RoboNED Conference,
Utrecht, The Netherlands, April 27, 2011

Robotics education in practice

intelligent autonomous systems

Universiteit van Amsterdam
Intelligent Systems Laboratory

Arnoud Visser

Benefits of using robots in education

Did you see that!? Robots in Computer Science Education

UNIVERSITEIT VAN AMSTERDAM

Arjen Swellengrebel, Sharon Gieske, Anna Keune, Duncan ten Velthuis, Merijn Martens, Arnoud Visser & Vanessa Evers

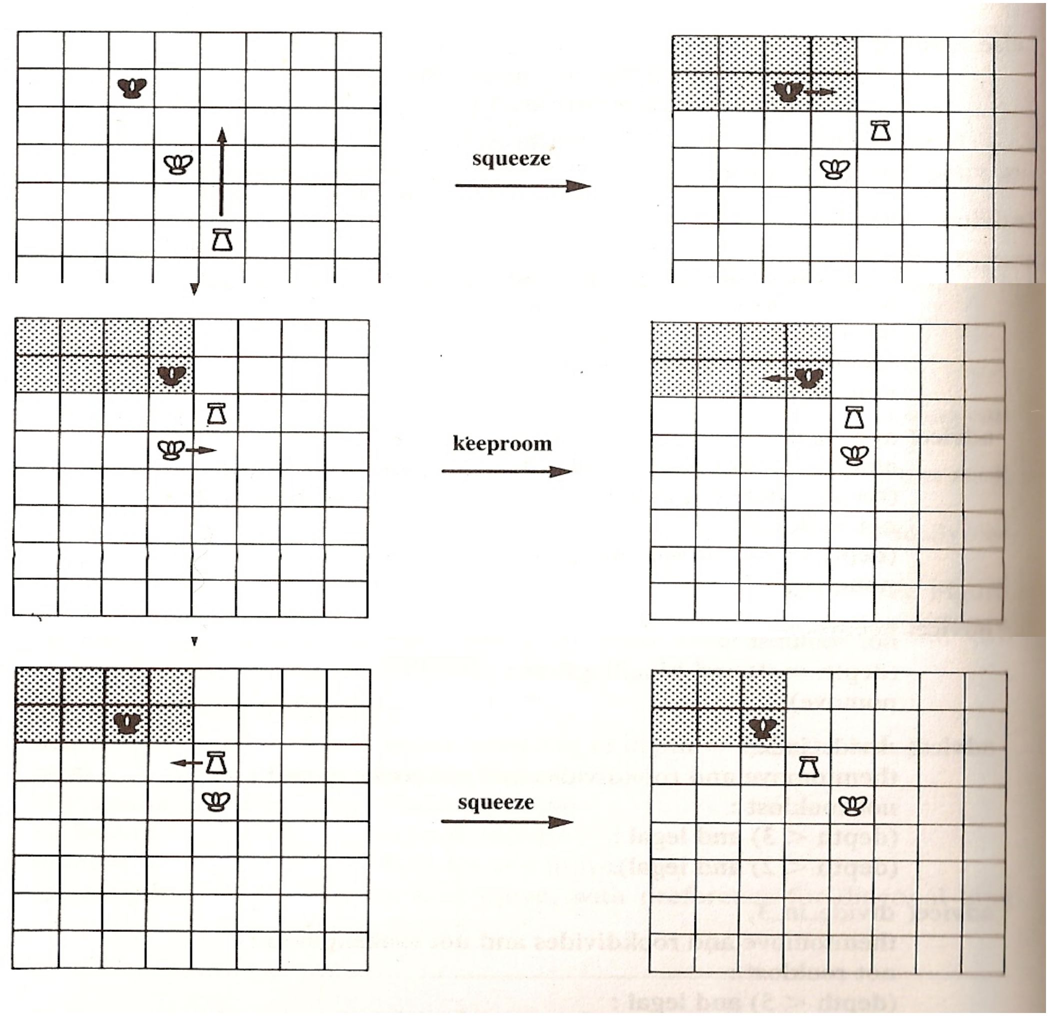
University of Amsterdam, The Netherlands

- Immediate real life effect of programming efforts
- Emotional bonding with robot
- Natural team building

