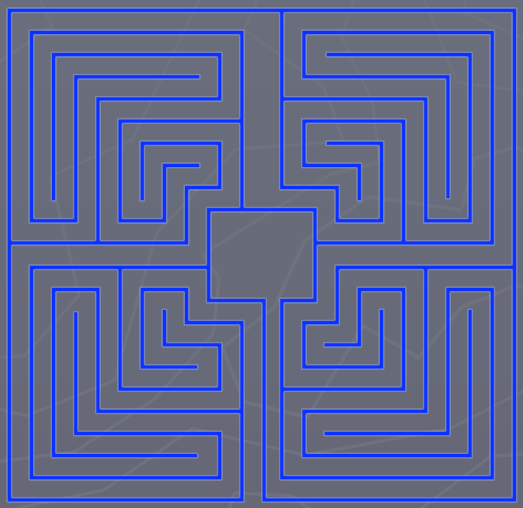
The Sony AIBO:

Using IR For Maze Navigation

Kyle W. Lawton and Liz Shrecengost

Project Goal

- The goal of the project was to allow the AIBO to autonomously navigate and map an unknown maze.



Outline

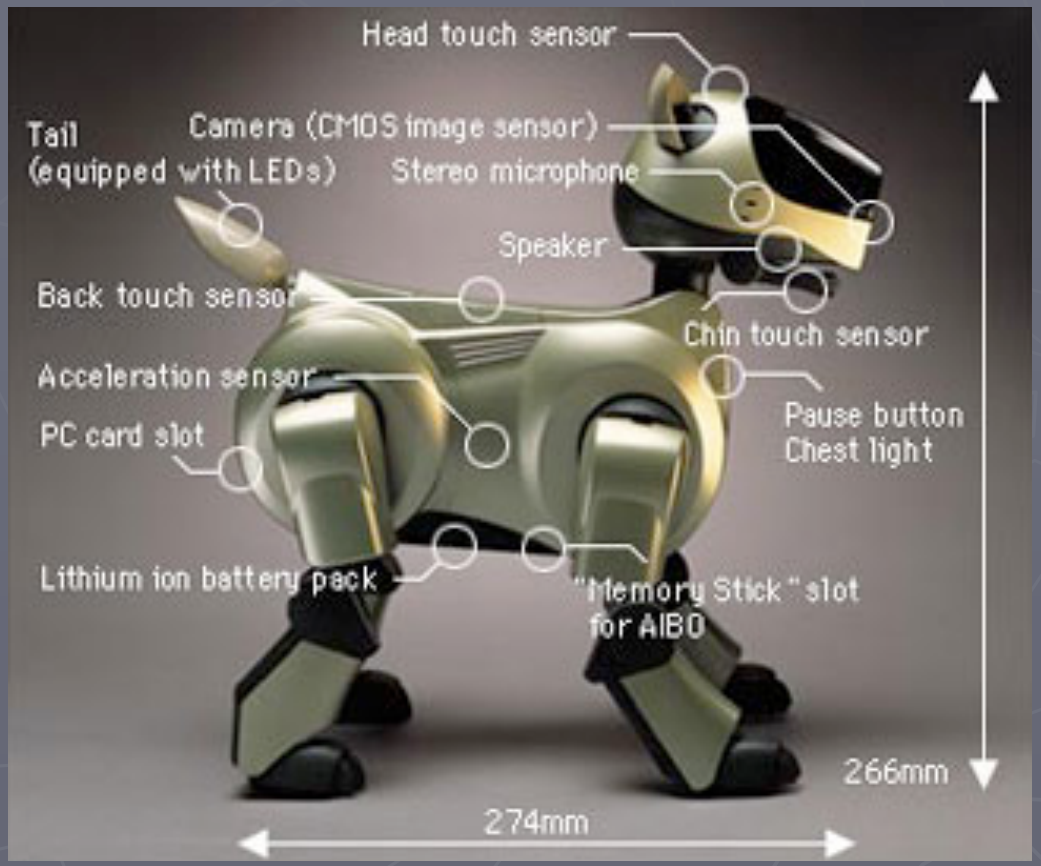
- The Sony AIBO
- Tekkotsu
- Our Project
- Conclusion

The Sony AIBO

AIBO stands for Artificial Intelligence roBOt. It also means “companion” in Japanese. The first-generation AIBO was launched in 1999.

