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Enhancing Wi-Fi Signal Strength of a Dynamic Heterogeneous System Using a Mobile Robot Provider

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Motivation

Heterogeneous robot-human-device teams have complex and dynamic Wi-Fi requirements. We propose and validate an algorithm in which a **mobile robot Access Point** (AP) enhances the WLAN network of a team consisting of a robot (DARwin-OP), a human controlled device (Nexus tablet), and a stand-alone device (Edimax Range Extender).

1. Components

Clients:

DARwin-OP

Tablet

Router

Provider:

Pico Station Wireless AP

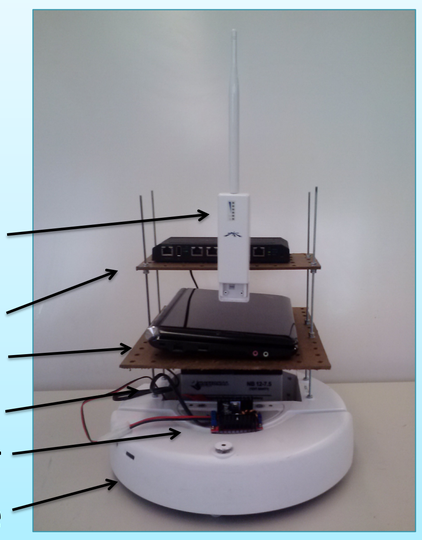
Network Switch

Asus Eee PC

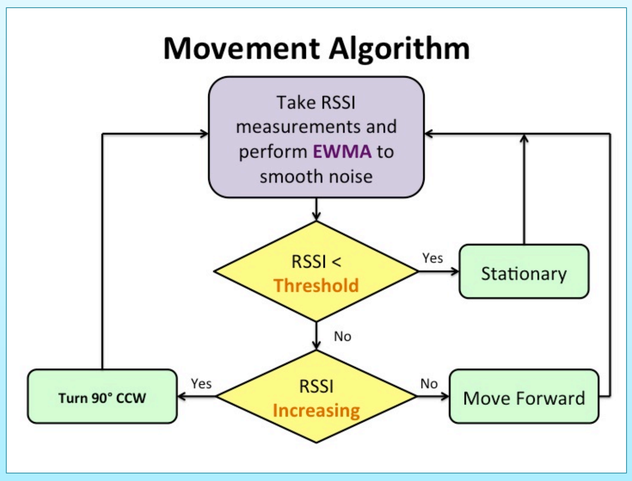
12V Battery

Power Transformer

iRobot Create



2. Algorithm



- **Exponentially Weighted Moving Average (EWMA):**

$$S_t = \lambda \cdot Y_t + (1 - \lambda) \cdot S_{t-1}$$

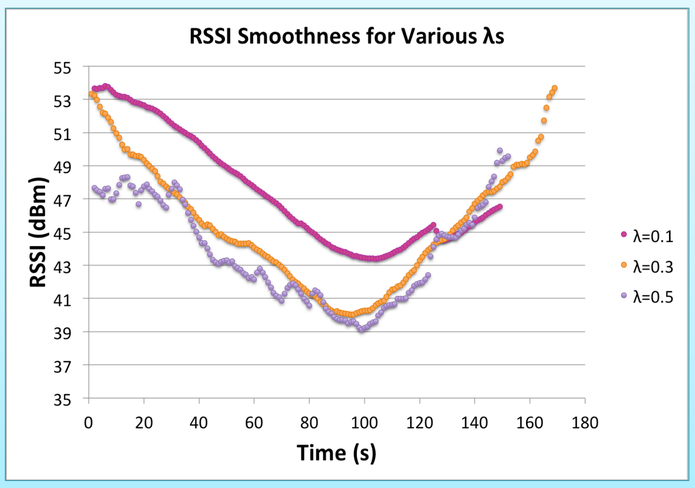
$$S_1 = Y_1$$

Where S = Sum, Y = individual data

(see below for determining λ)

- **Threshold: 42 dBm**
- **Increasing: Linear Regression with slope > 0; σ > 0.05**

3. Condition Testing - Optimizing λ

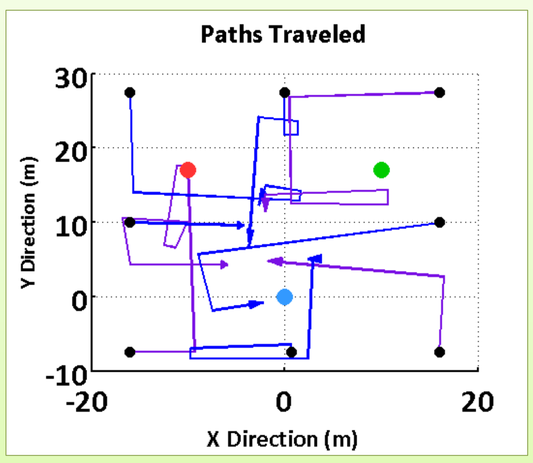


Objective: optimize smoothness of EWMA RSSI values by adjusting λ.