1^{th} year course BscAI

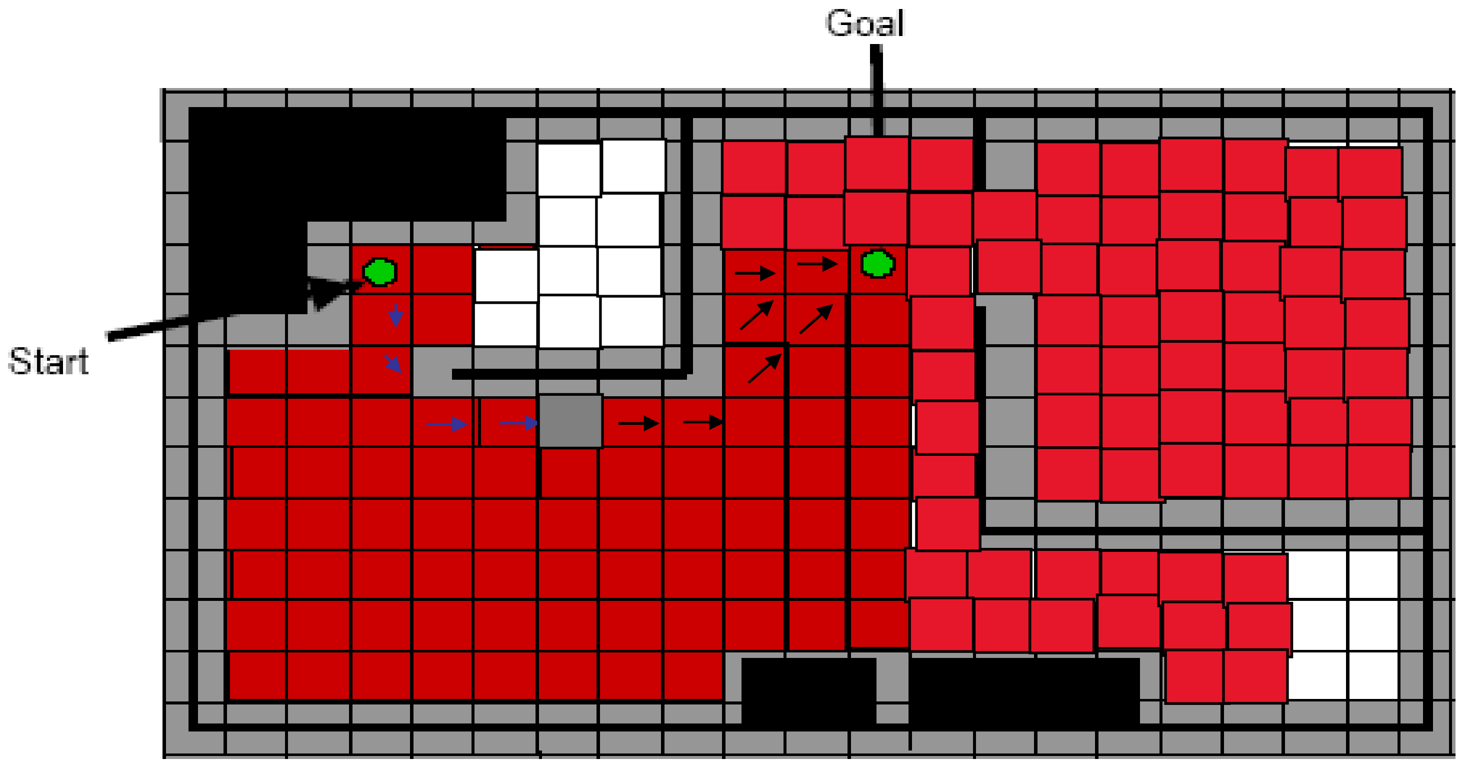
- Introduction to robotics
  - Search algorithms
  - Path Planning
  - Inverse Kinematics
  - Open assignment

Search Algorithms



- Tactics stored in Advice Language (forcing game-tree with preconditions)

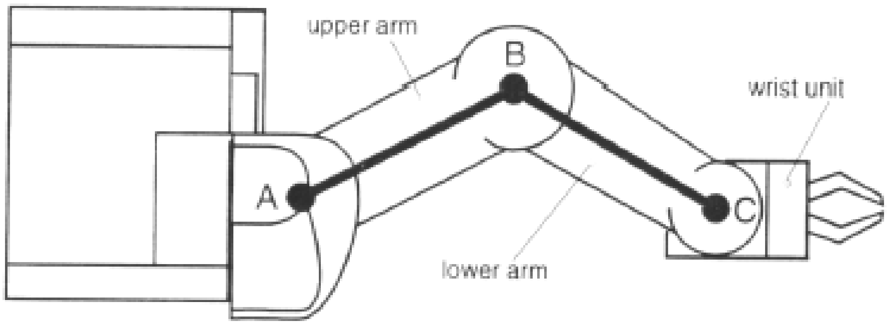
Path Planning

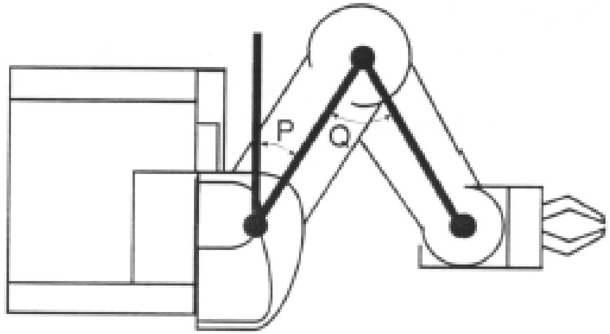


Differential A*

Keep the costs and arrows, redo only nodes that are 'pointing into' new forbidden areas

Inverse Kinematics





Homogeneous transformations or vector manipulation?

ZSB: Limonade Inschenken

Na vier dagen van de ochtendgloren tot aan schemering in Euclides onszelf achter eigenwijze lappen code (die dus heel moeilijk hun wil overgaven aan de onze) uitgeput te hebben, zijn we aangekomen op de dag der demonstratie. Ondanks alle moeite hebben we niet alles tot een geheel kunnen integreren, waardoor we de demonstratie in twee delen lieten zien. Allereerst het fantastisch inschenken van zwarte bessen limonade;

Open Assignments

Open Assignments

UMI-RTX MASTERMIND

This is the site for an Artificial Intelligence (AI) Project of Auke Wiggers and Steven Laan. In this project we'll try to teach a robot to play mastermind.

