INSTRUCTIONS FOR CREATING A LANDSCAPE POSTER FOR THE ENGINE 2022 SHOWCASE

QUESTIONS? EMAIL: PR_TEAM@ECE.UW.EDU

1. VIEW THE EXAMPLE (2) AND BLANK LANDSCAPE TEMPLATE (3) BELOW.

NAVIGATE TO THEM USING SLIDES ON THE LEFT.

2. WE'VE COPIED THE BLANK TEMPLATE (3) TO A NEW SLIDE (4) FOR YOU TO BEGIN CREATING YOUR POSTER.

IF YOU'D LIKE TO CREATE DIFFERENT VERSIONS OF YOUR POSTER, RIGHT CLICK & CHOOSE "DUPLICATE SLIDE".

3. TO DISPLAY GUIDES, PRESS CMD + OPTION + CONTROL+ G (MAC) / ALT + F9 (WIN)

OR GO TO VIEW – GUIDES IN THE POWERPOINT MENU.

4. WHEN FINISHED, SAVE IN THE FORMAT REQUIRED BY YOUR PRINTING VENDOR

5. IMPORTANT!! DO NOT CHOOSE TO 'OPEN WITH GOOGLE SLIDES'!

YOUR TEMPLATE WILL NOT BE FORMATTED PROPERLY. DOWNLOAD AND OPEN WITH POWERPOINT.

***PREFERRED FONTS ARE USED IN THIS SAMPLE PRESENTATION: ENCODE SANS FOR TITLES AND OPEN SANS FOR BODY. UNI SANS IS ALSO ALLOWED –**
These can be downloaded and installed on your computer for free here: https://www.washington.edu/brand/graphic-elements/font-download/

Deep Contact Graph Routing for Lunar Operations

01

STUDENTS: Andrew J Tettamanti, Rohan Menon, Isaac Remy, Paolo Torrado, Marcus Chen, Lyla Cain, Alex Sklar, Hanh Dang

Introduction and Objective

To meet the demands of NASA's exploration and science missions, advanced communication technologies are needed for space networks.

However, long-distance communication in space poses challenges like delays, disruptions, and data loss. NASA addresses these challenges with Delay Tolerant Networking (DTN), a reliable solution for space missions.

Additionally, the Cognitive Communications project focuses on enhancing the autonomy of space communication using AI agents.

Our project aims to develop an ML-enhanced version of Contact Graph Routing, combining RF information and DTN to enable successful data transmission between space and Earth.

Method

Data Collection: Utilized the UW MuSHR Car and an ESP32 device to collect Channel State Information (CSI) and position data from an access point (AP) in the ECE basement.

DTN Simulator: Developed an agent-based DTN simulator to replicate the moon rover environment and simulate data transmission scenarios.

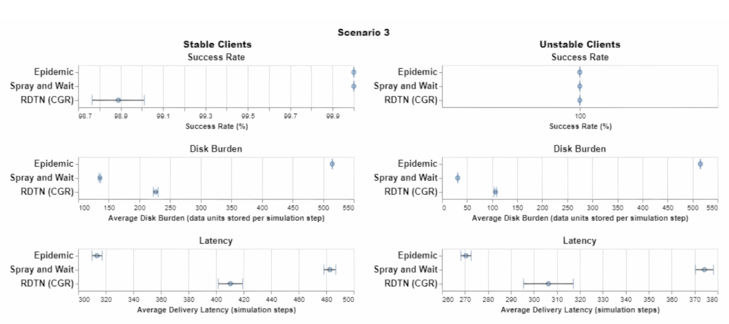
RSSI Integration: Incorporated RSSI measurements into the simulator using a simple pathloss and shadowing model for realistic signal propagation.

ML-Based Navigation Algorithms: Utilized the collected data to test machine learning-based navigation algorithms within the simulated environment.

Performance Evaluation: Assessed the performance of the ML-based algorithms using metrics such as accuracy and efficiency.

Model Training and Evaluation: Trained the selected ML models using the training data and evaluated their performance.

