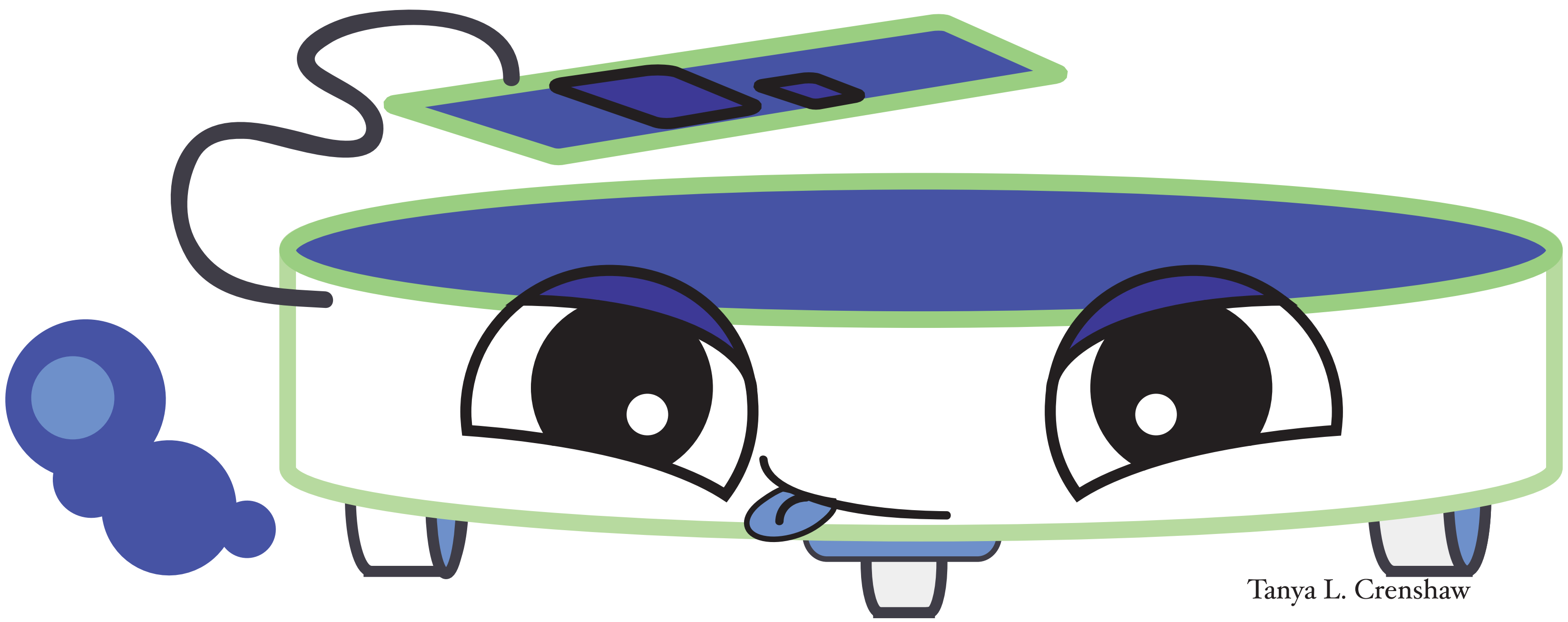
Hi.



Tanya L. Crenshaw

UPBOT: A Testbed for Cyber-Physical Systems

Tanya Crenshaw, assistant professor
Steven Beyer, senior EE undergraduate
University of Portland
CSET 2010

October 2006

http://varma.ece.cmu.edu/cps/

cyber physical systems are:

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massively distributed

cyber physical systems are:

massively distributed   safety-critical

cyber physical systems are:

massively distributed safety-critical (sensor) networks

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and control systems

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in unpredictable environments

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massively distributed (sensor) networks

safety-critical

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monitoring or regulating the physical world

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cyber physical systems are:

networked, component-based, real-time systems that control and monitor the physical world.

October 2006

doing cyber-physical systems research means you are at the mercy of really busy people working at rockwell-collins.

August 2008

1.

is it possible to reproduce a cyber-physical system in a meaningful way?

2.

what features would be necessary for testing security threats and defenses?

3.

how can it be accessible to undergraduates and useful to researchers?

August 2010

the upbot testbed

let’s begin with the first question.

1.

is it possible to reproduce a cyber-physical system in a meaningful way?

key characteristics

1. networked control.

cyber-physical systems control the physical world, executing across multiple nodes.

key characteristics

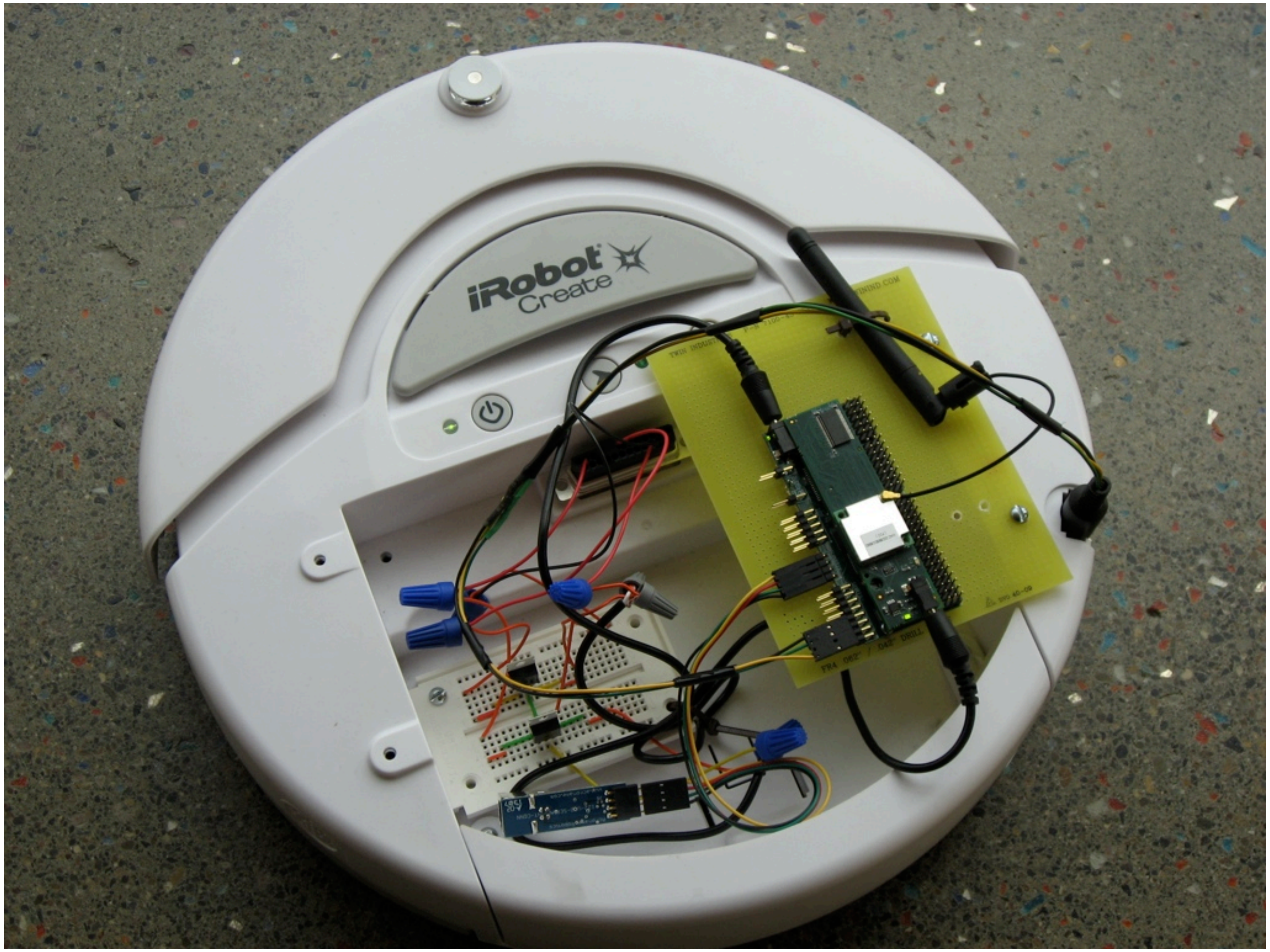
2. enforceable physical properties.