Person	Description	Complete
Auke	Board Layout Design	✓
Auke	Alpha-Beta Prolog Solver	✓
Auke	Path planning module	✓

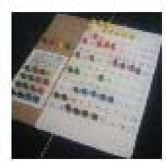
Showing 3 items from page To-Dos sorted by Person, Complete. View more »

Messages

Almost done... At time of writing, we're almost done with everything. The only things we're doing now is commenting and posting our previous changes. Some minor additions have been made ...
Posted Jun 25, 2010 12:37 PM by Steven Laan

Finally! C our solution! I finally managed to create a wrapper for all our separate programs. The key to this was not to program in java or prolog, but in C (thanks to Arnoud ...
Posted Jun 25, 2010 12:26 PM by Steven Laan

Everything but a wrapper!? Every program we've written so far is working. There is one problem: how do we link these programs to each other? We have a prolog solver and there is ...
Posted Jun 24, 2010 12:13 PM by Steven Laan



Testing Our first test was a complete failure. Every boardposition and every coordinate seemed right if we looked at them in the terminal. Auke had made a terrible mistake: every coordinate ...
Posted Jun 25, 2010 1:08 PM by Steven Laan

Path Planning Today Auke started on the path planning module. Since we already solved this problem last week, there aren't much changes to be made. There is one important change here ...
Posted Jun 22, 2010 2:14 PM by Steven Laan

Umi-Helicopter

The arm moves

De arm maakt alle bewegingen op de joystick, alleen hebben we de diagonale moves uitgezet omdat de helikopter dan een grote bocht maakt. Dit is met de kleine ruimte niet mogelijk. In het volgende filmpje zie je dat de arm de volgende moves maakt; vooruit,achteruit,links draaien, rechts draaien en omlaag.

De arm en de joystick

robotarm with joystick

Conclusie

Bij onze tests vloog de helikopter redelijk goed; de helikopter deed wat hem gevraagd werd, hij bleef alleen binnen de beperkte ruimte die we hebben kwam hij soms nog tegen een obstakel aan (het plafond bijvoorbeeld). Met wat tweaken met de arm en the throttle, bereikte we een hoogte waarbij hij niet direct tegen het plafond aanvloog.
Het is gelukt om een rechte lijn te vliegen met alleen de robotarm, en draaien wilt hij ook wel als we hem dat opdragen.

Open Assignments

AIBO: Taking it to a new level

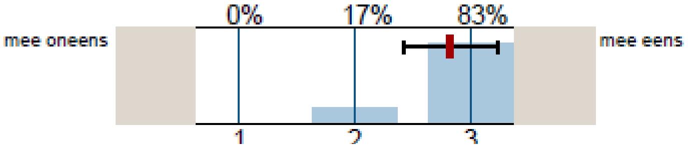
How we made an AIBO robot climb a cardboard box

Ons oorspronkelijke plan was een AIBO de trap op te laten lopen, maar de tredes leken te hoog. Daarom hebben we er voor gekozen de robot een kartonnen doos op te klimmen.
Bij het beklimmen van de doos zijn wij er vanuit gegaan dat de AIBO tegen de doos aan staat. Het beklimmen van de doos is een lange serie van bewegingen net als ingebouwde functies als dance. Afmeting:
11,5 cm hoog
28,5 cm diep
45,0 cm breed

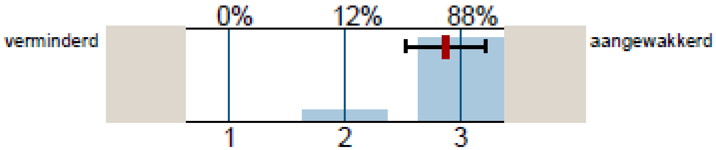
1th year course BscAI

- Introduction to robotics
  - Guided Assignments
  - Ambitious final projects
  - Solve part of solution

1.6) De mate van samenwerking speelde een belangrijke rol in dit project



1.18) Mijn belangstelling voor het onderwerp van dit vak is



2nd year course BscAI

- Robot Programming
  - Context dependent behaviors
  - Object recognition
  - World modeling
  - Obstacle avoidance

Organizational aspects

Media >

Opening Robolab

70
days until
World RoboCup 2011

- **Home**
- **Project Definition**
- **News**
- **The Team**
  - Scientific Advisor
  - Project Manager
  - Vision Team
  - Motion Team
  - Communication Team
  - Architecture Team
  - Sponsoring Team
  - Media Team
  - Expedition Leaders
- **Events**
  - Iran Open
  - Mediterranean Open
- **Media**
  - Movies
  - Posters
  - Opening Robolab
- **Contact**
- **Links**

