Project Proposal

Lego Learning

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Course: ICS 635

Assignment: Course Project

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Introduction to Lego Mindstorms

The brain (Brick)

CPU:	Pentium II
RAM:	32 MB
Hard disk space:	115 MB

The sensors

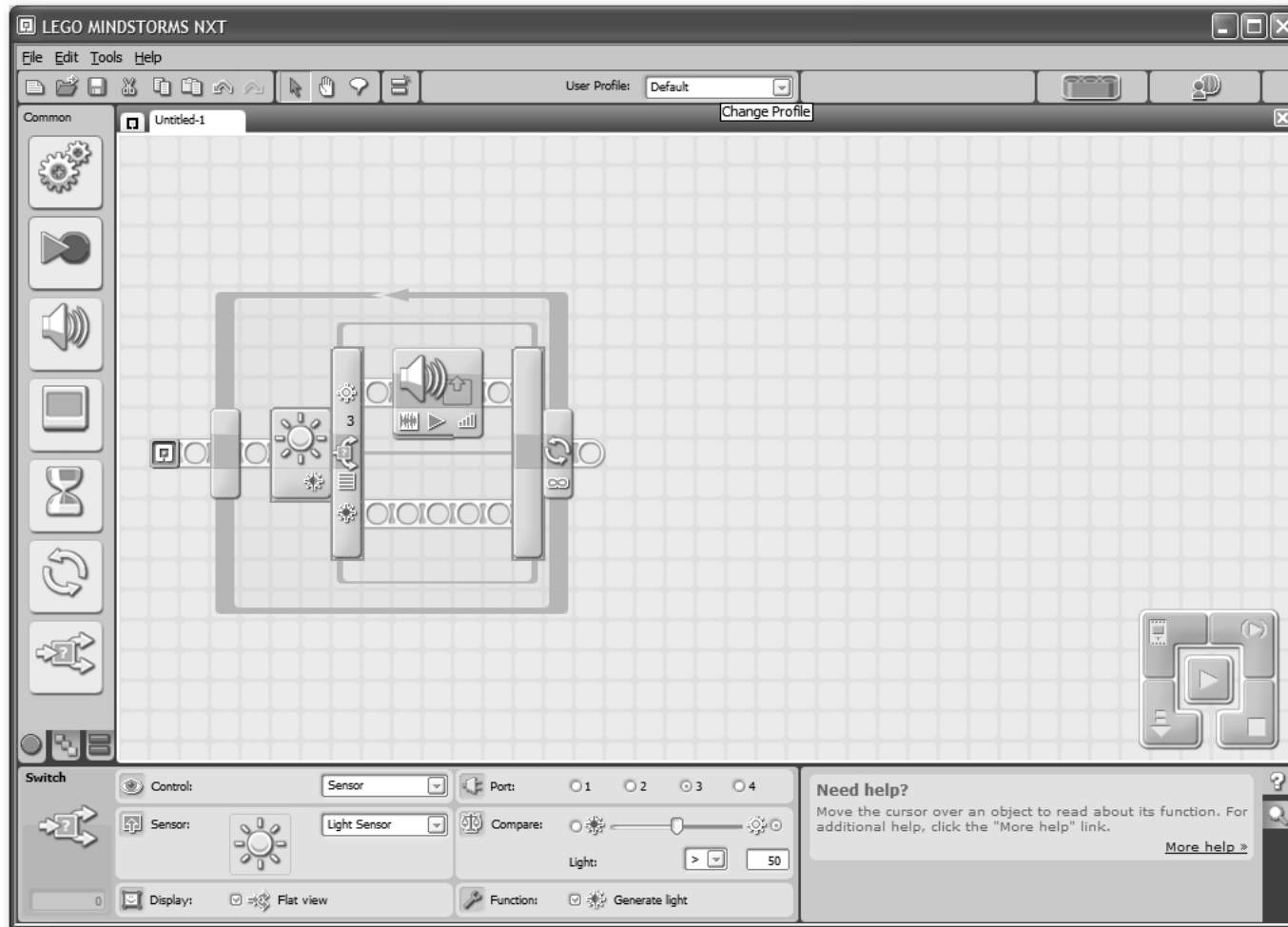|	
Touch:	0 or 1
Ultrasonic:	0 ~ 170 (cm)
Light / Color:	0 ~ 100 / RGB 0 ~ 255
Sound:	0 ~ 100
Rotation:	0 ~ 360 (degrees)