Results:

Optimal λ = 0.3

Test Case 1: Initial Position

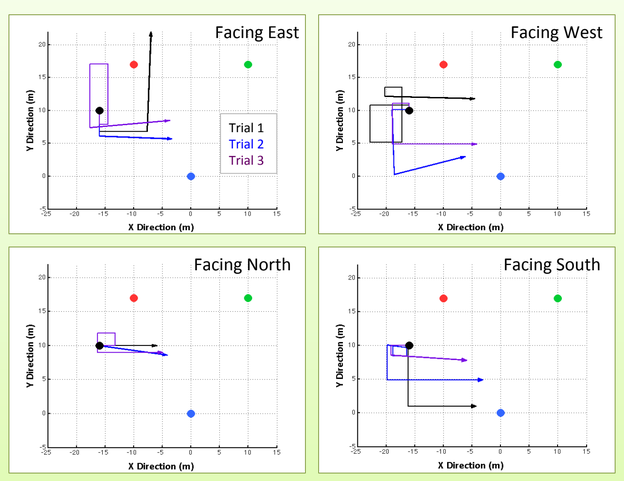


Objective: test the provider's path given various initial positions.

Results:

Average # of turns	3.375
Average time (min:sec)	2:50

Test Case 2: Initial Orientation



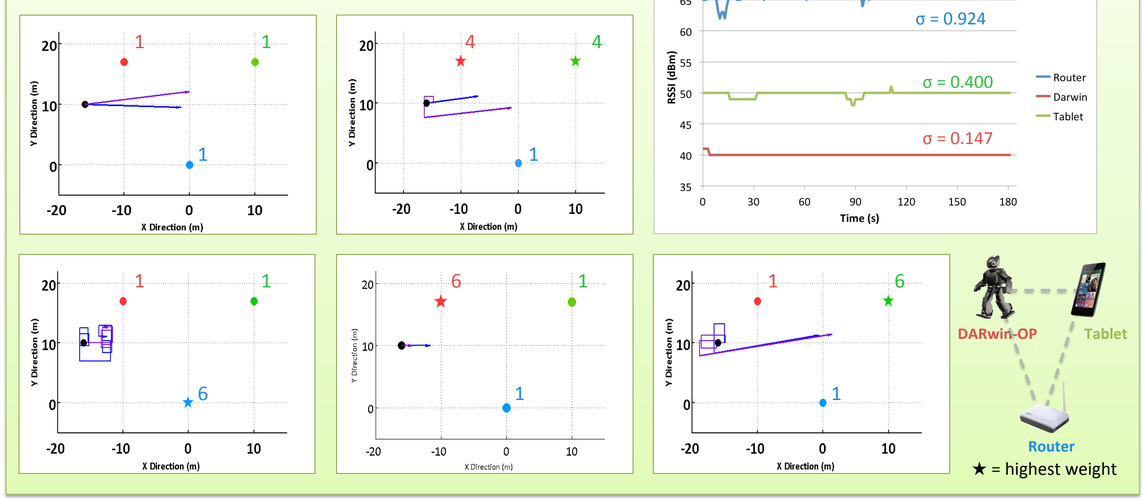
Objective: test variability of the provider's path given various initial orientation.

Results:

Direction	E*	N	W	S
Turns taken/ turns necessary to final location	2 1 5/ 2 1 3	0 0 4/ 0 0 3	7 3 3/ 3 3 3	2 6 2/ 2 3 2
Average time (min:sec)	2:32	1:17	2:56	2:14

*Trial 1 facing East: the provider moved off the grid. Measurements for turns taken / turns necessary are provided. The time provided is an average of the 2nd and 3rd trials facing east.

Test Case 3: Weighting Clients



Conclusions

- **Successful implementation** of a mobile AP to enhance Wi-Fi signal of heterogeneous clients.
- **Optimal algorithm parameters may be dependent on location** and should be tested prior to further experimentation or implementation in new environments.
- Algorithm is successful for a **variety of initial positions and orientations**.
- **Weighting higher-noise clients less** provides more efficient movement.

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