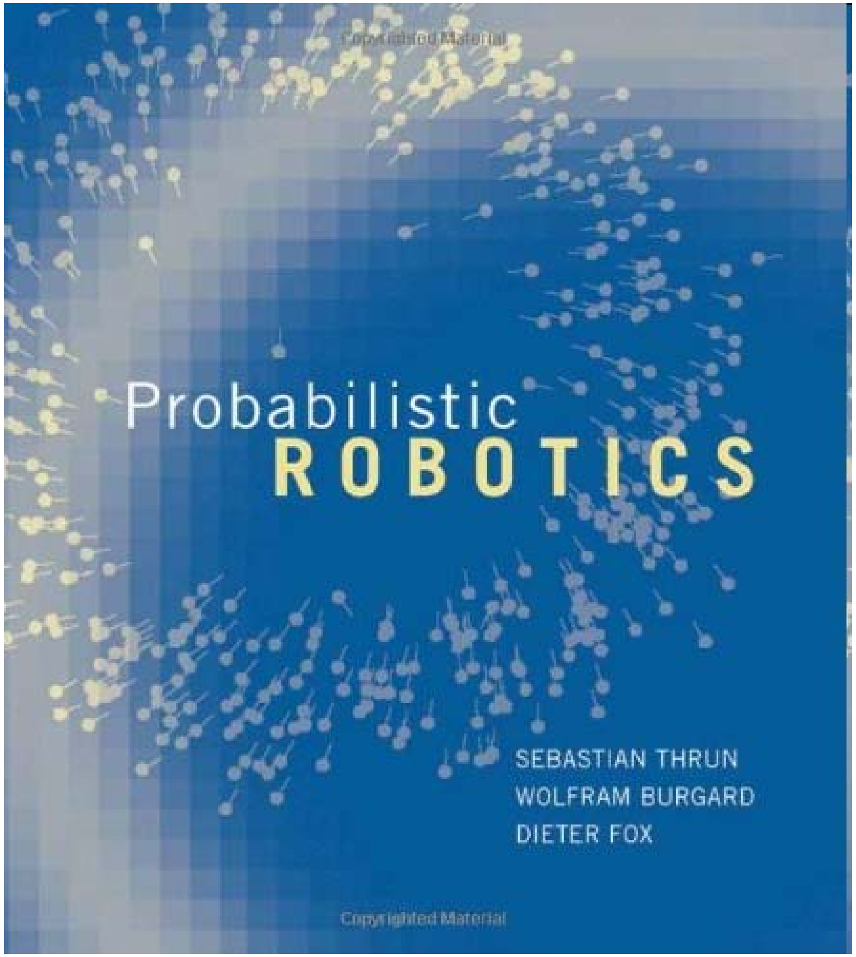
To request a picture in an higher resolution,please mail to timothydingeman@gmail.com

2nd year course BscAI

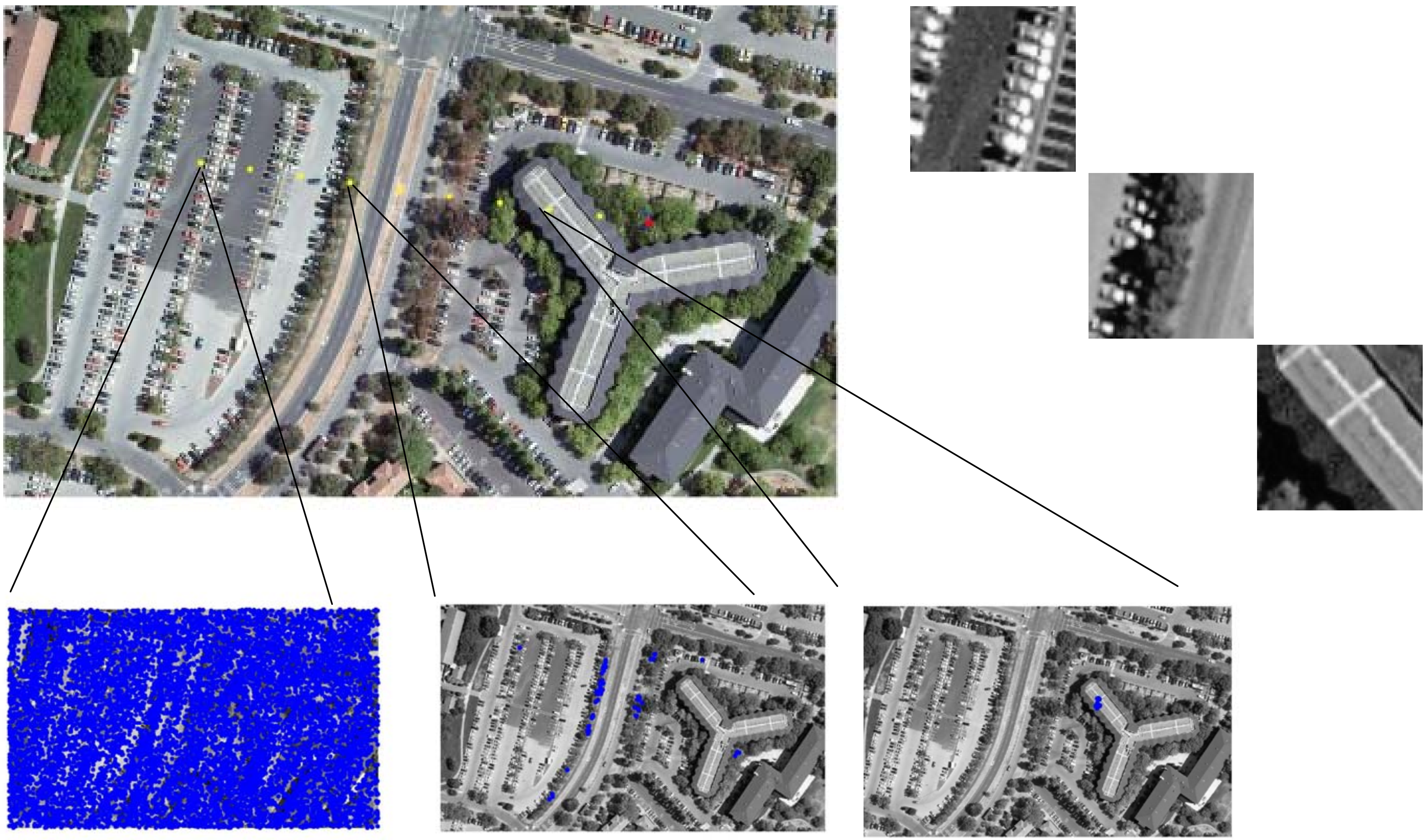
- Robot Programming
  - Focus on competition rules from RoboCup
  - Integrate partial solutions to working solution