Introduction to Lego Mindstorms

NXT-G toolkit

LabVIEW: A data flow / visual programming language

Java Setup
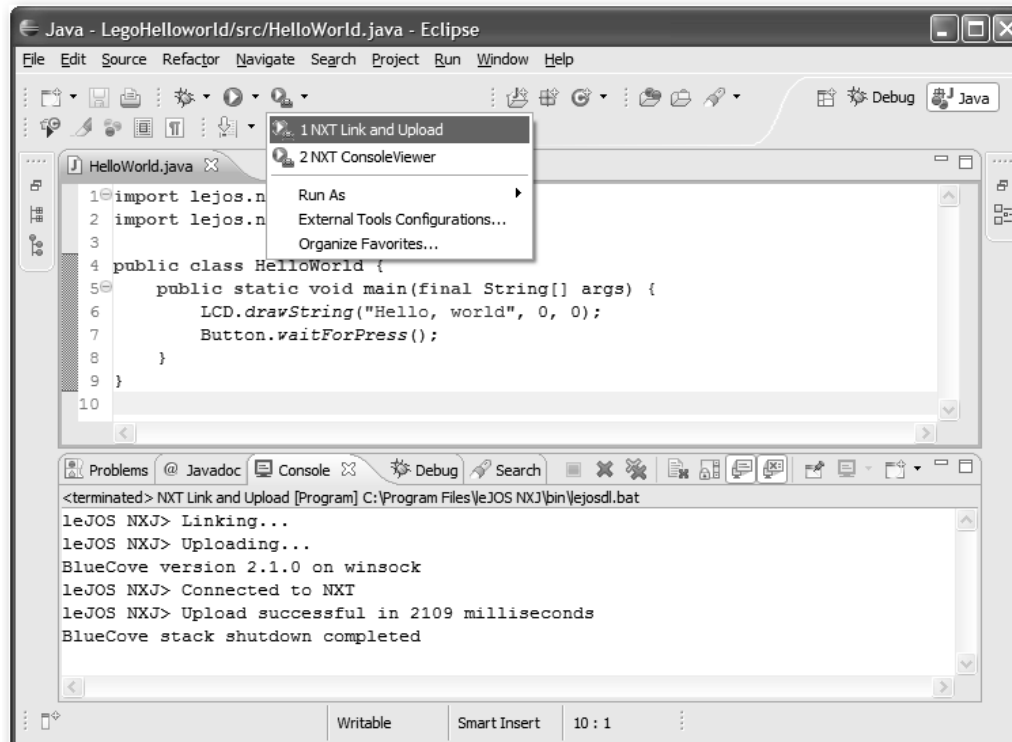
Firmware setup

Replaced NXT-G operating system with leJOS, a Java-based firmware.

Robot now carries limited versions of JRE and JVM.

