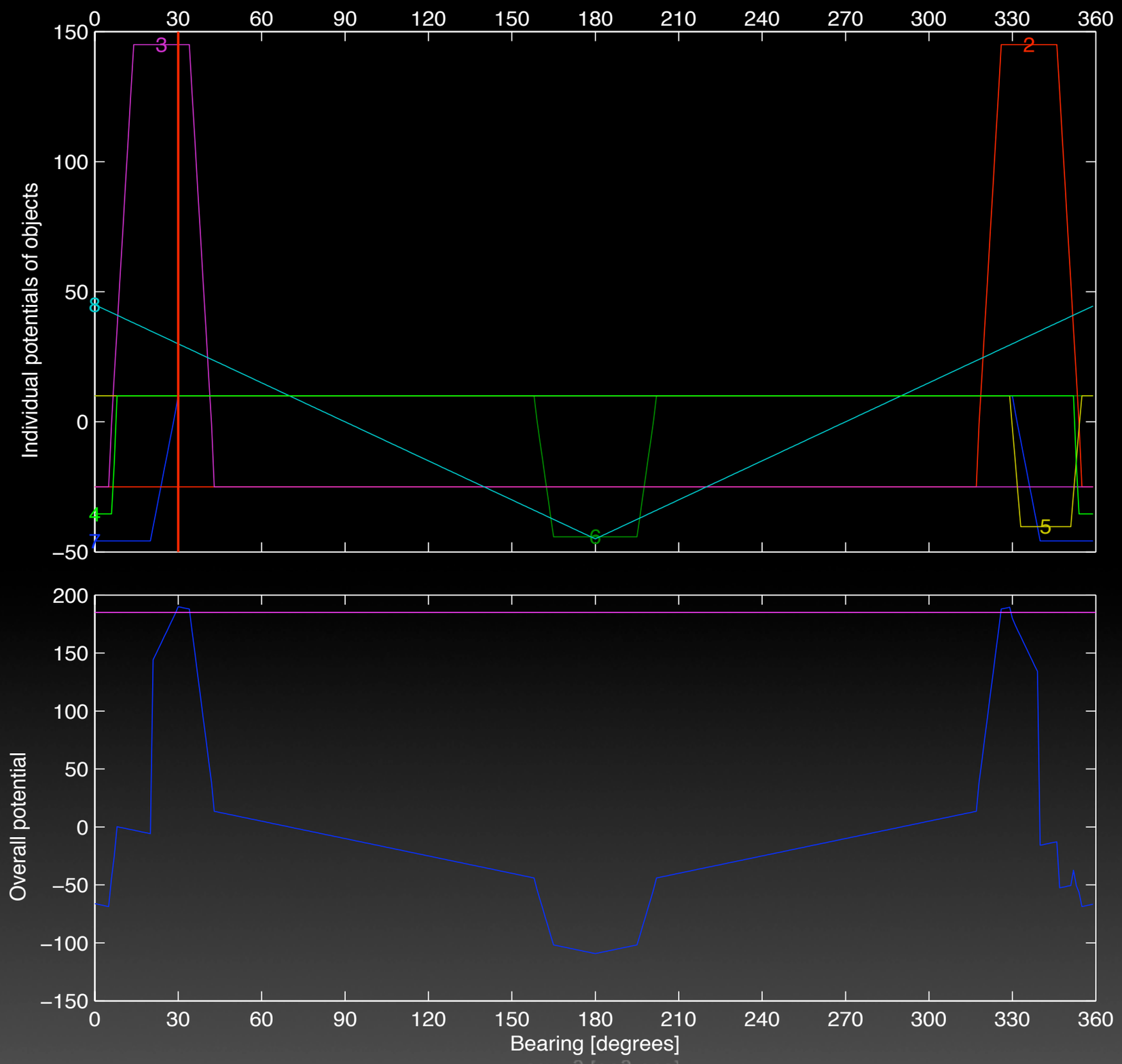
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−50
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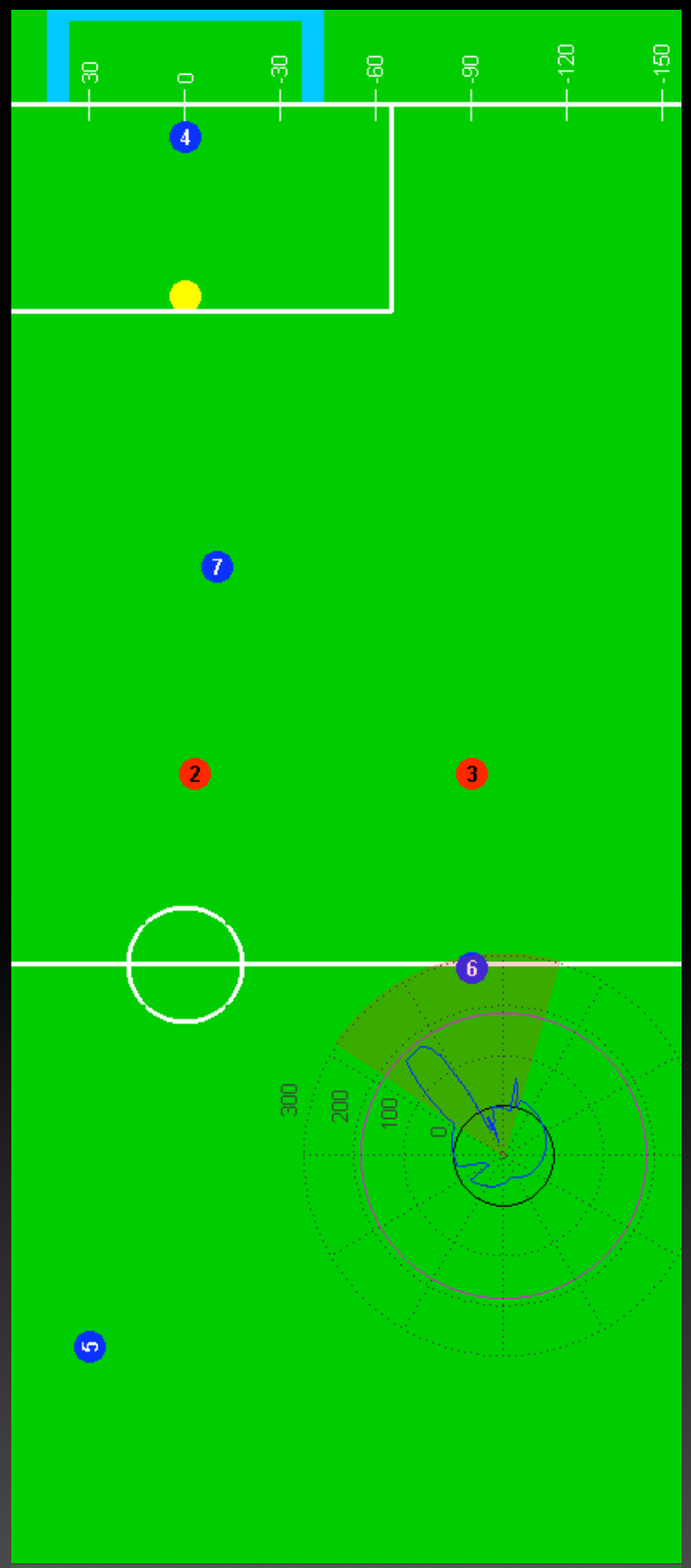
−150
Overall potential
Bearing [degrees]

No pass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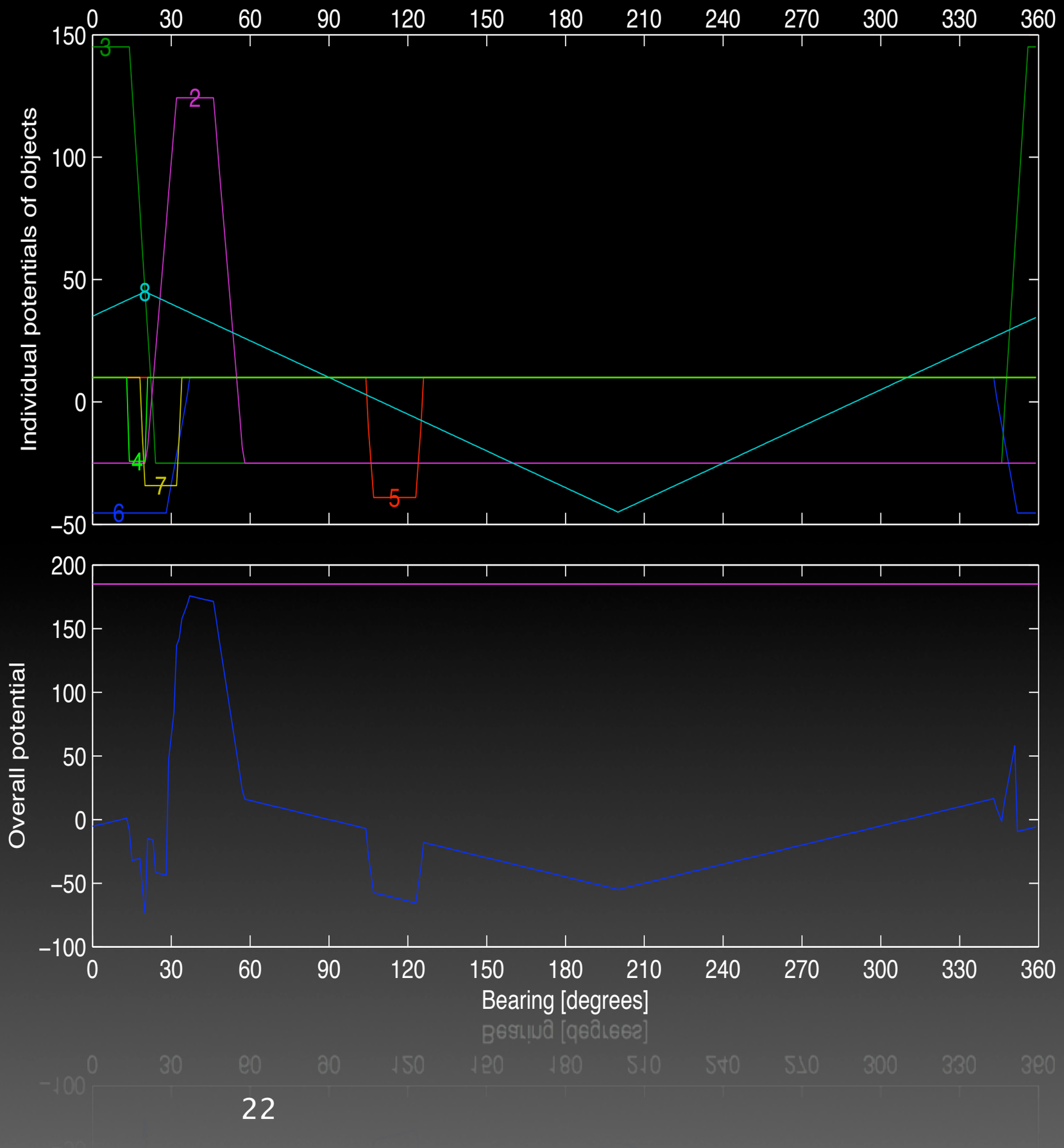
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```
# calculate pass receiver
if max_att > 0: # we found a winner

  min_d = 1000.0; receiver = -1;