AIBO Diagram

	Comments
384 MHz MIPS Processor	
32 MB RAM	
802.11b Wireless Ethernet	
Memory Stick Reader/Writer	
20 joints	18 PID joints with force sensing 2 boolean joints
9 LEDs	
Video Camera	Field of view 57.6° wide and 47.8° high Resolutions: 208x160, 104x80, 52x40 Up to 25 frames per second
Stereo Microphones	
IR Distance Measure	
X, Y, and Z accelerometers	
4 Buttons	2 pressure sensitive, 2 boolean
Sensor updates every 32 ms	4 sample per update



Tekkotsu

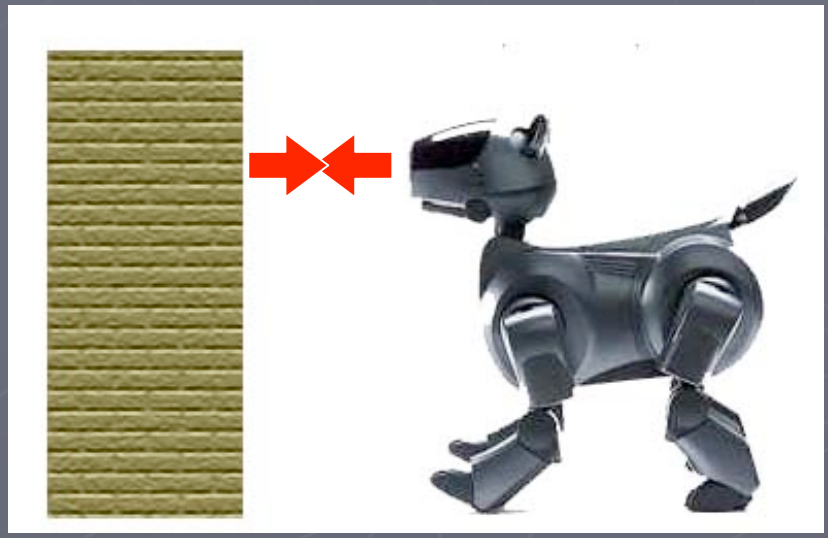
- An open source program created at Carnegie Mellon University
- Handles routine tasks and allows the user to concentrate on their unique application
- Designed to make adding new functionality easy

Pertinent Abilities of the AIBO

- Pre-programmed Walk
  - Walking is an extremely complicated process
- Infrared Sensors

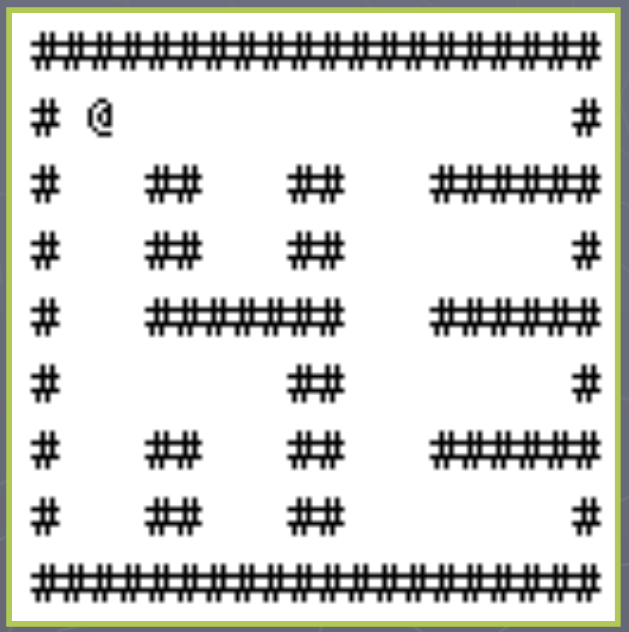
Infrared

- The AIBO measures distance based on long it takes IR light to get back to it
- It can only measure things within a very short range (no closer than 100 mm and no further than 900 mm)
- Measurements are taken every 32 milliseconds