cyber-physical systems interact with unpredictable environments, yet certain physical properties must remain invariant.

key characteristics

3. off-the-shelf-components.

cyber-physical systems are composed of heterogenous commodity parts with varying levels of criticality.



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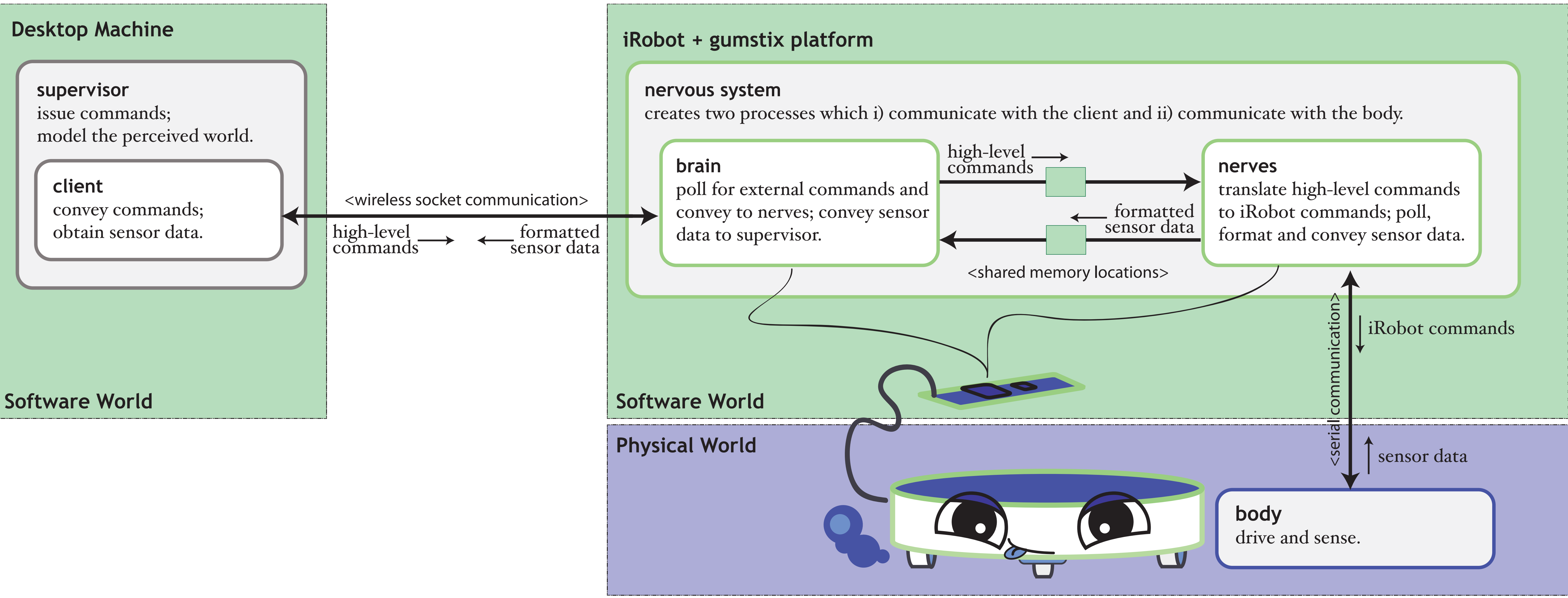
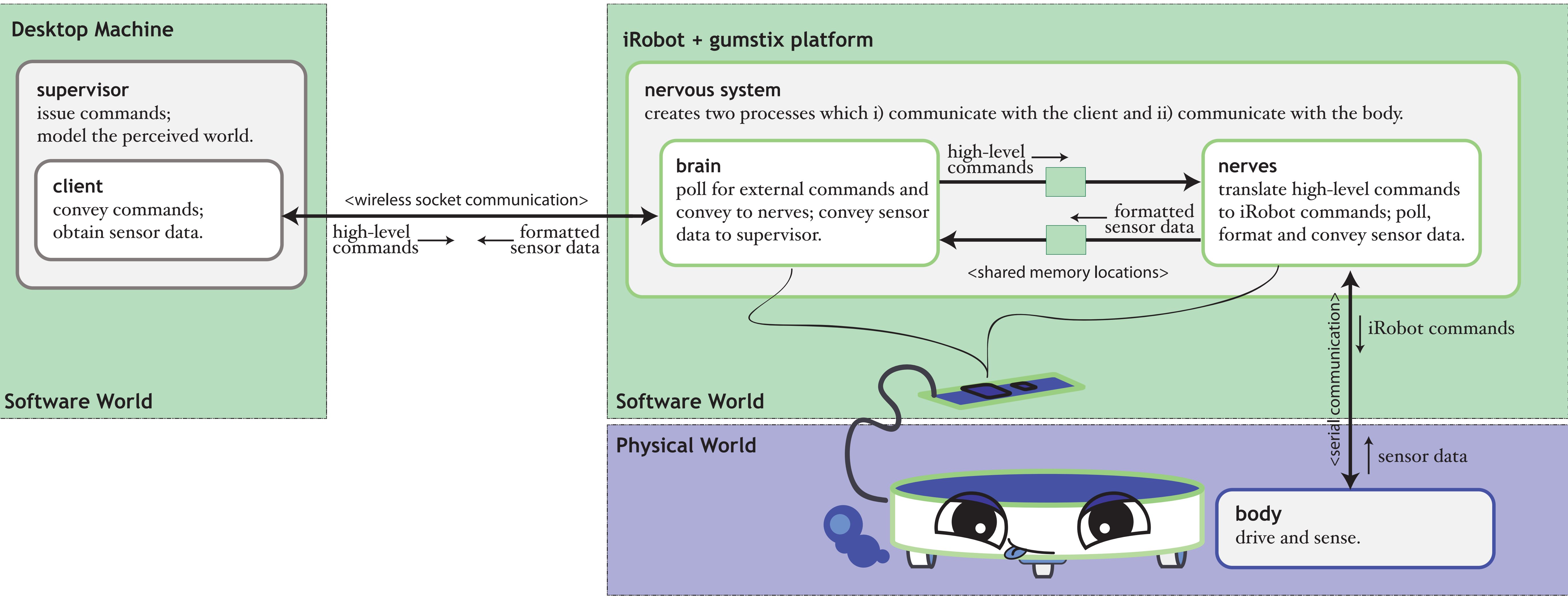
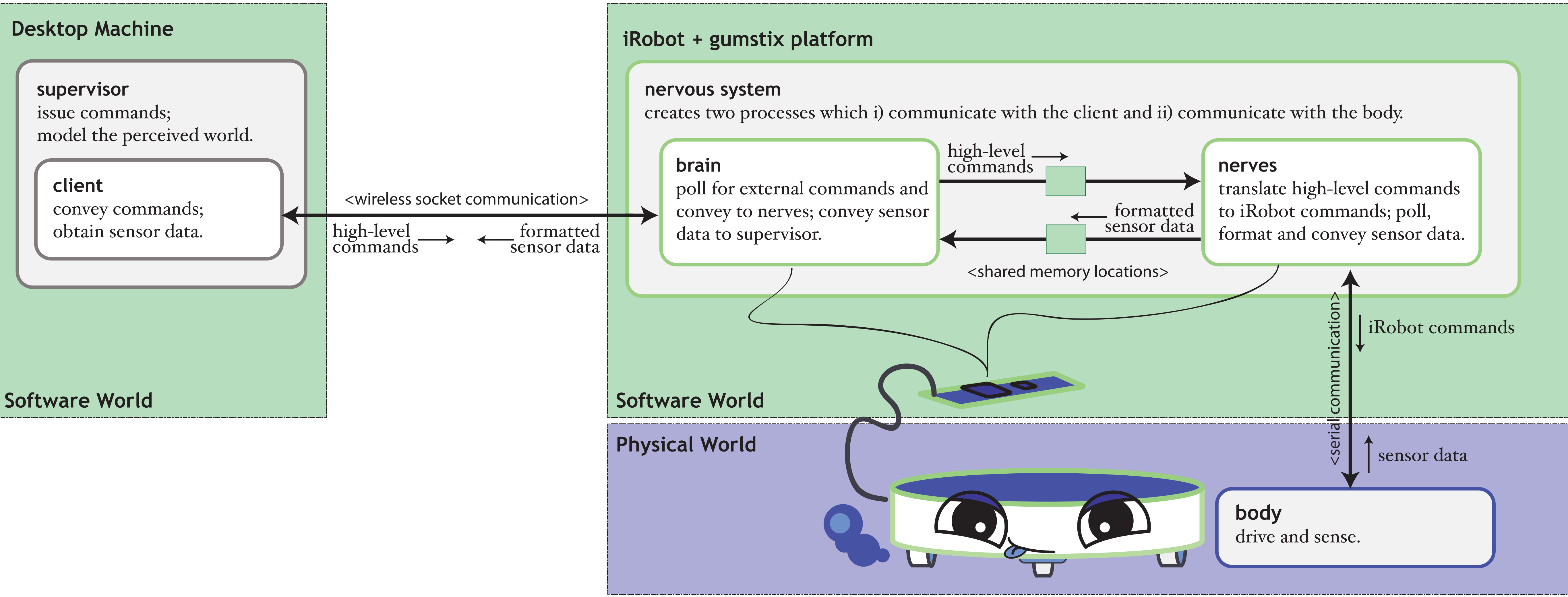