3rd year course AI

- Statistical techniques
  - State Estimation
  - Motion & Perception models
  - Localization & Mapping
  - EKF-SLAM, FastSLAM
  - Exploration



Warmup Assignment

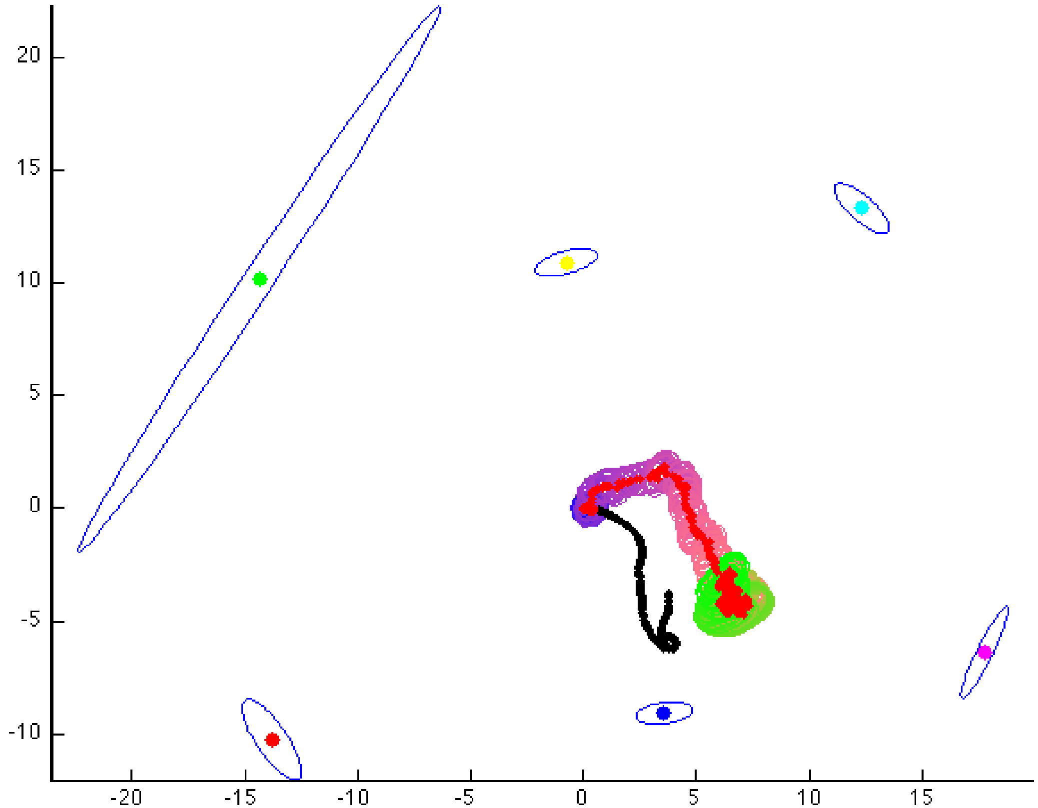


The Guttman dataset

Archived at the Robotics Data Set Repository (Radish): an initiative of Andrew Howard and Nicholas Roy to providing a platform to share datasets under the Creative Commons License.

