



Remote

Members:

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Introduction

Welcome to your division diary!

Here we will be updating what progress we have made in order to track it and use it for the reports in the future. This allows us to be very specific in our report on challenges we faced, different methods we used, etc.

Formatting

In order to keep things tidy we should all follow the same formatting for ease of use and accessibility. The information we want to display would be title, date, description, picture(s) and your name.

See next page for an example.....

After viewing the example you notice that Nate's didn't have a title right? This is because they fall under the same subject/project therefore we don't need to make a new title. We want to separate it like this so that it's easy to view the progress of each individual project and subsections rather than having it mixed up. If there's any questions feel free to reach out to me (Gio/Jefferson).

Table of Contents

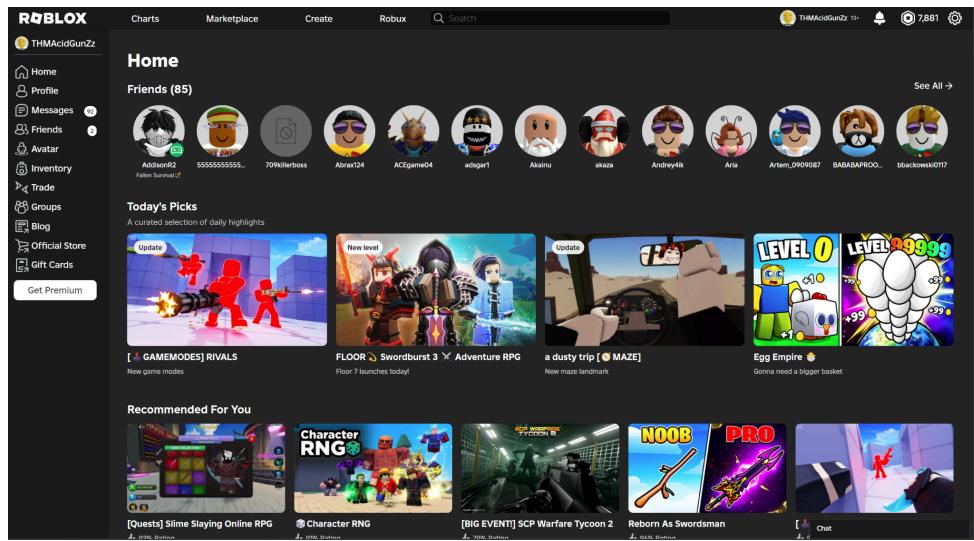
To make it easier for everyone to search for stuff we need to make a table of contents. This doesn't need to be made now but it would be nice to have in the future as it makes getting to each section easier.

If your team is feeling confident and don't need these instructions anymore feel free to delete it. If there's any questions feel free to reach out to me (Gio/Jefferson).

Installing Roblox

Giovanni Diaz-Lopez

10/02/2024



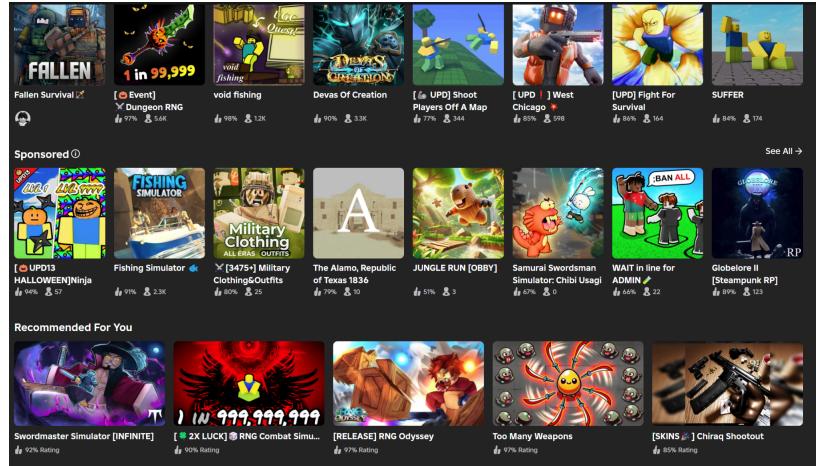
(Cool Roblox Shiz)

Today I decided to download roblox, I played for about 10 minutes.

Don't look at the robux I have, I forgot that I was paying for the membership for almost a year.

Nate Weast

10/04/2024



(More Roblox Shizzz)

I also downloaded roblox and worked on my skillz.

End of Example, return to the instructions!