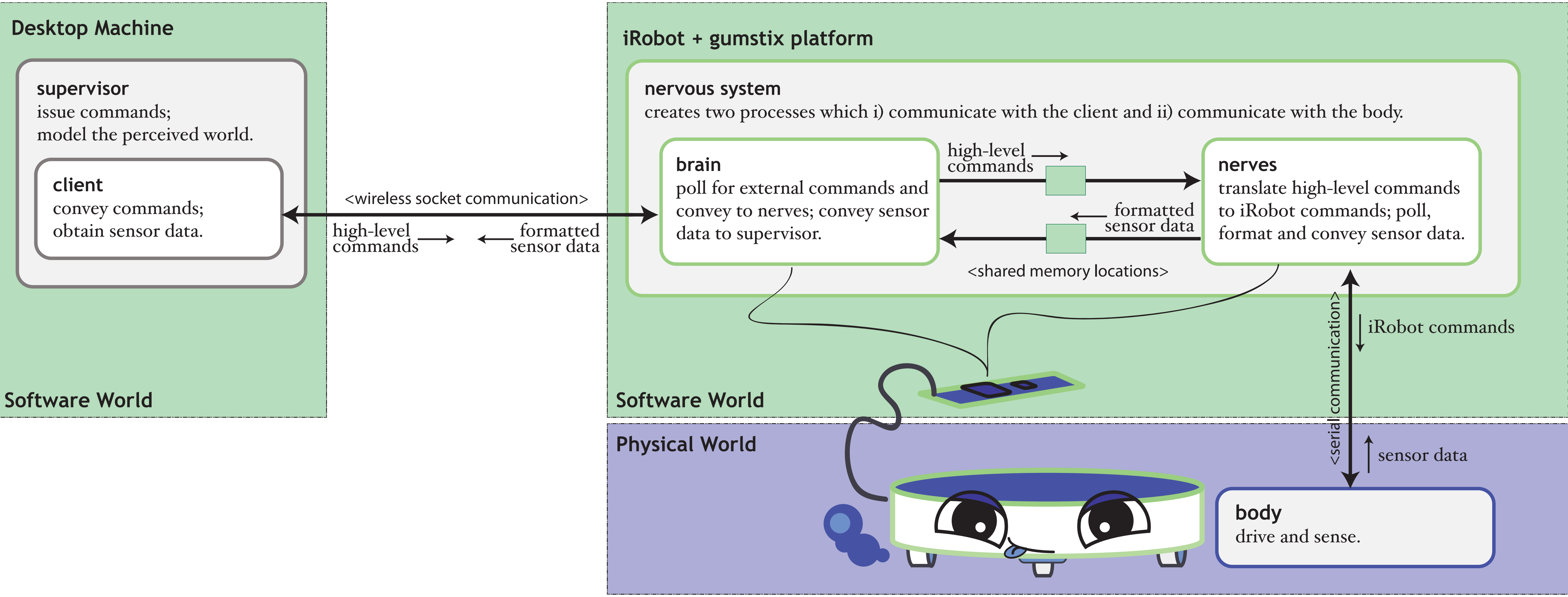
1. networked control.