EKF-SLAM results

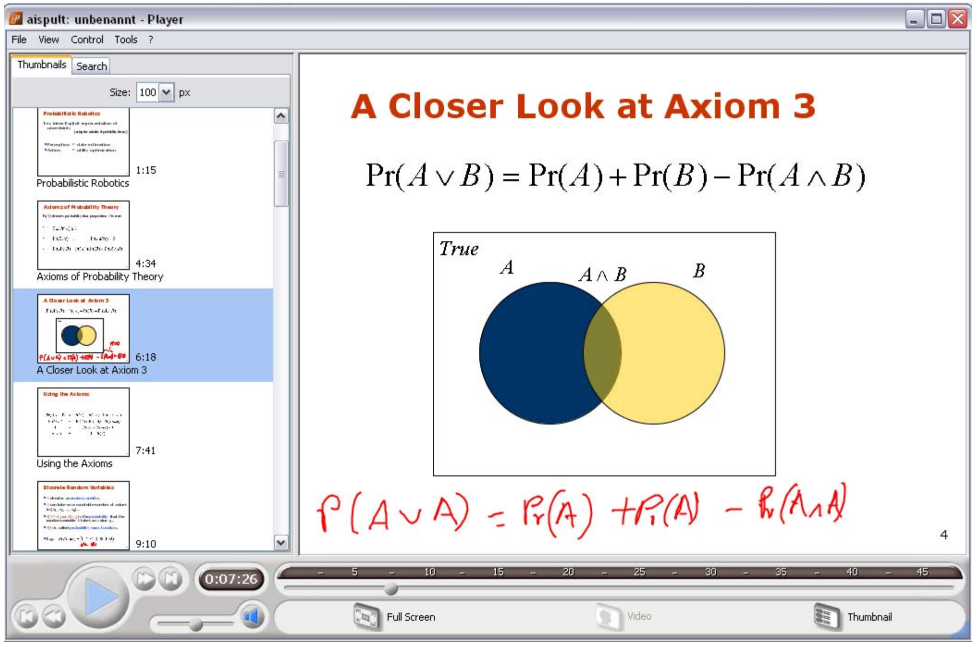
- First dataset (758 points)



- Landmark upper left sparsely seen

Interactive Lectures

- All lectures are recorded
- Every week one lecture in Dutch



- Every week one English recording, with interrupts and classroom discussions

Open Book Exam

Question 2

Assume the following 1-D lineair dynamic system, with a simple motion model:

$$x_t = x_{t-1} + u_t + \epsilon_t \tag{1}$$

and a simple measurement model:

$$y_t = x_t + \delta_t \tag{2}$$

The terms ϵ_t and δ_t represent respectively the control and measurement error, a random number from a Gaussian distribution $\mathcal{N}(x; 0, R_t)$ and $\mathcal{N}(y; 0, Q_t)$. For the moment you can assume that the variance $R_t = 0$ and $Q_t = 1$, which means that you have perfect control over the dynamic system (ϵ_t can be ignored). For all timesteps, the same input is given ($u_t = 0.5$). The initial estimate is represented with a Gaussian distribution $\mathcal{N}(x; \mu_0, \Sigma_0)$ with $\mu_0 = 5$ and $\Sigma_0 = 10$.

You receive the following measurements ($y_1 = 0.0, y_2 = 2.1, y_3 = 5.6$).

(a) Use the measurements (y_1, y_2, y_3) to estimate (μ_1, μ_2, μ_3). For this lineair system you can use a traditional Kalman Filter, as described in section 3.2 of the book. This will be a two step approach, a prediction and an update step. The result of the prediction step will be a Gaussian distribution $\mathcal{N}(x; \overline{\mu}_0, \overline{\Sigma}_t)$. In the update step you can shift and narrow this distribution to $\mathcal{N}(x; \mu_t, \Sigma_t)$ making use of the measurements and the following precalculated Kalman gain $(K_1 = \frac{10}{11}, K_2 = \frac{10}{21}, K_3 = \frac{10}{31}, K_4 = \frac{10}{41}, K_5 = \frac{10}{51})$.

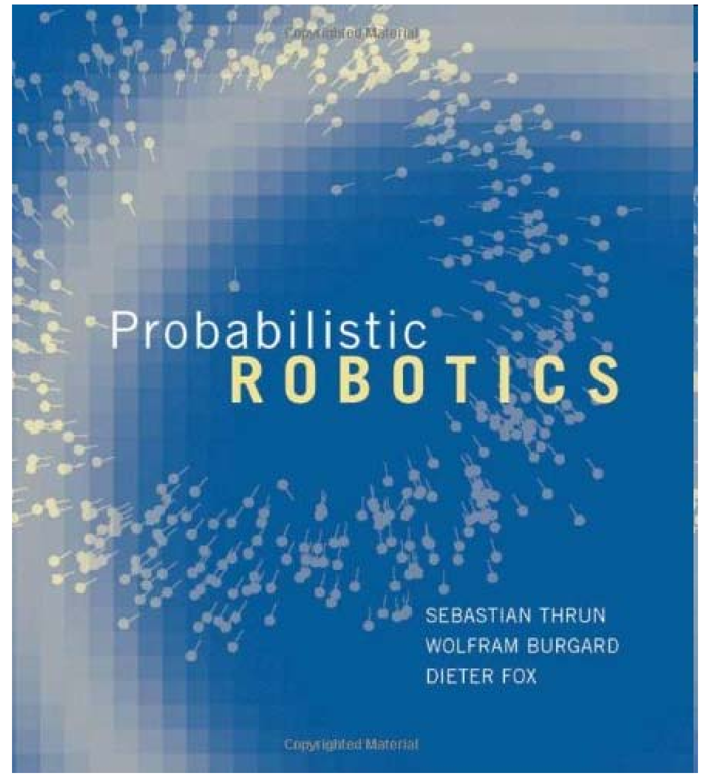
(b) Explain why the Kalman Gain decreases for every time step.