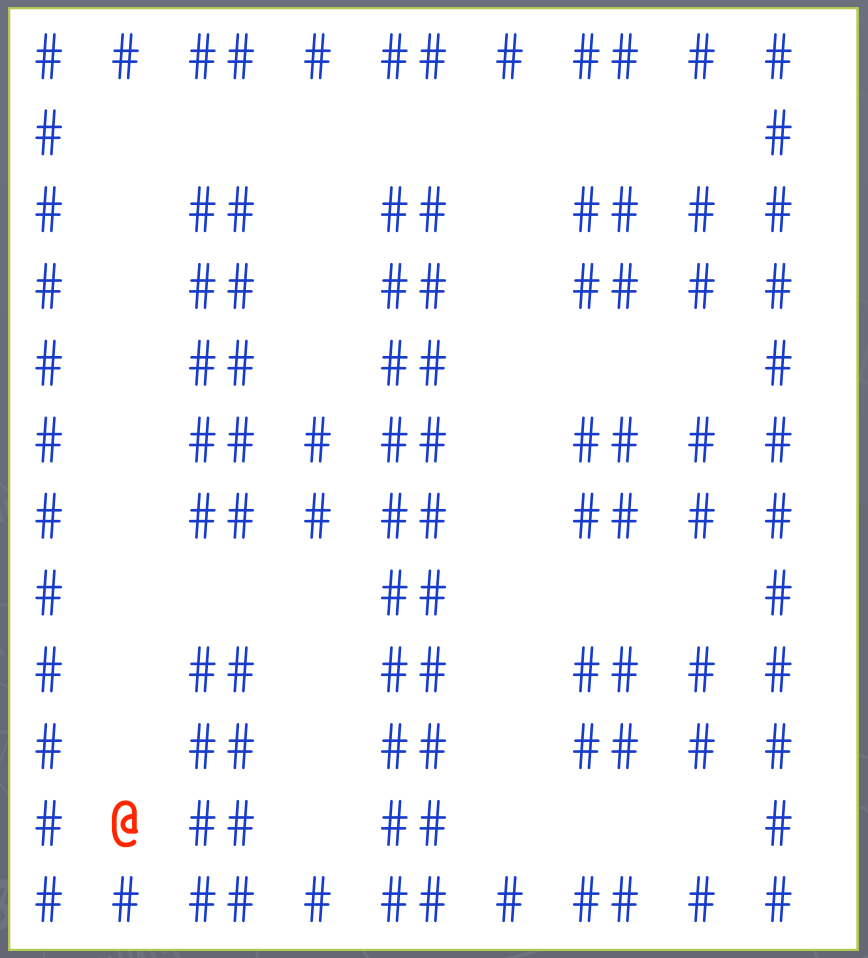


Maze Generation

- Virtual maps were generated to simulate the process of exploration
- As the AIBO actually moves, it stores which walls it actually sees and updates its own map



Maze Navigation



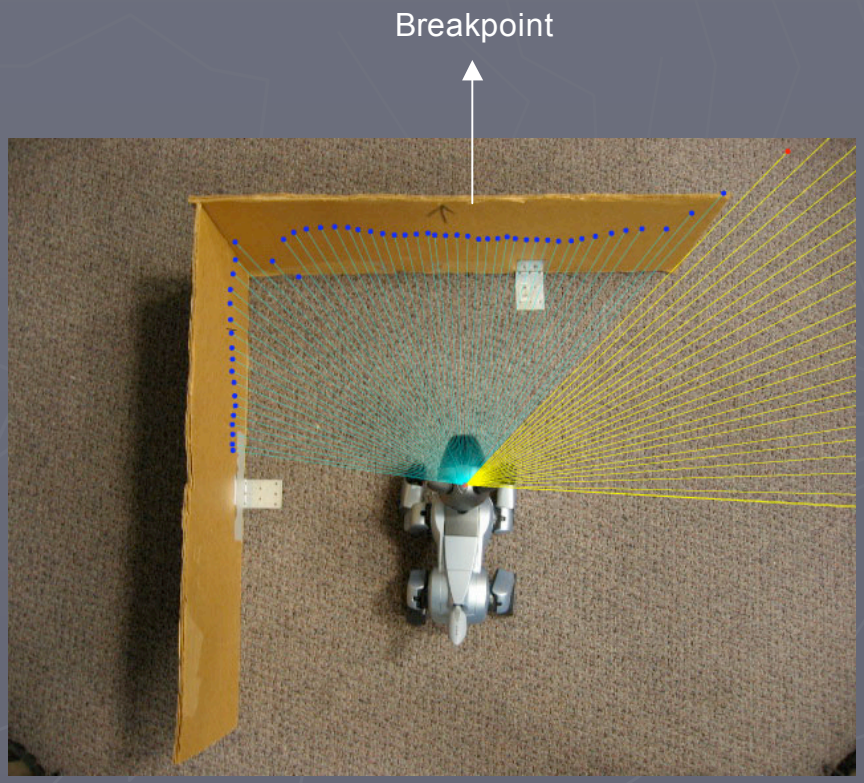
- Unexplored cells are preferred to explored ones
- When the AIBO reaches a dead end, it is able to back-track

