ONS
(Optical Navigation System)

Jessica Chen
Dennis Yue
Chitoku Yato
Team Members and Areas of Expertise

- Chitoku Yato
  - leader, system and mechanical design

- Jessica Chen
  - mechanical design, power

- Dennis
  - software (firmware) design
We build a two-wheel robot that chases after a target utilizing the visual information obtained by an onboard camera.
Final Product
Fabricated Final Board
Product Application

Automated Transportation
  - Multiple vehicles forming a fleet and just follow the one ahead

Driving Assistance
  - This navigation model can be used for driving assistance
## Data Sheet

<table>
<thead>
<tr>
<th></th>
<th>ONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera</td>
<td>CMUCam2</td>
</tr>
<tr>
<td>Sensors</td>
<td>1 x Ultrasonic range detector,</td>
</tr>
<tr>
<td></td>
<td>2 x IR range detector,</td>
</tr>
<tr>
<td></td>
<td>1 x Digital compass</td>
</tr>
<tr>
<td>MCU</td>
<td>PIC18F6520</td>
</tr>
<tr>
<td>Gear</td>
<td>GM2</td>
</tr>
<tr>
<td>Motors</td>
<td>RM2</td>
</tr>
<tr>
<td>Speed</td>
<td>24 m / min (MAX)</td>
</tr>
<tr>
<td>Power Source</td>
<td>6 x AA batteries for motor driving,</td>
</tr>
<tr>
<td></td>
<td>1 x 9V for control.</td>
</tr>
<tr>
<td>Dimension</td>
<td>W: 10cm, L: 14cm, H: 13cm</td>
</tr>
</tbody>
</table>
High Level Block Diagram

- CMUCam2 (RS-232)
- PIC18F6520
- SRF10 (I²C)
- GP2D12 (analog)
- CMPS03 (I²C)
- L298 (digital + PWM)
Processor - PIC18F6520

- Central Processing Unit (CPU)
- Interfaces with all the sensors and motors.
- Calculate the movement from sensor inputs and movement memory.
- Send signal to drive motors.
## Processor Definition

<table>
<thead>
<tr>
<th>Manufacture</th>
<th>Microchip Inc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part number</td>
<td>PIC 18F6520-I/PT</td>
</tr>
<tr>
<td>Ordering information</td>
<td>$10.73 at Digikey.com</td>
</tr>
<tr>
<td>Speed</td>
<td>DC – 40MHz</td>
</tr>
<tr>
<td>Operating speed</td>
<td>40MHz</td>
</tr>
<tr>
<td>Clock source</td>
<td>External, 10MHz Crystal</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>300mA (1.0W)</td>
</tr>
<tr>
<td>Operating Voltage</td>
<td>2.0V – 5.0V</td>
</tr>
<tr>
<td>Busses</td>
<td>UART, I2C</td>
</tr>
</tbody>
</table>
### Processor Definition (cont)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal memory</td>
<td><strong>EEPROM(1024bytes)</strong></td>
</tr>
<tr>
<td>Firmware changeability</td>
<td>Firmware stored in flash program memory that can be programmed by ICSP method via 2 pins.</td>
</tr>
<tr>
<td>System software availability</td>
<td>All provided by Microchip Inc.</td>
</tr>
<tr>
<td>Boot process</td>
<td>Program starts from location 0h of program memory.</td>
</tr>
<tr>
<td>Reset</td>
<td>MCLR pin is usually pulled up. To reset the PIC, pull down the MCLR pin to the ground.</td>
</tr>
</tbody>
</table>
CMUCam2

Captures a scene and gives a tracking information at up to 50 fps

Pixel = size of the object
Ultrasonic range detector

- Measure the amount of time it takes to detect the ultrasonic reflected on the object.
- Have wide range.
- Used to detect obstacles in front and avoid collisions.
IR Range Detector

- Measure the amount of time it takes to detect the IR reflected on the object.
- CPU reads off the voltage level and know the distance.
- Used to check the obstacles on both side of the robot when turning.
Motors

- Tank configuration
- Motor on each right and left wheels
- Each motor runs in 4 modes (Forward, Backward, Brake, Stop), thus the robot can also “spin on a dime”
Digital Compass

gives directional information at 0.1° accuracy

Used to achieve inertial navigation
Software Structure

- Initialize camera and set tracking information
- Loop: simple round-robin
- Acquire data from camera and sensors
- Calculate the next movement based on the acquired data
  - Track mode
  - Search mode
- Send signals to drive motors

Flowchart:

1. Start
2. Camera Initialization
3. Set Tracking Info
4. Read camera
5. Read sensors
6. Navigation: Calculate the next move
7. Drive Motors
Power supplies

Two independent power supplies to avoid possible CPU power drop

1. Control Board, camera and sensors
   - One 9V NiMH battery

2. Motor & Servo
   - Six 1.5V AA Alkaline batteries
Annotated Board Layout
Other capabilities

- ICSP
- Human Interface
- Status LEDs
- DIP Switch
- Pin headers
- RS232
Demo Video

Enjoy!
End of Presentation

Thank You!