Roaming DTN



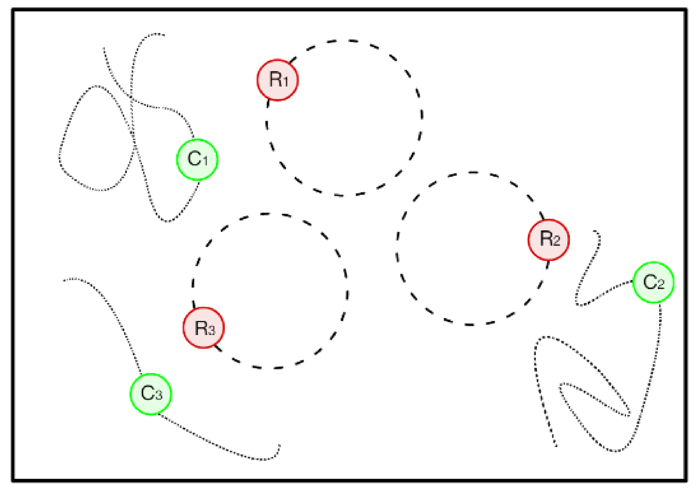


Fig. 1 (left): Success Rate, Disk Burden, and Latency plots of Stable and Unstable Clients in Scenario 3.

Fig. 2 (right): A simulation of the movement of DTN clients in relationship to the predictable movement of DTN routers.

Radio Map Collection

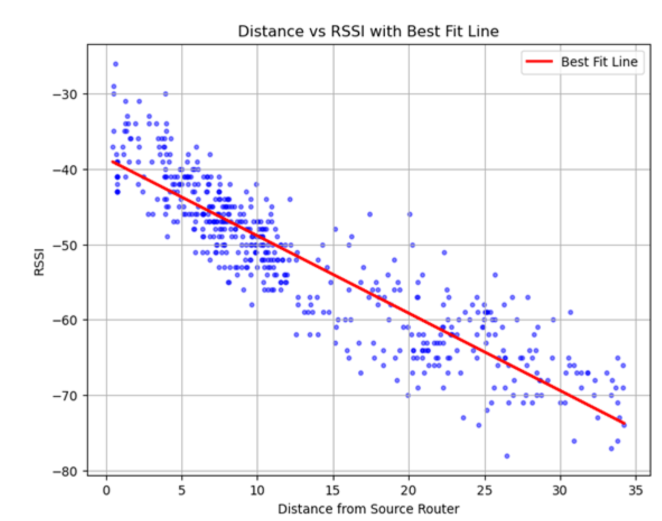
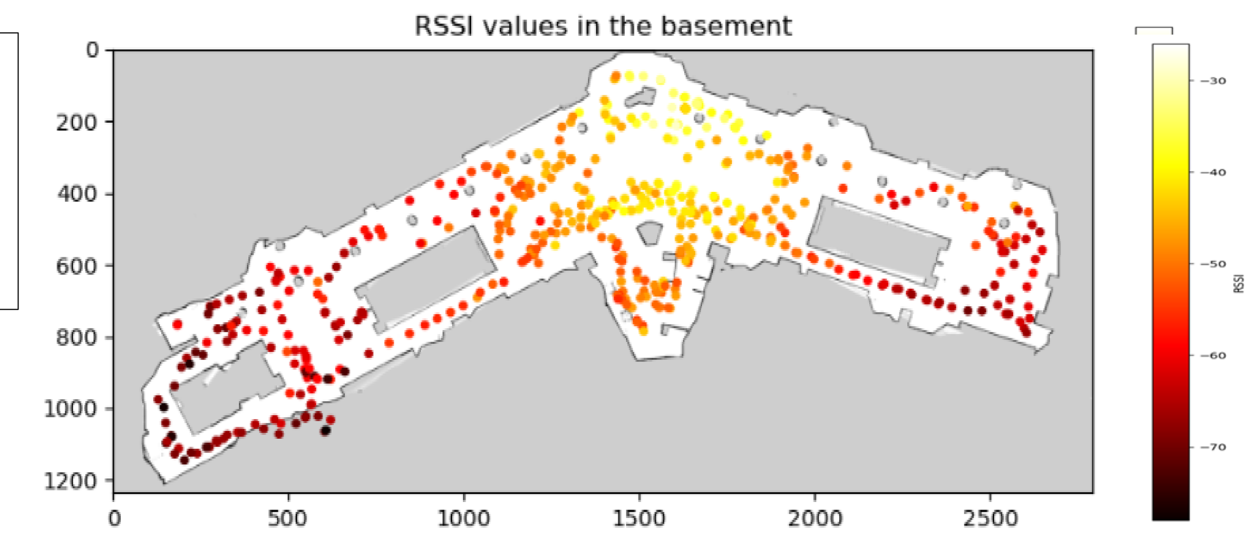