Alignment

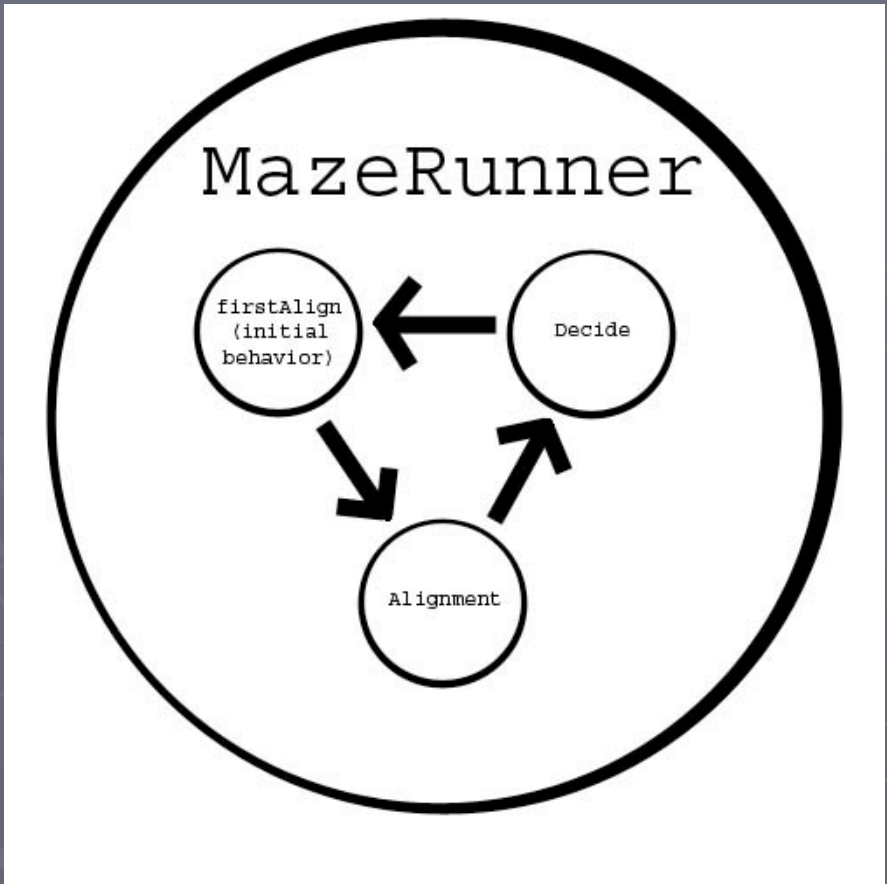
- The robot is very likely to go off course as it is traveling through the maze.
- Alignment comes in two steps:
  - Position to the center of the path
  - Orientation parallel to walls

Processing Alignment

- Pan head to get the distances and angles of walls
- Use this information to determine your relative position in the maze
- The picture to the left represents actual data from a maze



Integration



- The program uses a finite state automaton to transfer between the different behaviors
- Each state is called when the previous one has completed its motion

Results

- The maze navigation uses a grid, but the AIBO is not confined to move likewise
- The preprogrammed walk had to be recalibrated in order to account for the different surfaces that it was walking on.
- It is able to explore a maze and account for commonly occurring anomalies

What Else Could Be Done

- Adapt for different maze types
  - Different wall thicknesses
  - Curved walls
- More efficient navigation
  - Removing excessive stops
  - Panning head while walking
  - Cutting corners

Conclusion

- The real world is very different from our maze
  - Accounting for errors is critical for robust behaviors
- Real World Applications
  - Building Navigation
  - Search and Rescue

Thanks to Advisor Ethan Tira-Thompson and TA Jack Shi!

Image Credits

http://www.sonystyle.com (slides 1 and 7)
http://mlist.biz/arc/200209/08/01_200.htm (slide 4)
http://students.bath.ac.uk/en1alc/aibo.htm (slide 5)
http://www.tekkotsu.org (slide 6)
http://www.msue.msu.edu/dairy/dairycd/cow2.html (cow, slide 17)
http://www.perso.wanadoo.fr/roberty/aibo/photos_des_membres_2.htm (slides 8 and 17)

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