2. enforceable physical properties.



3. off-the-shelf components.



2.

what features would be necessary for testing security threats and defenses?

security characteristics

1. networked control.

➡ provides multiple points of attack by which one may test against security threats.

security characteristics

2. enforceable physical properties.

➡ simulations make assumptions that can hide physical issues. A testbed eliminates some of these.

security characteristics

3. off-the-shelf-components.

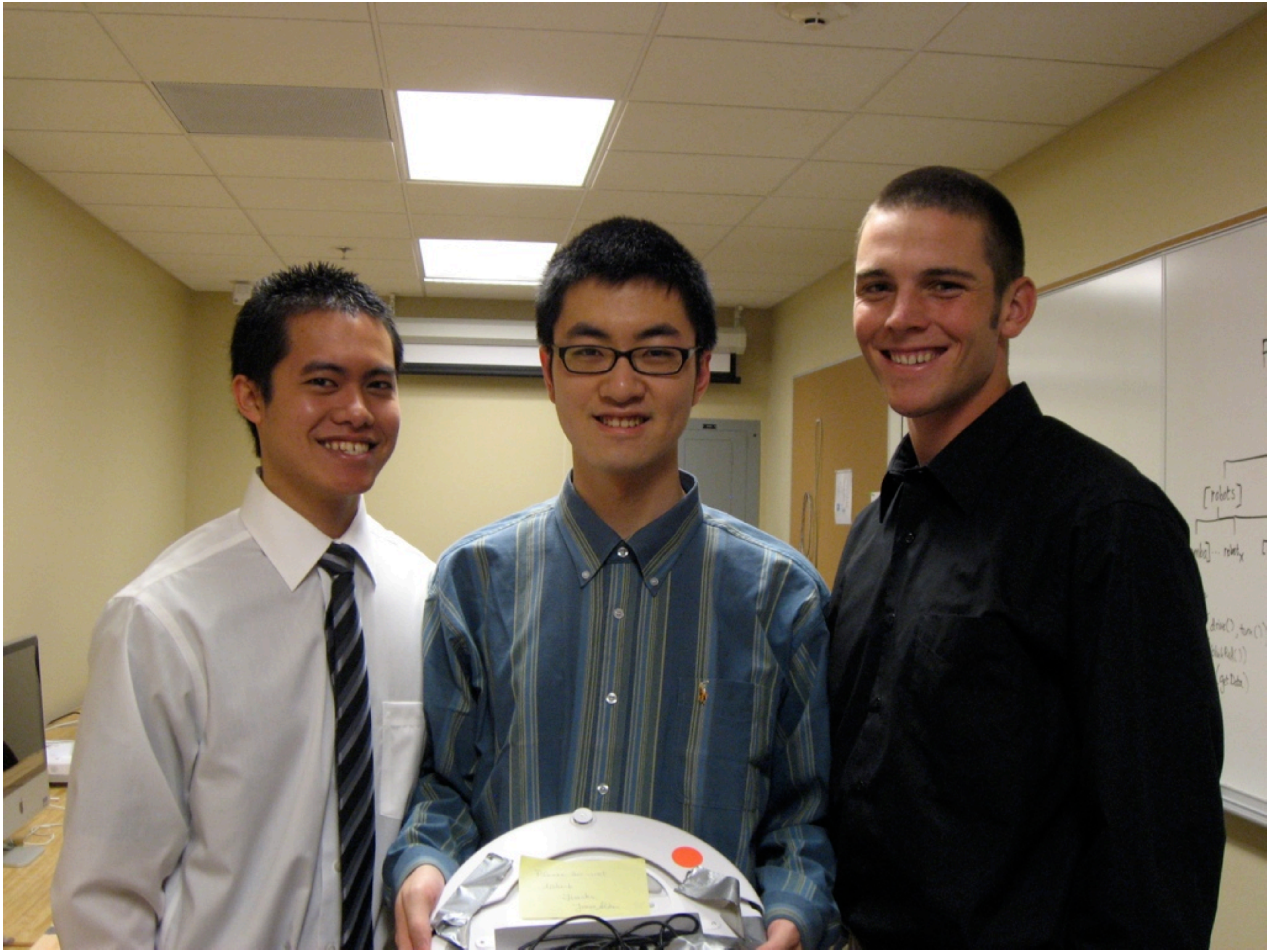
➡ defensive and fault-tolerant measures must be built into software solutions.

3.

how can it be accessible to undergraduates and useful to researchers?