(c) Lets drop the assumption of perfect control, and reintroduce the control noise ϵ_t modelled with a Gaussian distribution $\mathcal{N}(x; 0, 1)$. Recalculate $(K_1, K_2, K_3, K_4, K_5)$ for the given variance $Q_t = 1$. Explain the observed pattern in the Kalman Gain K_t.

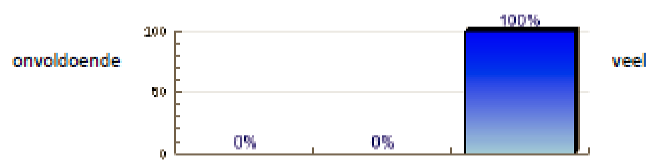
(d) Make a new estimate of (μ_1, μ_2, μ_3) based on the recalculated Kalman Gain K_t.

3rd year course AI

- Statistical techniques
  - Theoretical background
  - Solve problems from published datasets



6.2) Ik heb van dit vak geleerd



Graduation work

Research questions which can be solved in 2 months resp. 6 months:

Student	**Subject**
Djura Smits	Modelling human behavior at an airport
Nick Dijkshoorn	Unmanned Aerial Vehicle Elevation Mapping Based on Monocular Vision and Sonar
Sander van Noort	Realistic movements for a simulated Humanoid robot
Christiaan Meijer	Reinforcement learning with a humanoid robot
David de Bos	Loop closure with Visual SLAM
Stefan Konecny	POMDP policies for Robot Tag

