Hack A Robot Meetup

Thomas C. Lee
Welcome!

This group exists because of you
Your organizer

• Thomas C. Lee
  – Profession: Semiconductor/chip design; “cpu guy”
  – Hobbies
    • Photography
    • Programming
    • Hiking
About this group

• Open group for robotic, embedded systems, hardware and software hobbyists

• Goals
  – Networking
  – Share ideas
  – Group projects
  – Competitions
  – Have fun
Mission

• Build an intelligent robot together
  – Autonomous
  – Responses to environment
  – Capable of learning
Born in Year 2338
Opportunity Rover
- Solar Array 140W; 4 hours
- Li-ion batteries
- 20MHz IBM RAD6000 CPU
- 128MB DRAM
- 3MB EEPROM
- 256MB flash memory
- 400lbs
BigDog Military Robot

- 2005 Boston Dynamics, NASA JPL, Harvard
- 240 lbs
- 4 miles/hour
- Carries 340
- 15-HP go-kart engine
- Pentium 4 class CPU
- Climb 35 degree incline
- 50 sensors
Advanced Robots

Fastest Running Robot: Cheetah; 28mph

https://www.youtube.com/watch?v=chPanW0QWhA

WildCat – Boston Dynamics

Atlas – Boston Dynamics
• Honda Asimo
  – 48kg
  – 1.3m tall
  – Walks 2.6km/hour
  – Runs 9km/hour
  – Battery operated
    • 51.8v
    • Walk/run 1hour
REEM
CPU Intel Core i7 x 2
1.65m tall
Walks 3 hours. 1km/h

TOPIO
Plays ping-pong
Short term

• Rome wasn't built in a day
• Build a common platform
  – Low cost
  – Low learning curve
  – Everyone can own one and participate
• Focus on basic capabilities
  – Communication to host computer
  – Mechanics, simple maneuvers
    • Positioning
    • Mapping the environment
Short term
Mid term

• Add new capabilities
  – Communication between robots
  – More sophisticated maneuvers
    • e.g. on foot instead of wheels; kicks; jumps; etc
  – Basic computer vision
  – Competitions
    • Push the system to the limit
    • Spark new ideas
    • Find new solutions
Mid term
Next platform

Host Computers / Tablets / Other Robots

Arduino

Basic platform

Basic Sensors

Motors

Next platform

Cameras

WiFi

BlueTooth

RF
Long term

- Machine Learning
- Truly autonomous
- Solving complex problems
- Making a difference to the society
Sounds good, but... no experience

• Where to start? I don’t have any experience...
• Don’t worry... I don’t either 😊
  – I was able to program my Arduino board in 2 nights
    • I skim through a beginner book the first night
    • I programmed my ultrasonic sensor and was able to measure distance in the 2\textsuperscript{nd} night
## Hardware

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>CPU</th>
<th>Memory</th>
<th>OS</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arduino Uno</td>
<td>&lt;$15</td>
<td>16MHz ATmega328P</td>
<td>2KB</td>
<td>n/a; C/C++</td>
<td>16 MIPS</td>
</tr>
<tr>
<td>Raspberry Pi B+</td>
<td>$30-40</td>
<td>700MHz ARMv6</td>
<td>512MB DDR</td>
<td>Linux</td>
<td>GPU 24GFLOPs 847MIPS/58 MFLOPS Single Precision</td>
</tr>
<tr>
<td>Intel Galileo</td>
<td>$60-70</td>
<td>400MHz Pentium</td>
<td>256MB DDR</td>
<td>Linux</td>
<td>No GPU;</td>
</tr>
<tr>
<td>Jetson Tegra K1</td>
<td>~$200</td>
<td>2.3GHz , 4+1 x ARMv7</td>
<td>2GB DDR</td>
<td>Linux</td>
<td>6829MIPS/158GFLOPs Single Precision</td>
</tr>
</tbody>
</table>

http://www.mouser.com/applications/open-source-hardware-galileo-pi/
http://setiathome.berkeley.edu/forum_thread.php?id=75346
http://www.pugetsystems.com/blog/2014/05/23/NVIDIA-Jetson-TK1-CUDA-performance-569/
Hardware

Arduino

Raspberry Pi B+

Intel Galileo
Next steps

- Projects
  1. Map the environment
  2. Motor control
  3. Robot positioning
  4. Follow another robot
  5. ...
Basic Platform

• HackaBot Uno ($75 – pre-order, 6-8 weeks turnaround time)
  – Arduino UNO R3 compatible
  – Ultrasonic HC-SR04 Distance Sensor
  – MPU-6050 3 Axis Gyroscope and Accelerometer Sensor
  – a motor driver module (L293D)
  – a 2-WD motor car chassis
  – a 640x480 camera (OV7670)
  – a wifi module
  – a 2.4GHz RF module

• Optional/Additional
  – GPS module
  – Bluetooth module
  – Prototype module
  – Motion sensor
  – Compass
#1 Map the environment

- Use sensors to create a 2-D map of
  - Ultrasonic, Infra Red
  - More advanced: Stereo Vision
- Store the map locally or to a host computer
#2 Motor Control

- Go to a given direction for a given distance
- Break when obstacles are detected
- Go to the destination with the shortest path
- Travel at certain speed
- Detect the bumpiness of the road
- Detect up/down ramps
#3 Robot Positioning

- Find and report the location to other robots/host computer
  - Needs to be accurate
    - For example, good enough to play robotic team sports

- Ideas
  - RF
  - DGPS (differential GPS)
  - Signposts
#4 Follow another robot

- be able to catch/intercept another robot
- be able to follow another robot and maintain the same speed
- May or may not have different communication with another robot

**Ideas**
- Communicate through wifi/RF/bluetooth
- Motion sensing
- Computer vision – not feasible with the basic platform
Teams

• Forum on HackaRobot.com
  – To be set up

• Software repository
  – https://github.com/HackaRobot
  – Open Source
  – To be set up
Future meetup

• 12/9 – Meet and Greet / Pick up components
• 1/15 – Finish Project #1, #2, #3 (Demo from members/teams)
• 2/18 – Finish Project #4/ demo
• More to come…
  – Competitions
References

• Arduino.cc – official site
• RaspberryPi.org – official site
• Adafruit.com/Sparkfun.com – DIY hardware
• OpenCV – computer vision
• ROS.org – Robot OS