undergraduate opportunities

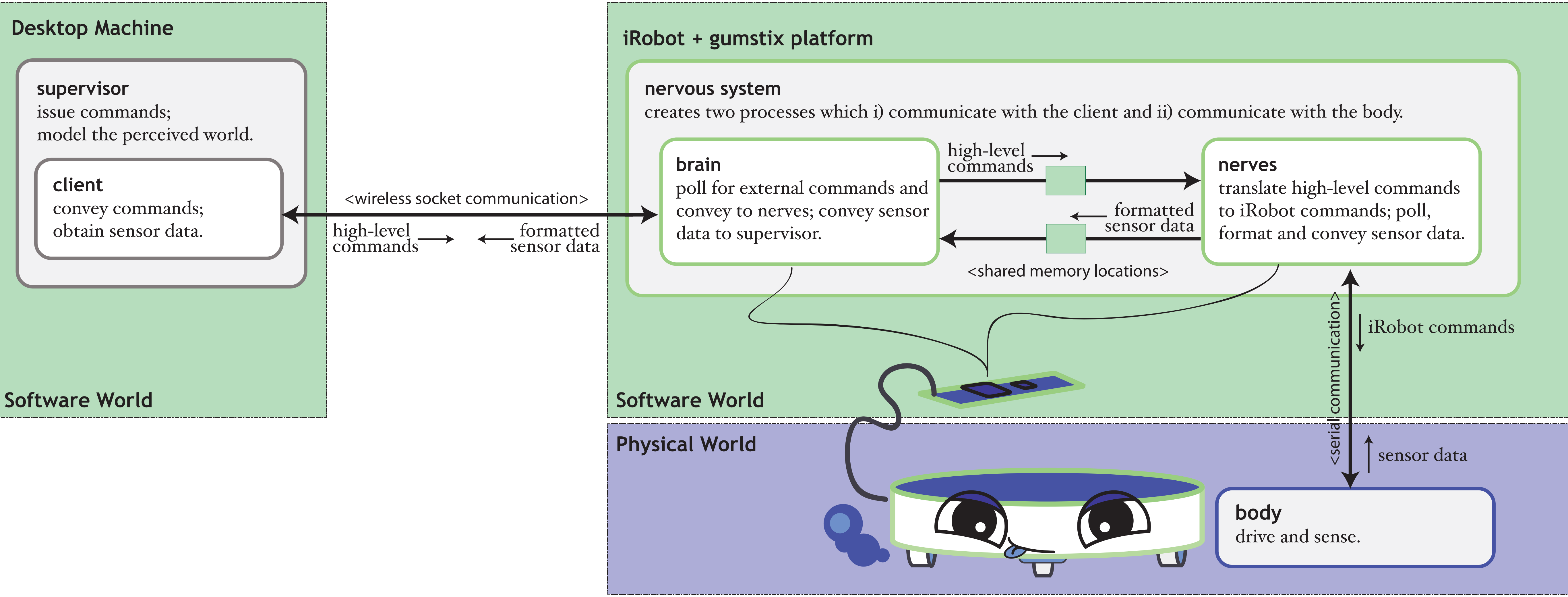
course modules



senior design project

5 undergraduate research projects

research opportunities


Desktop Machine
supervisor
issue commands;
model the perceived world.
client
convey commands;
obtain sensor data.
Software World
<wireless socket communication>
high-level commands
formatted sensor data
iRobot + gumstix platform
nervous system
creates two processes which i) communicate with the client and ii) communicate with the body.
brain
poll for external commands and convey to nerves; convey sensor data to supervisor.
high-level commands
formatted sensor data
nerves
translate high-level commands to iRobot commands; poll, format and convey sensor data.
<shared memory locations>
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iRobot commands
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Software World
Physical World
body
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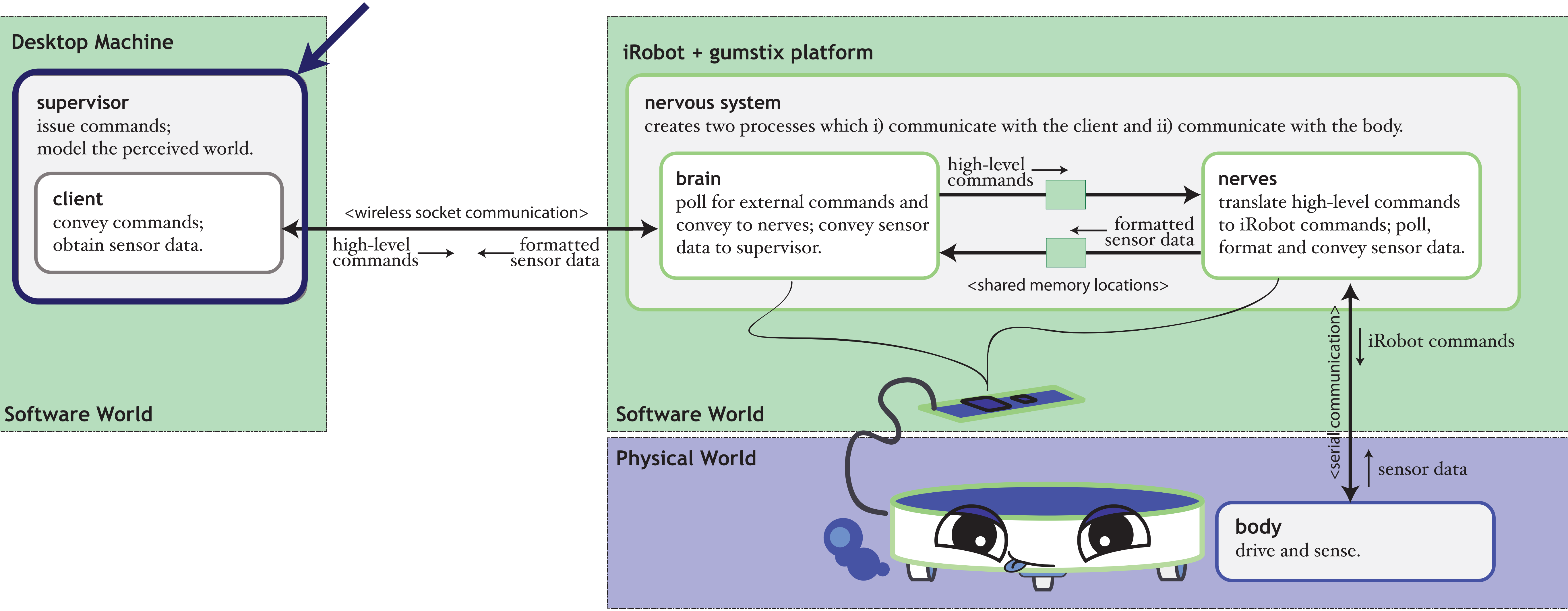
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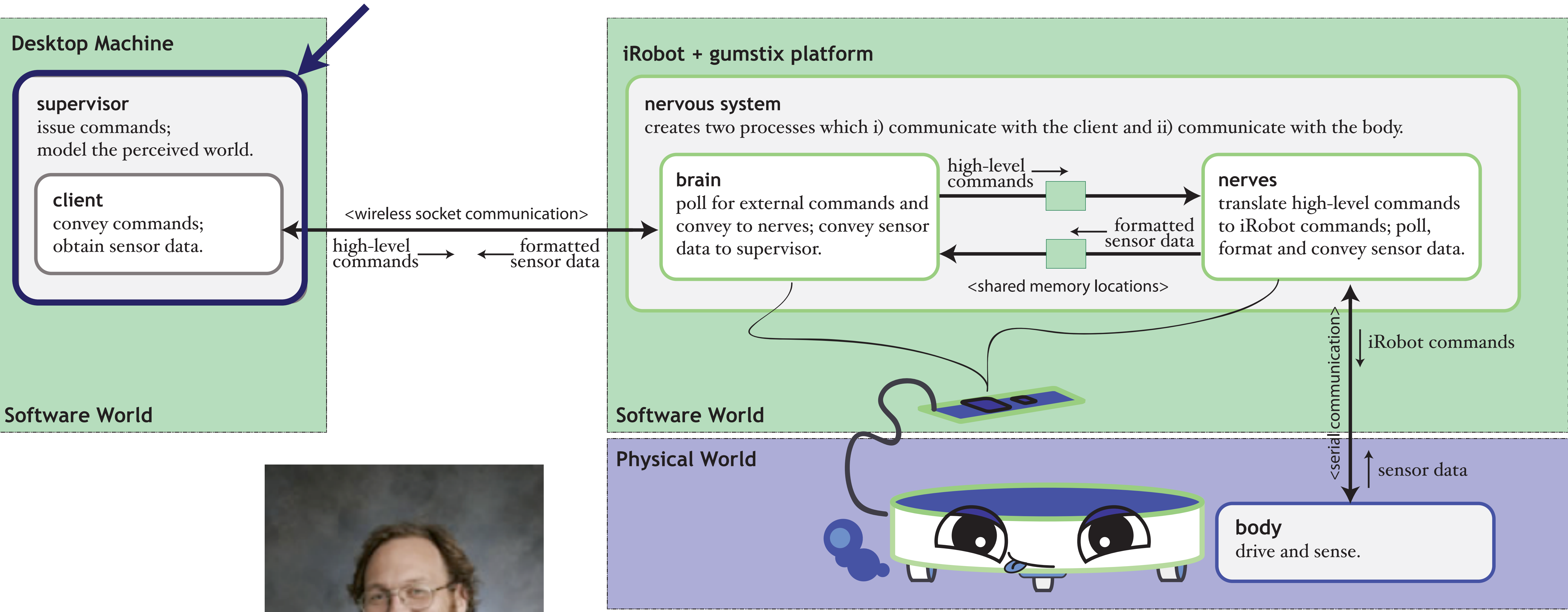
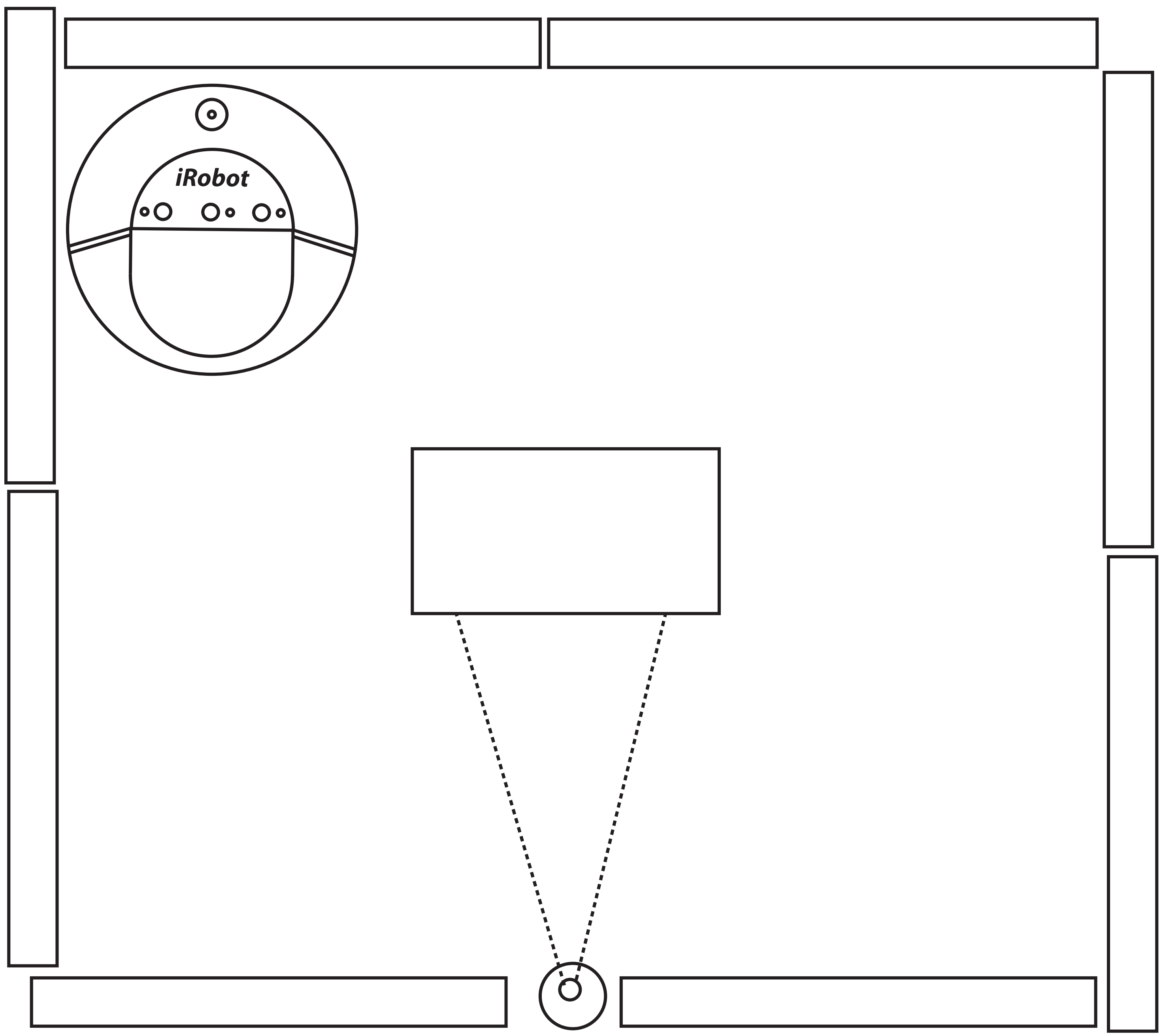