Embedded programming environment
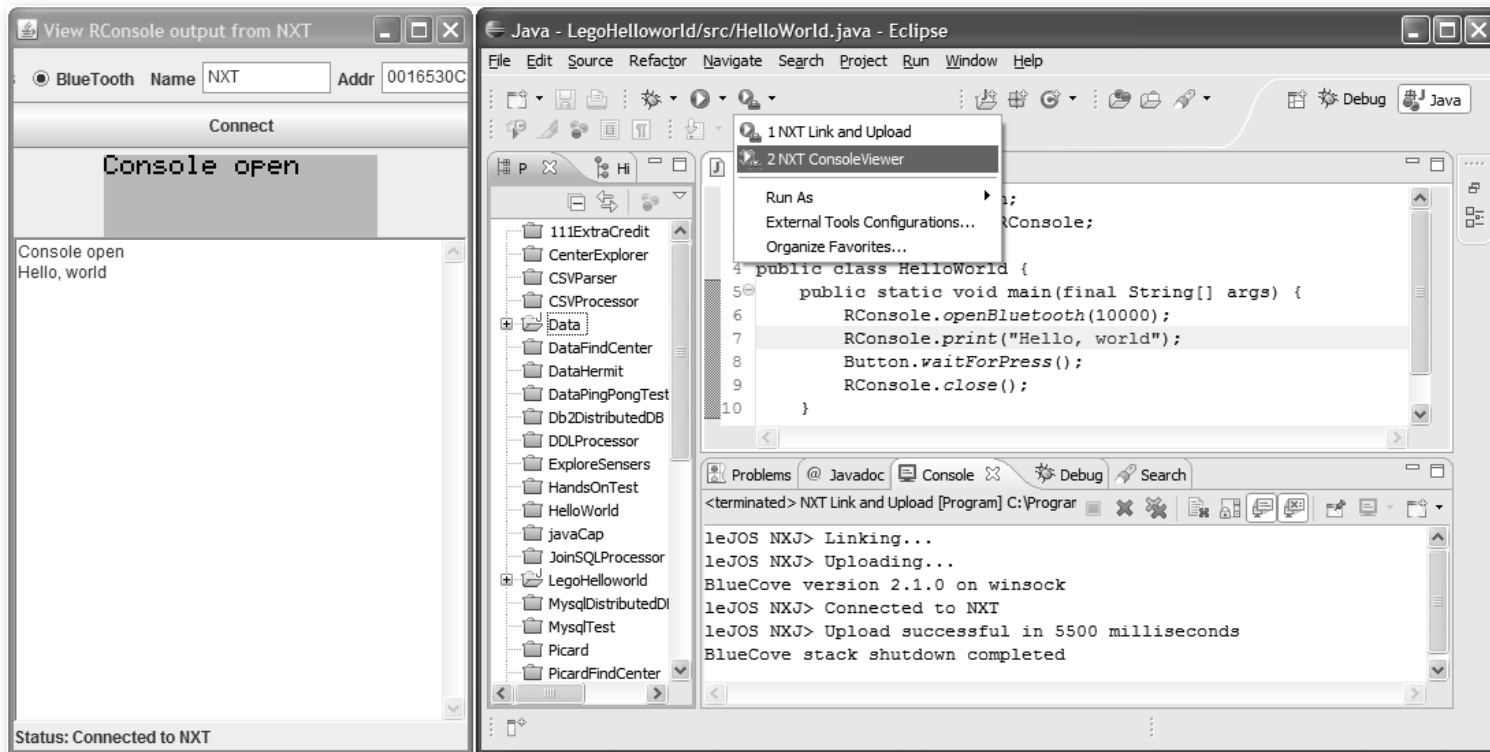
Configured Eclipse to compile and upload .nxt executable.

Java Setup

Runtime diagnostics

Bluetooth or USB communication with PC.

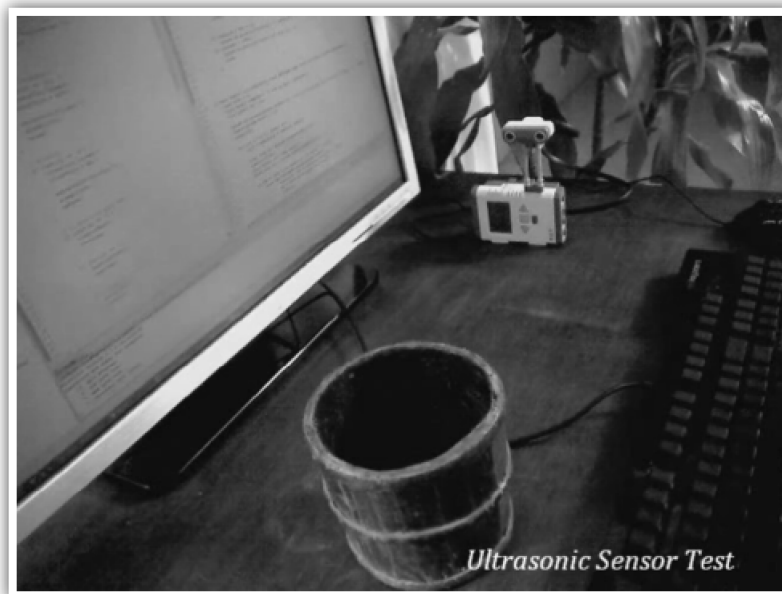Remote console provided with leJOS development kit.

Sensor Exploration

Ultrasonic sensor test

Measures continuously for 1 second.

Reports min, max, average distances.

Executes until Escape button pressed.