Fig. 3 (above): The collected data's relationship to distance

Fig. 4 (above, right): The MuSHR car using four ESP32's

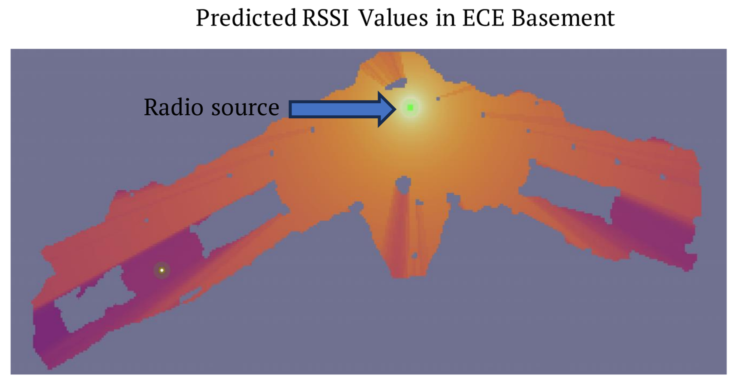
Fig. 5 (right): RSSI values in the ECE basement



We collected empirical data utilizing ESP32s in 802.11n mode targeting channel 7, 2.431–2.453 GHz.

RSSI data was collected and linked to the position of the MuSHR car in the ECE basement

Radio Map Estimation



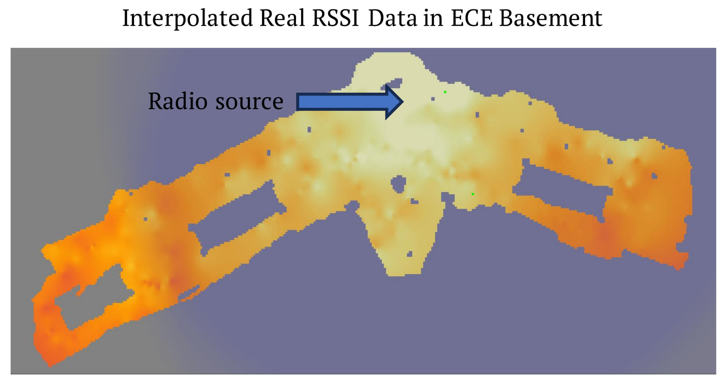


Fig. 6 : Prediction of RSSI using raytracing simulation

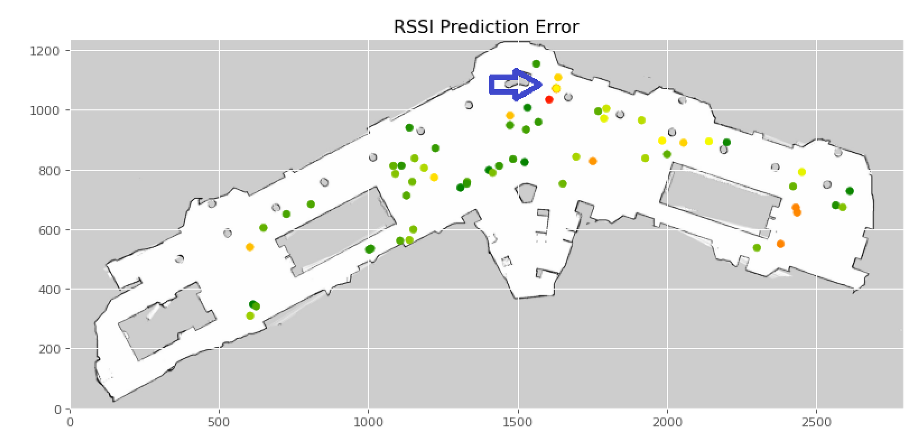
Fig. 7 : Real, interpolated RSSI values

Data in the simulation is generated using path loss, while factoring in shadowing from obstructions (fig. 6)

Real data was interpolated from our collected real data to create a continuous map (fig 7.)