Andrew Nuxoll

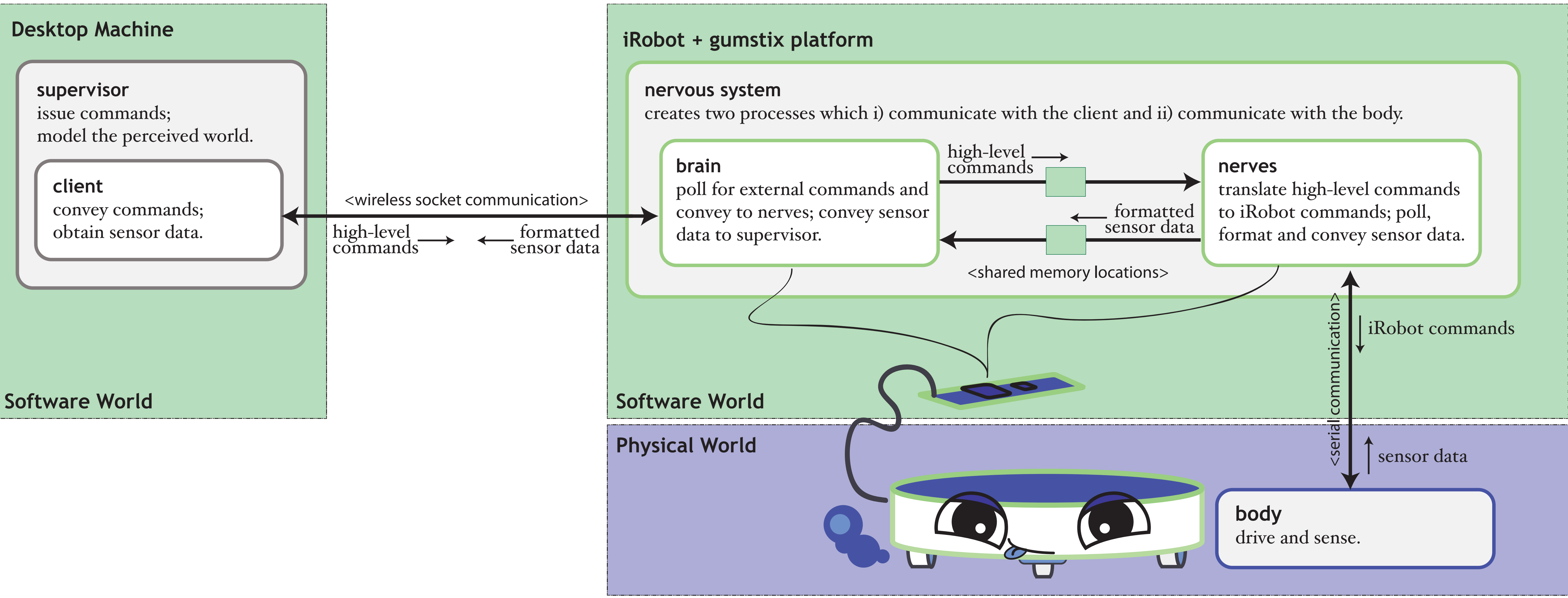
Research Question 1 (ongoing):