  pass_range = l_mod(range(pass_ang-35,pass_ang+36

  for i in xrange(n):
    if ( team_th[i] in pass_range ) and ( team_d[i
      receiver = i

  # calculate how far the ball is to go "ahead" of
  delta_ang = modpm180(pass_ang-team_th[receiver])
  d20 = fabs(delta_ang)-20 # pass more than 20 deg
  if d20 > 0: # delta > +-20 deg
    if delta_ang > 0:
      delta_ang = 20
      pass_ang -= d20
    else:
      delta_ang = -20
      pass_ang += d20

# output and return
  print "PASS: %i deg | Q: %3.3f | ID: %i | D: %i
```

Practical problems

- Errorprone localisation

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- No information about opponents

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- No information about opponents
- Kick execution dodgy

- Errorprone localisation
- No information about opponents
- Kick execution dodgy
- Grabbing rather unreliable

Visual Feedback

- NUbot code base contains robot detection

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  ➡ **Visually** lign up shot

- NUbot code base contains robot detection
  - ➡ **Visually** lign up shot
- Only works on red robots

- NUbot code base contains robot detection
  - ➡ **Visually** lign up shot
- Only works on red robots
- Large & bright red patch must be visible

Cooperation

sender – receiver

- Receiver: stay put & turn sideways for better visibility

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- Sender: line up & report when kicked

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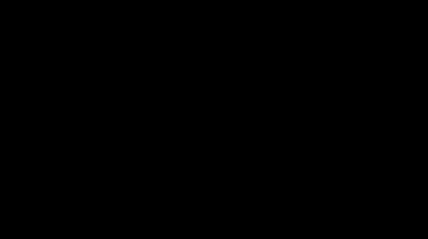