Ultrasonic Sensor Test

View RConsole output from NXT

○ USB ● BlueTooth Name Unknown   Addr 0016530C53BB

Connect

```
samples:□4431
average:□12.5984
max:□□12.9921259
min:□□12.5984251
```

Console open

```
[samples:      4363]
[average:      12.5984251968504]
[max:          12.992125984252]
[min:          12.5984251968504]

[samples:      4454]
[average:      12.5984251968504]
[max:          12.992125984252]
[min:          12.5984251968504]

[samples:      4449]
[average:      12.5984251968504]
[max:          12.992125984252]
[min:          12.5984251968504]

[samples:      4419]
[average:      3.54330708661417]
[max:          13.3858267716535]
[min:          2.75590551181102]

[samples:      4481]
[average:      2.36220472440945]
[max:          2.75590551181102]
[min:          2.36220472440945]

[samples:      4503]
[average:      2.36220472440945]
[max:          2.75590551181102]
[min:          2.36220472440945]

[samples:      4492]
[average:      2.36220472440945]
[max:          2.75590551181102]
[min:          2.36220472440945]

[samples:      4463]
[average:      3.54330708661417]
[max:          13.3858267716535]
[min:          2.36220472440945]

[samples:      4472]
[average:      12.5984251968504]
[max:          12.992125984252]
[min:          12.5984251968504]

[samples:      4471]
[average:      12.5984251968504]
[max:          12.992125984252]
[min:          12.5984251968504]

[samples:      4484]
[average:      12.5984251968504]
[max:          12.992125984252]
[min:          12.5984251968504]

[samples:      4431]
[average:      12.5984251968504]
[max:          12.992125984252]
[min:          12.5984251968504]
Console closed
```
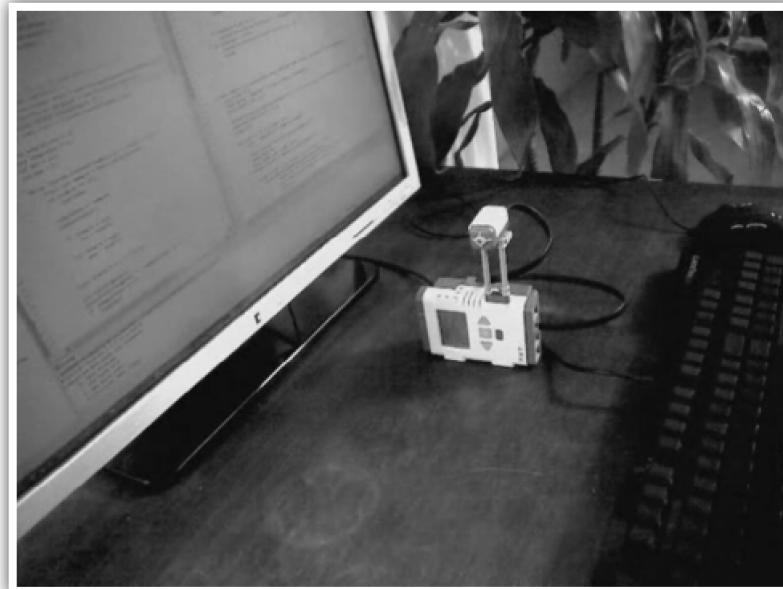
Status: Connected to Unknown

Sensor Exploration

Touch sensor test

Waits for button press.

Waits for button release.
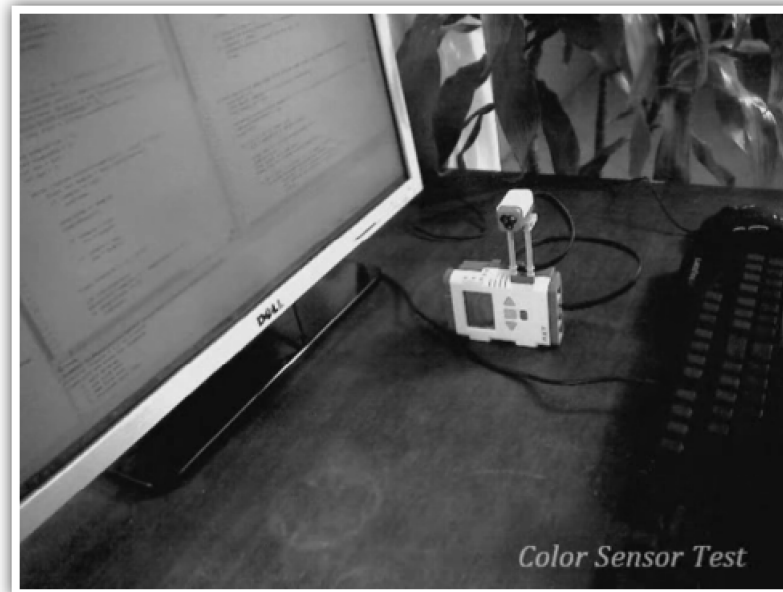
Reports duration.

Executes until Escape button pressed.