How successful is the episodic memory-based supervisor at learning how to navigate the robot through a simple maze?



1. Drive forward 630 mm.
2. Turn right 90 degrees.
3. Turn left 90 degrees.
4. Turn right 10 degrees.
5. Turn left 10 degrees.

Research Question 2 (future work):
Given that the supervisor has already learned a maze, how succesful is the supervisor at navigating the same maze in a threatening environment?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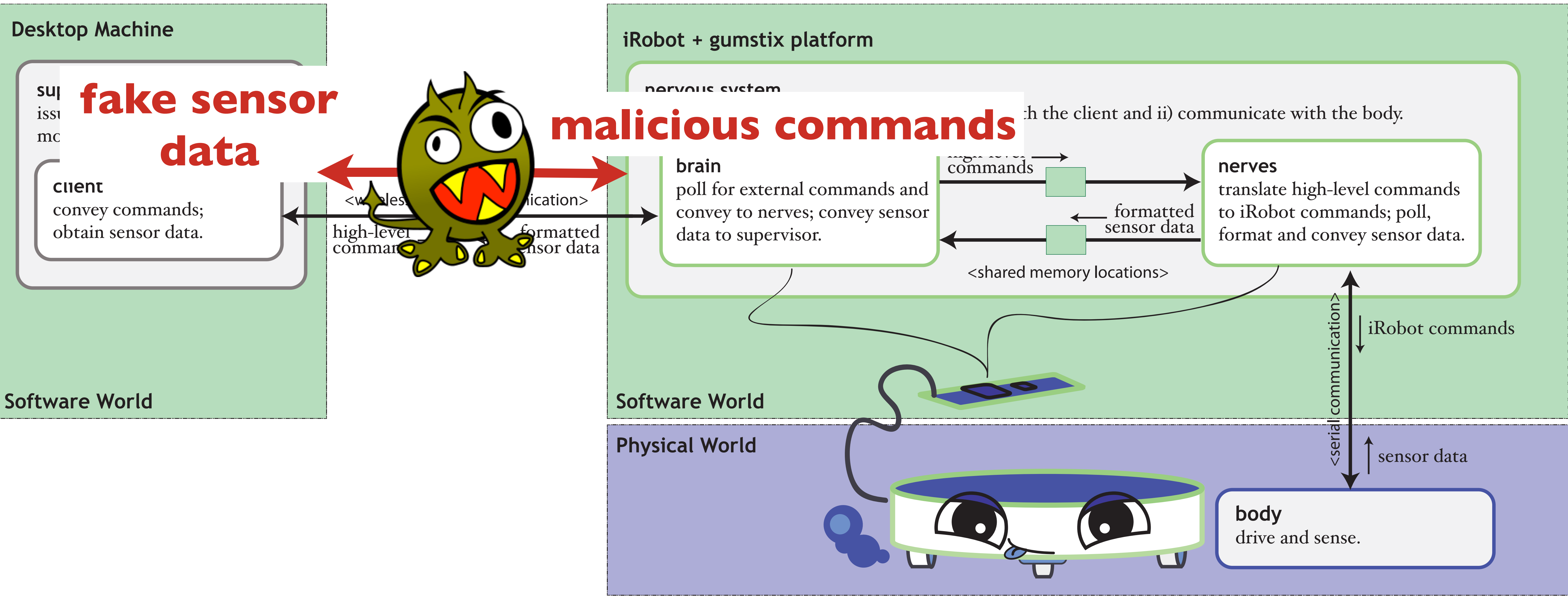
Desktop Machine
fake sensor data
malicious commands
client
convey commands;
obtain sensor data.
high-level
formatted
iRobot + gumstix platform
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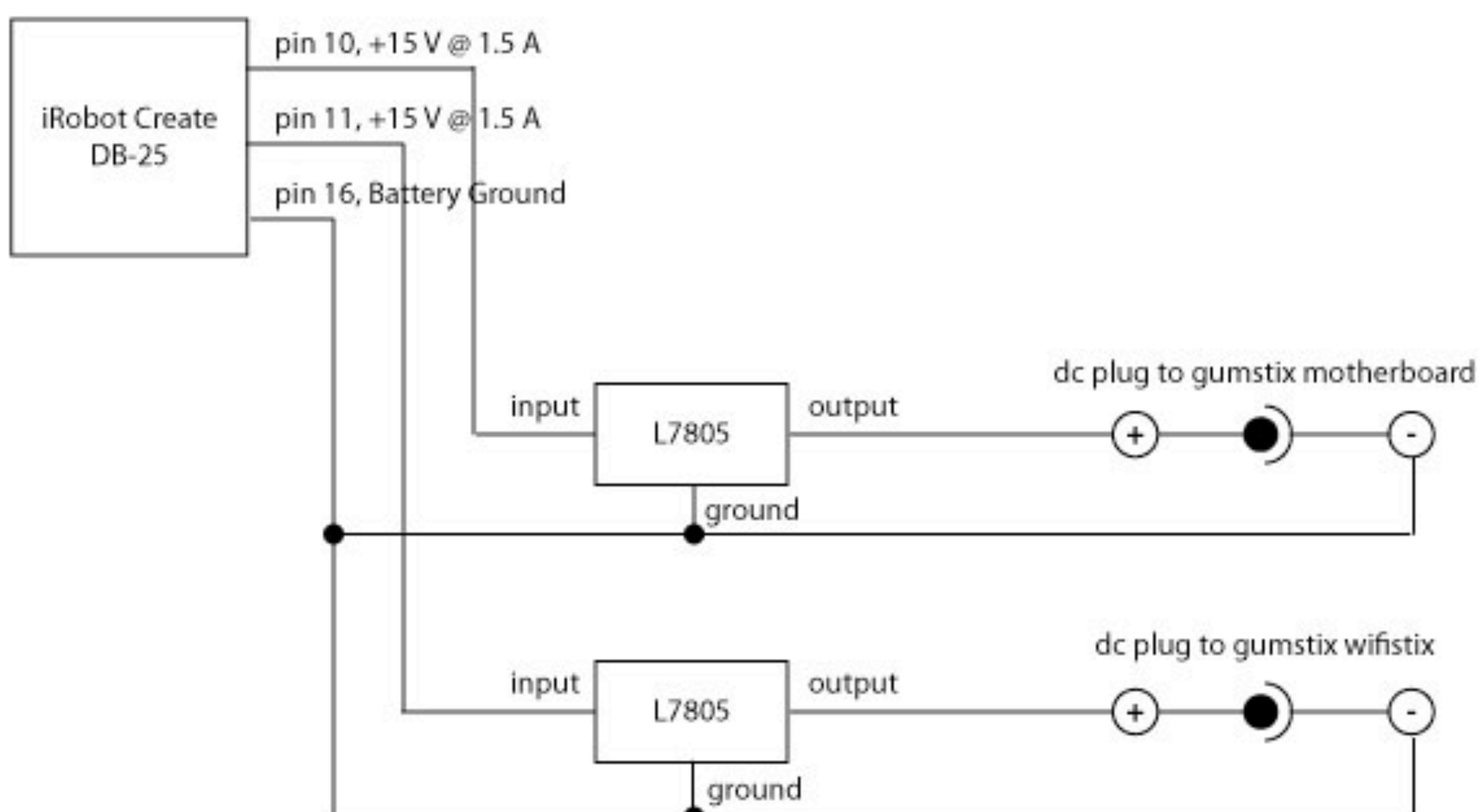
http://kaju.dreamhosters.com

