HoneyBot: A Honeypot For Robotic Systems

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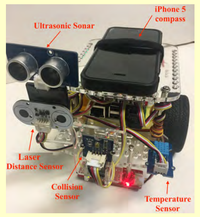
Abstract

- Historically, robotics systems have not been built with an emphasis on security
- Their main purpose has been to complete a specific objective
- As more and more robotic systems become remotely accessible through networks, they are more vulnerable than ever
- **HoneyBot:** The first software hybrid interaction honeypot
  - Specifically designed for networked robotic systems
  - Simulates unsafe actions and physically performs safe actions to fool attackers into believing their exploits are successful
  - Logs all communication to be used for attribution and threat model creation

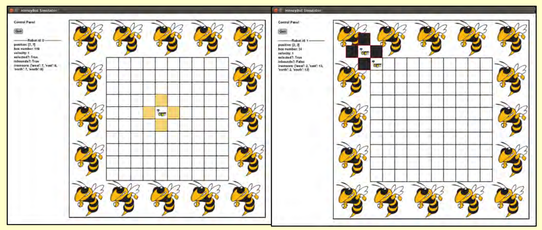


Background

- A robot is a device or mechanism guided by automated controls
- The prevalence of robotics growing in all facets of everyday life and robots are becoming a crucial part of our ecosystem
- New malware has demonstrated that hacking CPSs is possible and every networked/remotely accessible system is susceptible

Methodology

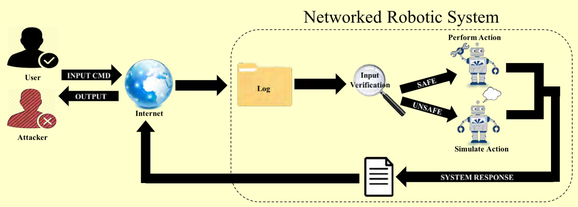
- **Reconnaissance:** Studied the building blocks of robotics and grouped them into three categories:
  - Sensors: enable the robot to judge features of the environment
  - Actuators: enable the robot to modify the environment and move
  - Controller: enables the robot to “think”
- **HoneyBot Simulator:** Build software GUI to establish the importance and feasibility of the HoneyBot



- **Sensor Correlation and Model Creation:** Reconnaissance revealed that the most important factor to being a believable robot is yielding sensor data that corresponds to the actions and environment of the robotic system

a) Ultrasonic Sonar b) Collision Sensor c) Infrared Distance Sensor

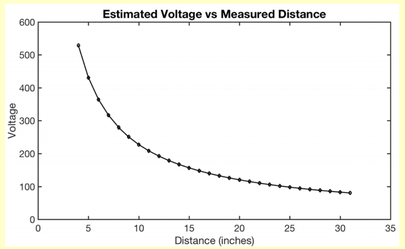
HoneyBot Architecture



Results

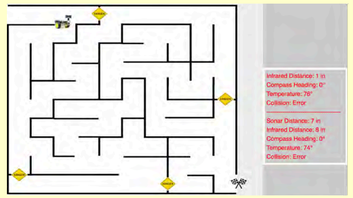
- A combination of experimentation and physical process modeling was used to simulate device behavior.
- The goal was to query these models at runtime and generate ”spoofed” responses
- **Ultrasonic Sonar:** Experiments were performed to measure ultrasonic sonar responses attached to a robot driving at different speeds towards a static target. Speed was determined to be an independent factor

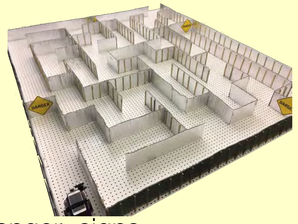
- **Collision Sensor:** This device model is triggered by reading from the sonar and infrared distance sensors. If below an empirically determined threshold it renders a collision event
- **Infrared Distance Sensor:** We built a plot of voltages outputted from the sensor versus distance (measured manually) and derived an equation from the fit of the line



Evaluation

- **Experiment:** Surveyed user experiment used to test effectiveness of HoneyBot
  - Participants connected to web GUI and navigated an onscreen robot through a maze
  - This physically navigated the HoneyBot through an identical maze in a lab environment.
  - Participants had access to robot sensor and no explicit instructions were given regarding danger signs.





  - Subjects weren’t aware danger signs indicated shortcuts though the maze and triggered HoneyBot simulations

Results: Collected from user surveys

Scale (1 is very inaccurate and 5 is very accurate)	How accurate did the sensor values displayed on the control panel seem throughout the experiment?	How accurate did the sensor values displayed on the control panel seem after you crossed through danger sign(s)?
1	1 (2.5%)	1 (7.14%)
2	4 (10%)	0 (0%)
3	13 (32.5%)	3 (21.43%)
4	15 (37.5%)	6 (42.86%)
5	7 (17.5%)	4 (28.57%)
Total	40 (100%)	14 (100%)