Sensor Exploration

Light and Color sensor test

Preliminary tests failed using sensor.
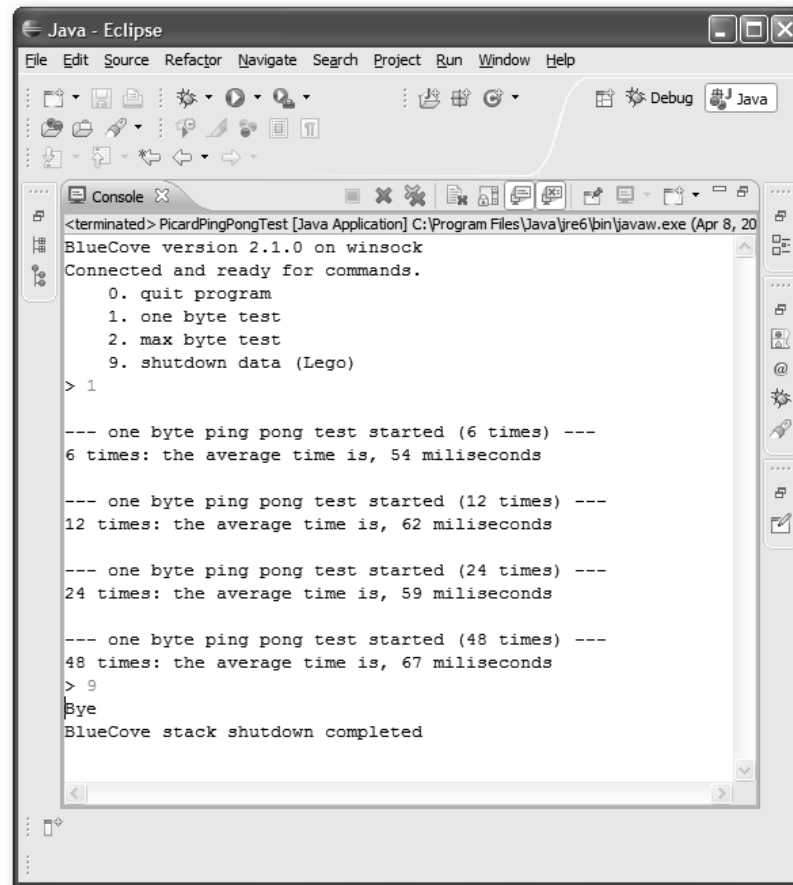
Validated hardware using third-party executable.

Color Sensor Test

Bluetooth Communication

Latency test

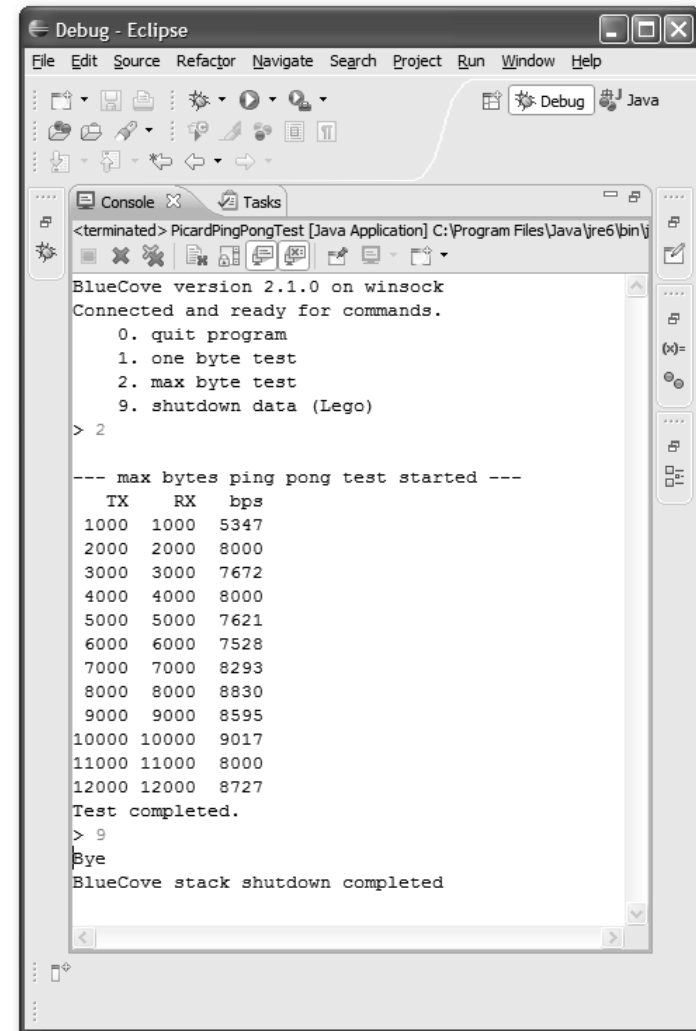One-byte ping-pong test.