http://kaju.dreamhosters.com

From its DB-25 serial port, the iRobot Create has multiple pins which supply +15V @ 1.5A when the iRobot is powered on. These are pins 10, 11, and 12. Powering the gumstix motherboards from the iRobot battery requires stepping down this +15V supply to +5V. To do so, build a simple step-down circuit using an L7805, a +5 Positive Voltage Regulator.

L7805 Positive +5V Voltage Regulator

I have not been successful at powering the gumstix from a single iRobot Create DB-25 pin. Instead, I power the gumstix motherboard and the gumstix wifistix separately from pin 10 and pin 11 using two L7805's, as shown in the circuit diagram below:



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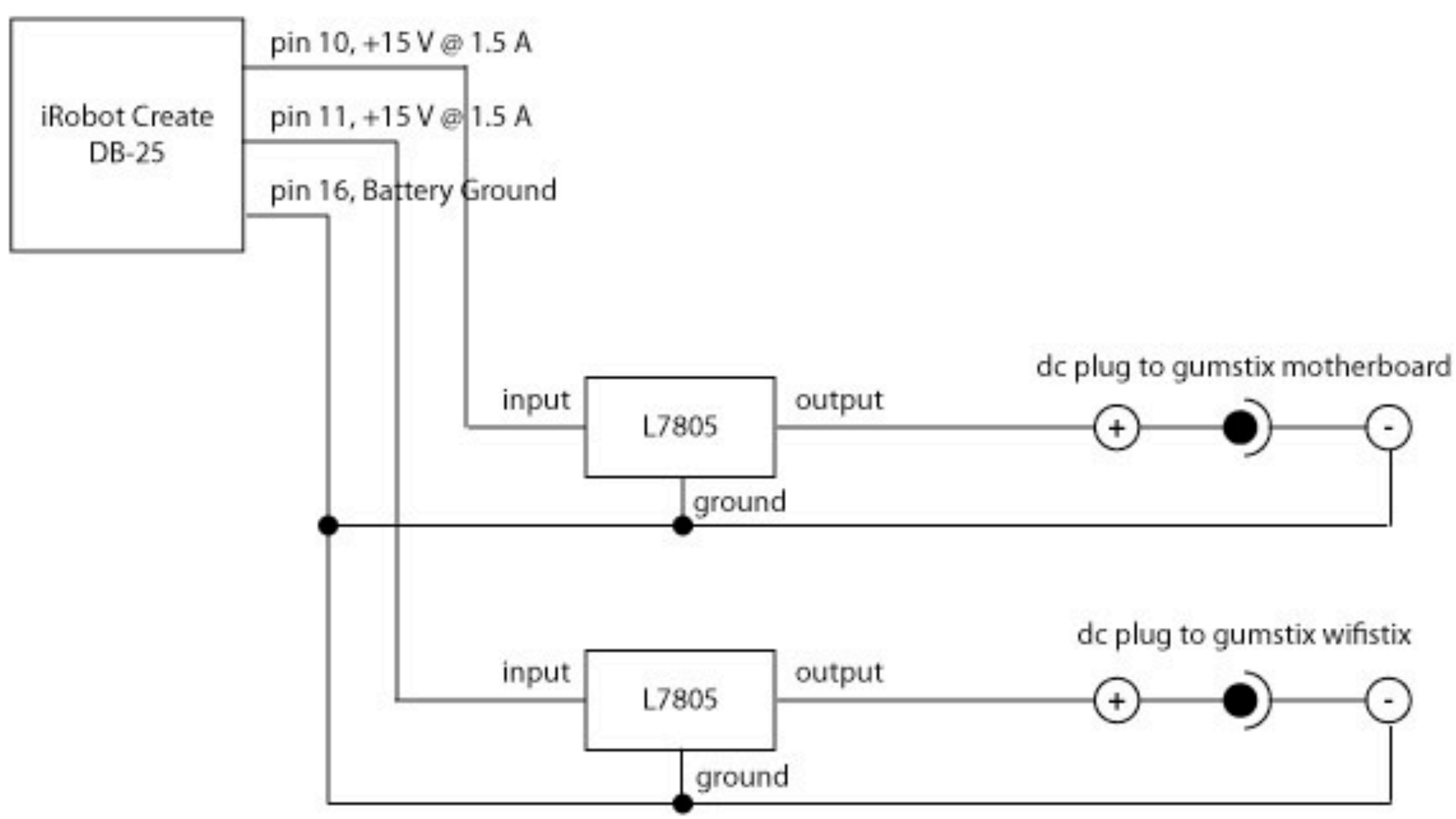
questions and collaborators welcome!



I do not think a bunch of dorky robots compare to an F-22.

I do think the upbot testbed offers a low barrier to entry for undergraduates and researchers in cyber-physical system security.

thank you

university of portland:

http://up.edu

robodocs:

http://kaju.dreamhosters.com

public code repository:

http://code.google.com/p/upbot/