In these maps, we can see that the shadowing simulation had a more aggressive drop in RSSI vs. what we actually observed and interpolated, but overall had a very similar distribution.

Evaluation



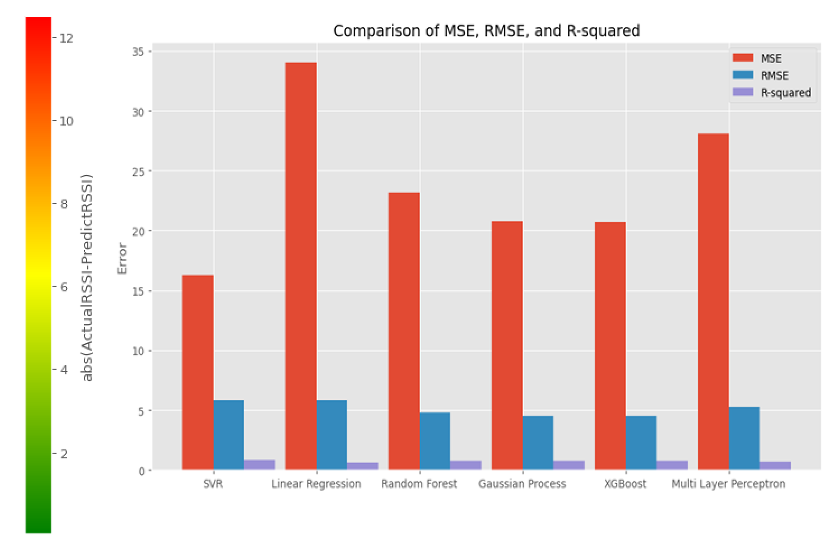


Fig. 8 (left): Prediction Error using SVR model. Locations of actual RSSI measurements are plotted on the map. The color of these dots represents the error of the predicted RSSI from the SVR model at these locations. The blue arrow shows the location of the source.

Fig. 9 (right): Comparison of MSE, RMSE and R-squared using different machine learning models.

Based on the observations, Support Vector Regression has the lowest MSE.

The map plot shows that our model struggles to predict RSSI in locations near obstacles or in hallways.

We see that this has more of an effect on accuracy than the distance from the source.

Summary

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DTN Simulation: Developed an agent-based DTN simulator to replicate a moon rover environment and simulate data transmission scenarios.

RSSI Integration: Incorporated RSSI measurements into the simulator using a simple pathloss and shadowing model for realistic signal propagation.

ML-Based Navigation: Utilized the collected data to train and test machine learning-based navigation algorithms within the simulated environment.

Future Work, References, and Acknowledgments

- Incorporate the ML algorithm on the UW MuSHR car
- Create a more complex Radio Propagation simulation model that can incorporate pathloss and shadowing
- Implement RDTN on the MuSHR cars to evaluate real world performance

Faculty: Joshua Smith
Students: Domonick Ta, John Taggart, Seth Feaser, Andy LeGrande, Rucha Kher

[1] J. A. Fraire, O. De Jonckère, and S. C. Burleigh, "Routing in the Space Internet: A contact graph routing tutorial," Journal of Network and Computer Applications, vol. 174, p. 102884, Jan. 2021, doi: 10.1016/j.jnca.2020.102884.

[2] S. M. Hernandez and E. Bulut, "WiFi Sensing on the Edge: Signal Processing Techniques and Challenges for Real-World Systems," IEEE Commun. Surv. Tutorials, pp. 1–1, 2022, doi: 10.1109/COMST.2022.3209144.

ELECTRICAL & COMPUTER ENGINEERING
UNIVERSITY of WASHINGTON

ADVISORS: Professor Josh Smith

SPONSORS: ELECTRICAL & COMPUTER ENGINEERING DEPARTMENT, UNIVERSITY OF WASHINGTON

STUDENTS: FIRST & LAST NAME, FIRST & LAST NAME, FIRST & LAST NAME