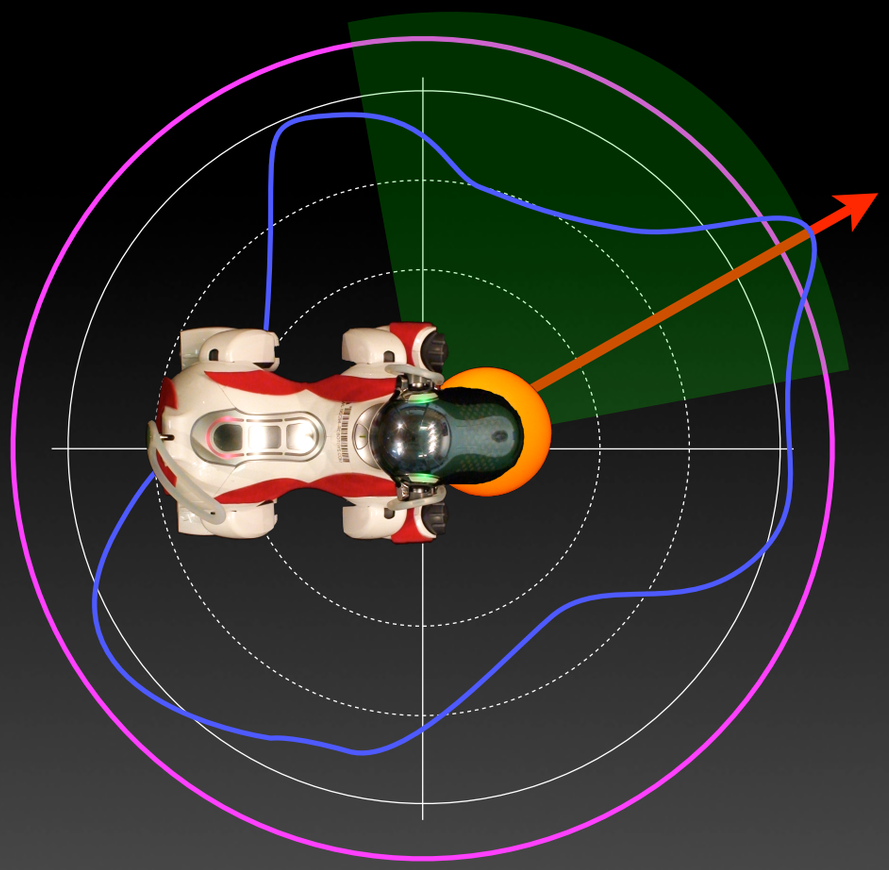
- Sender: line up & report when kicked
- Receiver: update Kalman filter & chase ball

Typical course of action



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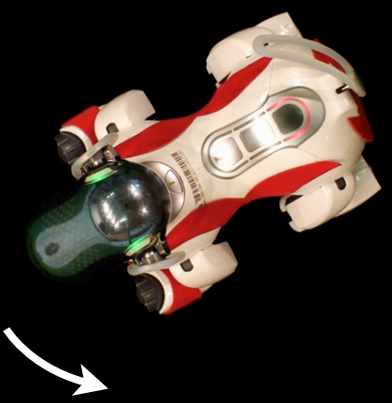

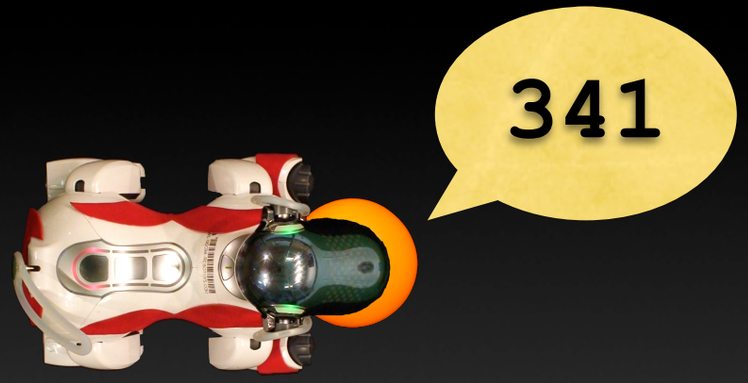
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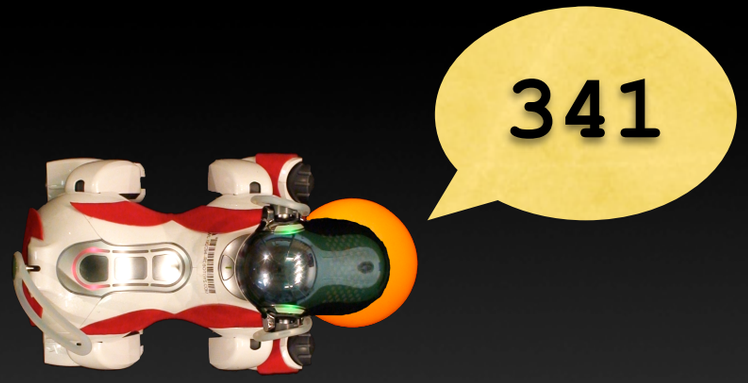
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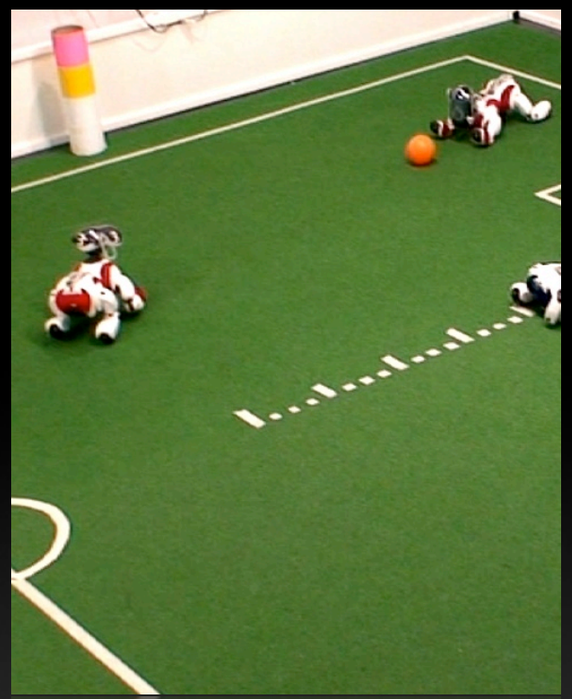