Bachelor theses

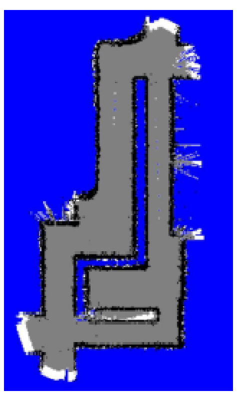
UNIVERSITEIT VAN AMSTERAM

BACHELOR THESIS

A Color Based Rangefinder for an Omnidirectional Camera

Author:
Quang Nguyen

Supervisor:
Arnoud Visser

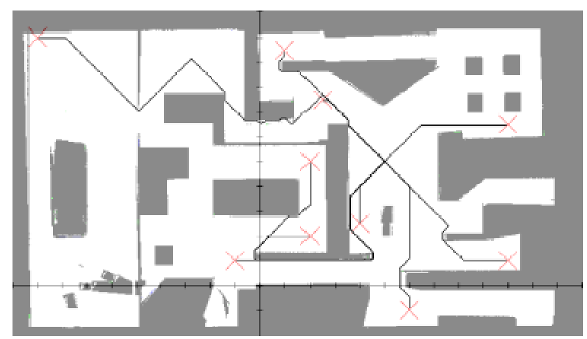


June 26, 2009

UNIVERSITEIT VAN AMSTERDAM

BACHELOR THESIS ARTIFICIAL INTELLIGENCE

Using path planning to grade the quality of a mapper

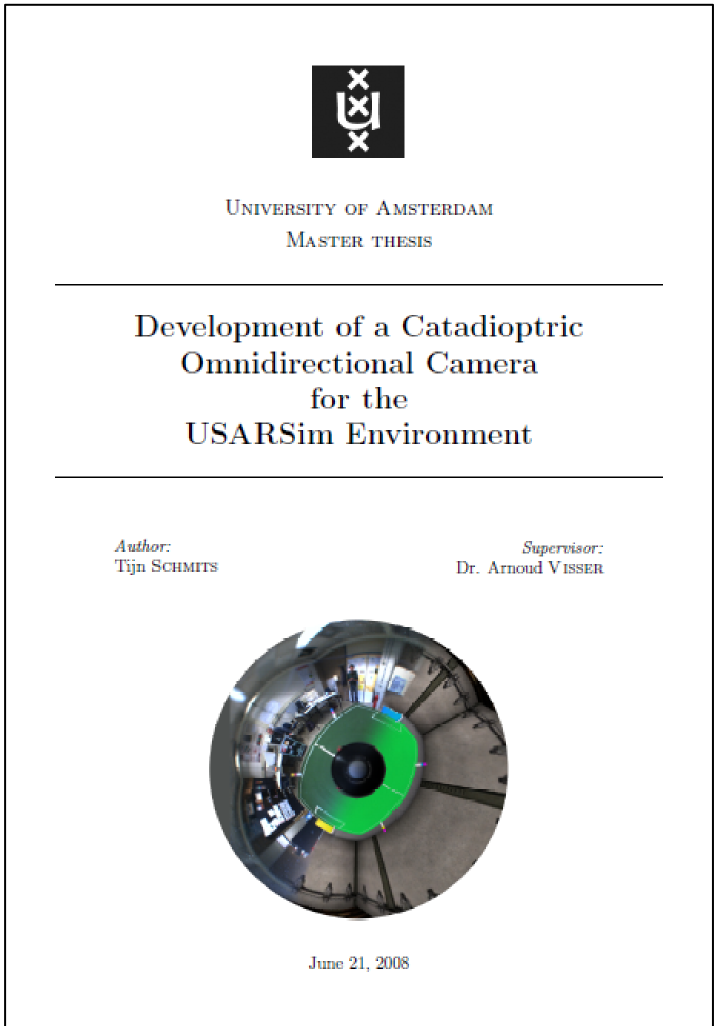


Author:
Christiaan Walraven
cwalrave@science.uva.nl

Supervisor:
Arnoud Visser
a.visser@uva.nl

June 26, 2009

Master theses



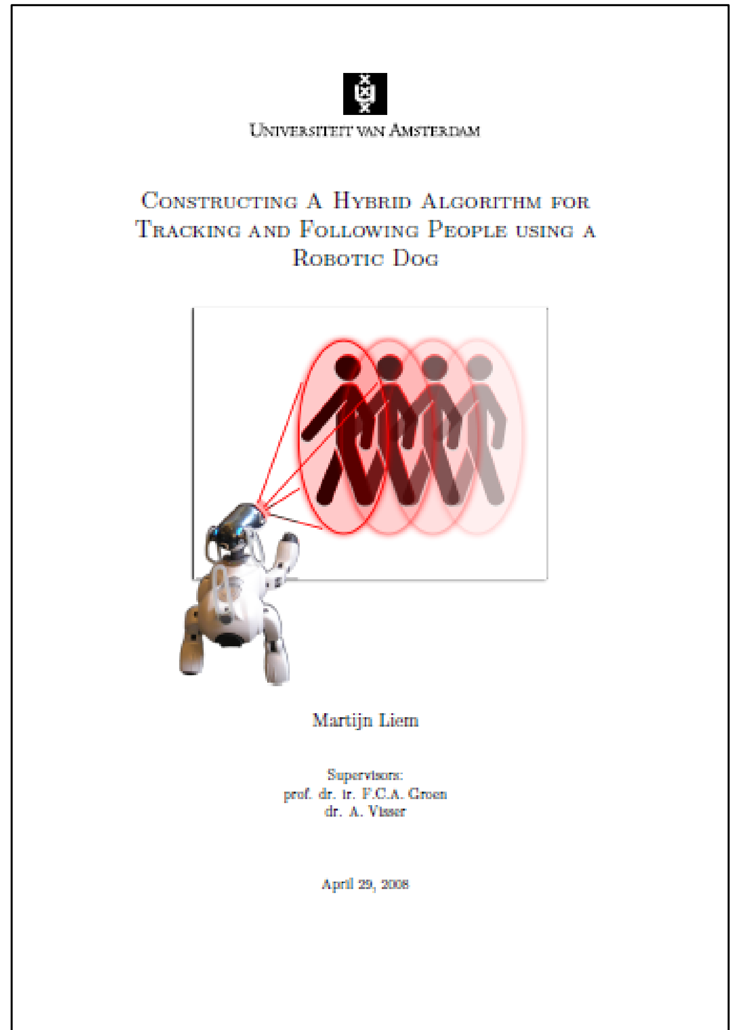
University of Amsterdam
Master thesis

Development of a Catadioptric Omnidirectional Camera for the USARSim Environment

Author:
Tijn Schmits

Supervisor:
Dr. Arnoud Visser

June 21, 2008



Universiteit van Amsterdam

Constructing a Hybrid Algorithm for Tracking and Following People using a Robotic Dog

Martijn Liem

Supervisors:
prof. dr. ir. F.C.A. Groen
dr. A. Visser

April 29, 2008

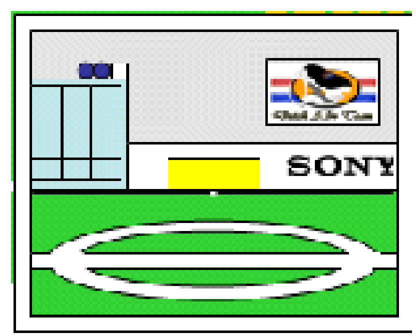
Graduation work

Original research, which often can be published:

1) J. Sturm and A. Visser, "An appearance-based visual compass for mobile robots", Robotics and Autonomous Systems 57 (5), pp. 536-545, Available online 31 May 2009
2) Quang Nguyen and Arnoud Visser, "A Color Based Rangefinder for an Omnidirectional Camera", Proceedings of the International Conference on Intelligent Robots and Systems (IROS 2009), October 2009
3) Martijn Liem, Arnoud Visser and Frans Groen, "A Hybrid Algorithm for Tracking and Following People using a Robotic Dog", in "Proceedings of Third International Conference on HumanRobot Interaction (HRI 2008)", pages 185-192, ACM, New York, NY, USA, 2008.

Conclusion

- Robotics in education has the benefit of direct feedback of the students efforts (1)
- The abstraction level can be raised gradually to a research level (2)
- International robot competitions are inspiring and give a good comparison of the academic level in different countries (1)



3rd place
Technical Challenge

1) Z. Dodds *et al*, **Compononents, curriculum and community: robots and robotics in undergraduate AI education**, in *AI Magazine 27(1): 11-22*, Spring 2006.

2) F.L. Crabbe, **Understanding undergraduate AI robotics: layers of abstraction over two channels**, in *AI Magazine 27(1): 23-38*, Spring 2006.