Approximately 50 – 70 ms round trip.

Bluetooth Communication

Bandwidth test

Experimentally discovered
maximum buffer size for
communication.

Approximately 16,000-byte
limit.

Approximately 8,000 bytes
per second.

First Objective

Goal

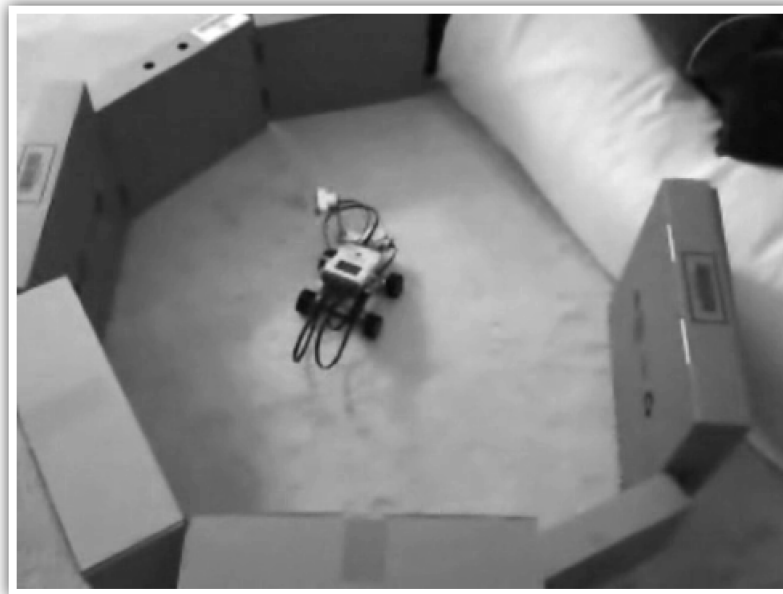   Drive away from obstacles. In other words, look for center of room.

Algorithm

       Continuously read from sensor, evaluate data, and decide new direction.

       Repeat this procedure until center is found within margin.

Implementation

       Simple state machine with command-response PC-robot protocol.

Second Objective

Goal

Simultaneous movement, measurements, and communication.
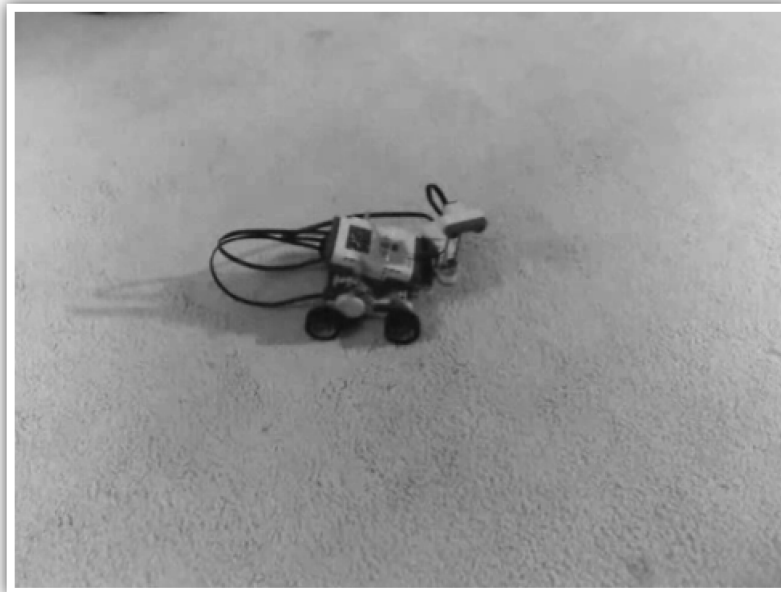
Algorithm

Vector superposition of robot distances to sample points in scalar field.

Implementation

Thread 1: Message pump.

Thread 2: Sensor recording, motor management, and decision making.

Possible Projects

Map exploring

        Currently under development.

Projectile targeting

        Building machine arm with two degrees of freedom.

        Challenged by targeting consistency and verification methods.

        Preliminary success using webcam as additional sensory input.