1. Outlines and Objectives

2. Introduction to the NUbots

3. Passing algorithm design

4. Implementation

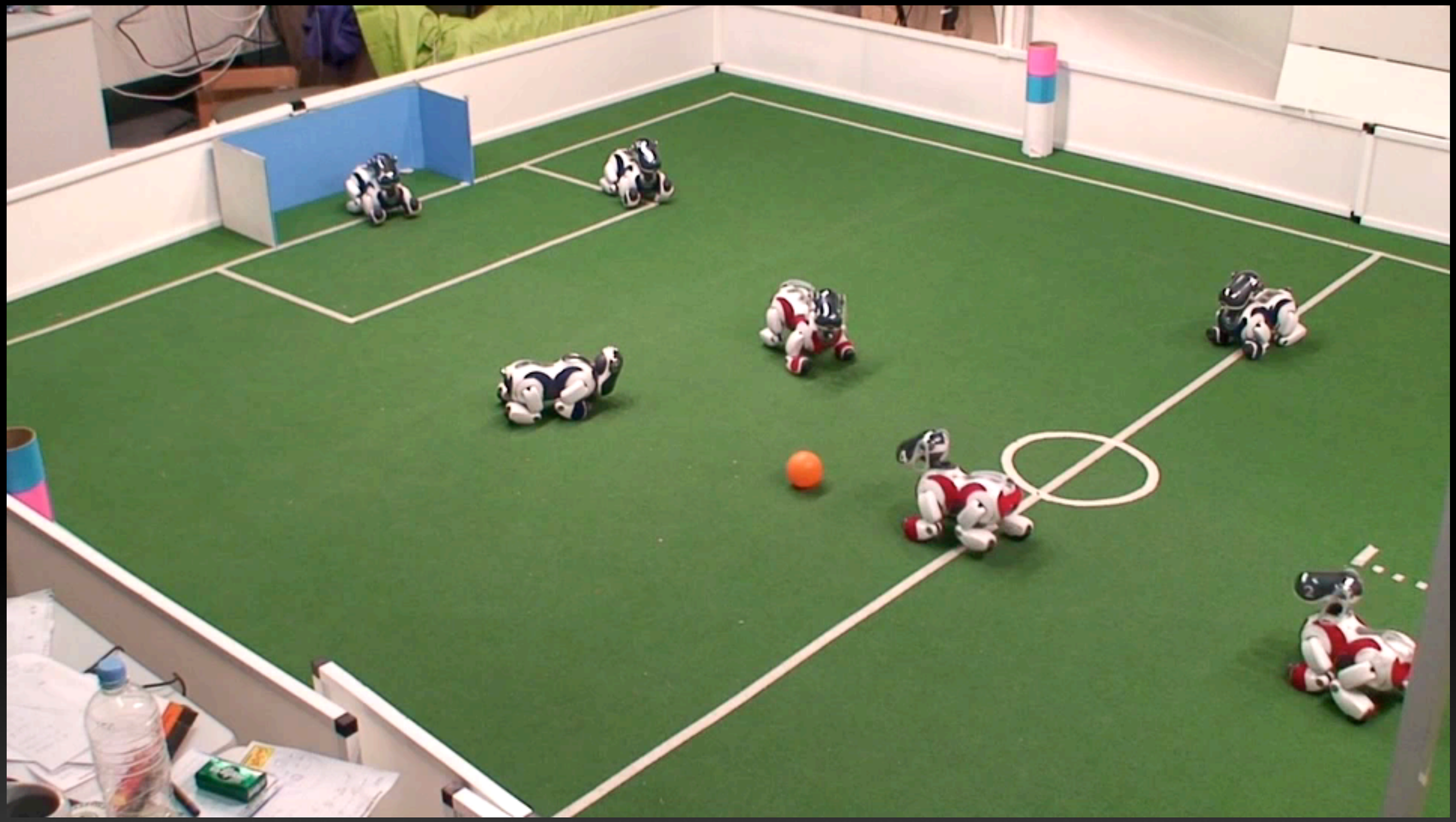
5. Demonstration and conclusion



Bad localisation

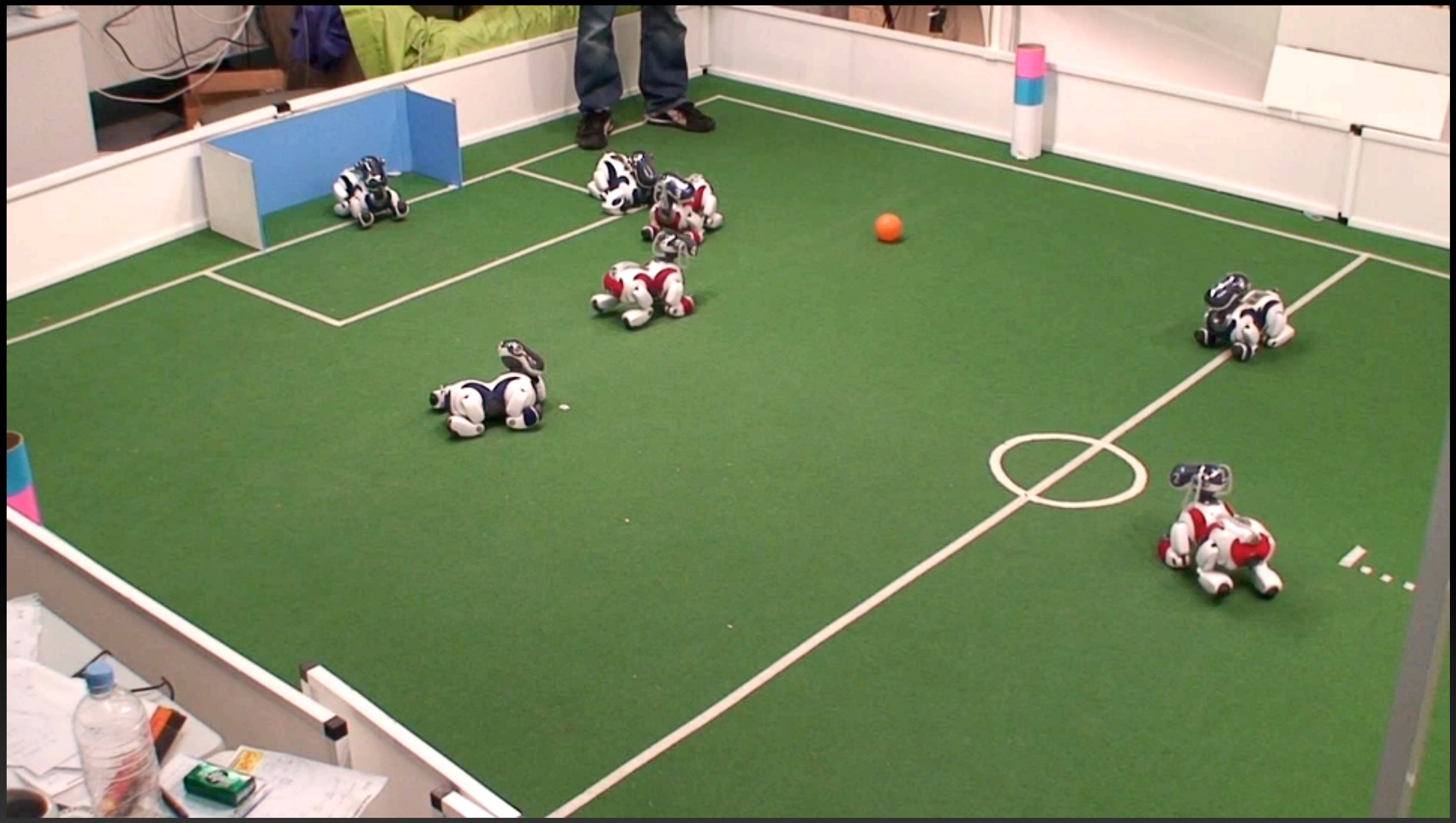
Bad localisation

Direct pass



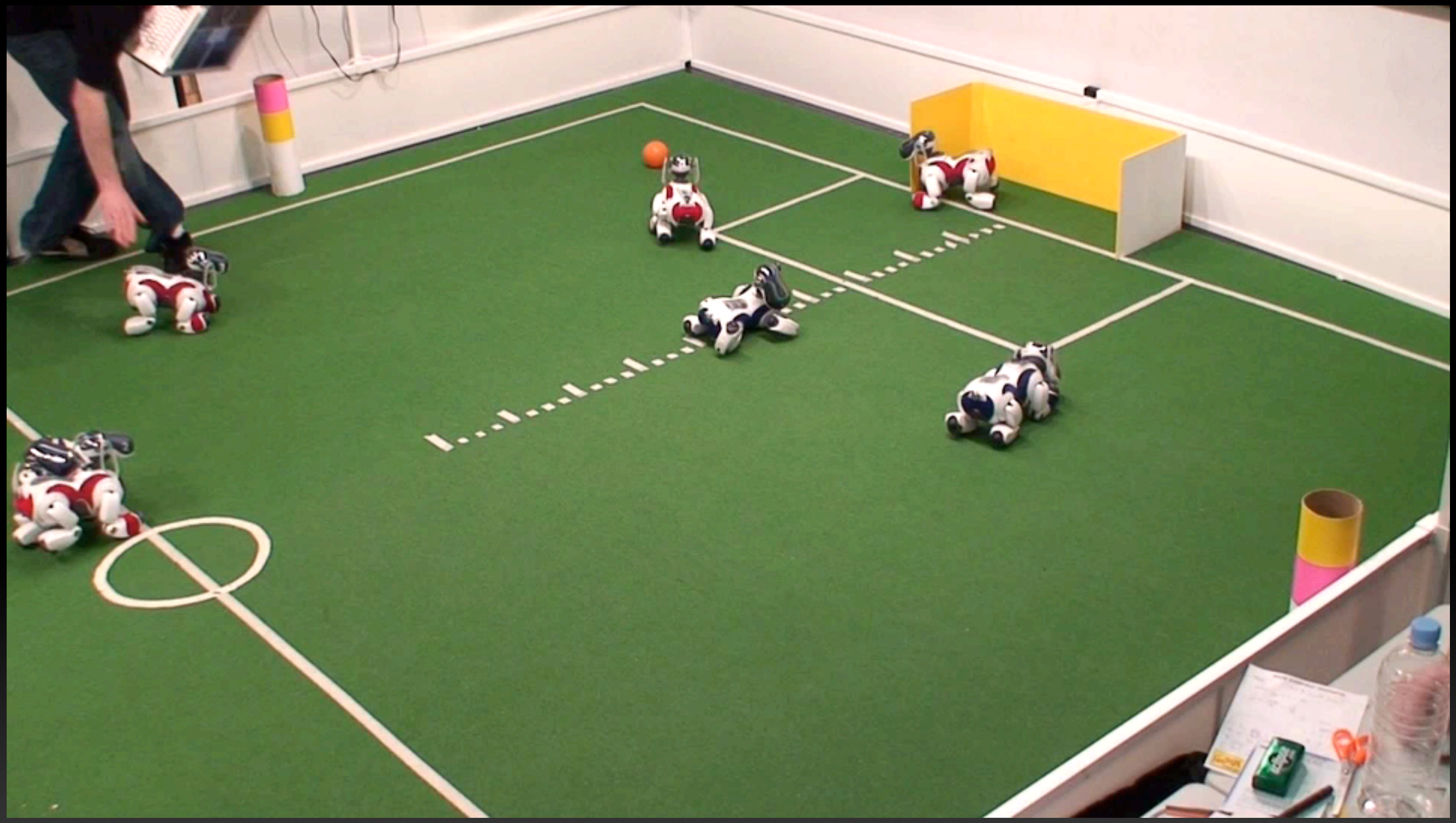
Direct pass

Through pass



Through pass

Clearing pass



Clearing pass

In conclusion

- Improved localisation (not discussed here)

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- Developed a robust decision making algorithm

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- Extended communcation for coordination
- Tested & demonstrated passing behaviour

Outlook

- Get robot detection for blue robots as well

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- Balance between passing & goal kicking

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- Vary core radius with localisation confidence

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- Get robot detection for blue robots as well
- Balance between passing & goal kicking
- Vary core radius with localisation confidence
- Consider receiver's heading / dynamics
- Recursive use of algorithm for chained passing

Thanks to . . .

- Prof. Rick Middleton & Dr. Michael Quinlan

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- My other lovely lab-mates & the NUbots

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- Janine Holzmann
- You - for being such a nice audience ;-)