Antenna research

William Sotelo

10/23/2024

Omnidirectional Antennas:

- The cost of omnidirectional antennas can vary from \$150 to \$300
- Yagi or patch designs require outsourcing ensuring reliabiliy.
- lower gain (around 2-9 dBi) compared to directional antennas
- Antennas for field use can weigh between 200 grams to 2 kg
- Omnidirectional antennas generally do not require extensive programming by operators since they emit signals evenly in all directions.
- The 900 MHz band supports various data rates, commonly ranging from 1 kbps to 100 kbps or higher
- Provides 360-degree coverage, allowing the rover to maintain communication with control stations from any direction. This is particularly beneficial in environments where the rover's orientation may frequently change.

Directional Antennas:

- Directional antennas require precise alignment to ensure optimal signal reception and transmission
- The design requires precise calculations for gain, bandwidth, and radiation pattern.
- beam patterns
- 8 dBi and 20 dBi depending on the design (Yagi, parabolic)
- Reduced interference due to focused reception
- Directional antennas can support higher data transmission rates compared to omnidirectional antennas due to their increased gain and focused signal.
- Generally heavier, typically ranging from 1 to 10 kg, with larger models exceeding this range.
- Focuses the signal in a specific direction, significantly increasing the range and strength of communication. This allows for long-range data transmission, making it suitable for remote control and data transmission when the rover is far from the base station.

Combo:

- Router integration, The router manages the communication between the antennas and the control system. It can switch between the antennas based on operational needs, ensuring optimal performance whether the rover is moving or stationary.
- If one antenna fails or is obstructed, the other can provide continued communication, enhancing reliability.

- The combination allows the rover to adapt to different environments and communication needs, providing both wide coverage and focused transmission.

Roverova UCR 2023 Rover: (Omnidirectional combo with directional antenna)

- 1km connection
- Wifi not required

ITU Rover team 2023 : (Directional Antenna)

- 2.4 GHZ wifi modules
- Long range
- Rotated in accordance to location of the rover

Yildiz Rover 2023 (Omnidirectional Antenna)

- 5.8 GHZ access points
- 2km Range

Omnidirectional antenna research

William Sotelo

11/06/2024

* Reference video:

<https://www.youtube.com/watch?v=nfSPFfpMGWA&list=PL8VXKzY8zO8Cle1lnLs2RgtIoTcVrej7&index=3>

* To use Omnidirectional antennae setup up we need 5.8 GHZ access points (access points use a directional antenna on the control station) and a Lora communication module up to a two-kilometer range

* Communication between electronic devices is provided by CAN communication protocol.

Components links:

<https://www.l3harris.com/sites/default/files/2022-10/cs-bcs-tactical-rover-cls-antenna-sell-sheet.pdf>

<https://www.commscope.com/product-type/antennas/base-station-antennas-equipment/base-station-antennas/omnidirectional/>

Wireless protocol + microcontroller research (Budget: \$1000)

Sean Hedgecock

11/06/2024

Notes:

Challenge presented by the Mars Society each year during the international University Rover Challenge. Our project revolves around the communications sub-team of the 2025 SDSU Aztec Rover Team. Our goal is to build a reliable communications system capable of communicating between a stationary base station and a moving rover both in and out of line-of-sight.

**Communications between rover and operator. There should be an emphasis on redundancy. We need to control all systems and get feedback data through WiFi protocol. This should include two times a router with an omnidirectional antenna. One at the operator station and one at the rover. It should provide up to a 1km connection. The critical systems should also be controlled with an RC transmitter through a 900MHz link and 2.4GHz link. This will provide control of up to several kilometers. The crucial data, like the view from the end effector would be doubled. The redundancy would allow us to drive the rover on WiFi only or completely without WiFi.

Here is an interesting PDF explaining how a previous team accomplished this:

<https://physics.byu.edu/docs/thesis/1338>

Protocol

1. ExpressLRS

- a. ExpressLRS aims to provide the best completely open, high refresh radio control link while maintaining a maximum achievable range at that rate with low latency. Vast support of hardware in both 900 MHz and 2.4 GHz frequencies.

The screenshot shows the ExpressLRS website's hardware selection section. The left sidebar lists various hardware components like R9M Inverter Mod, R9M Fan Mod, and DIY Transmitter. The main content area features a large green banner with the text "ExpressLRS | Hardware" and a Wi-Fi icon. Below the banner, a note states: "ExpressLRS is #blessed with the benefit of there being many options of transmitters and receivers available from a variety of manufacturers. This begs the question 'what is the best?' There is no best option for hardware, only one that has the features you want for the price you want to pay in the size you want it. ExpressLRS does not recommend a specific brand or model, but provide the information to help you select the right ELRS hardware for your needs. The following page will list manufacturers and features to look out for on their hardware." A note box at the bottom left says: "This list will list primarily 2.4GHz hardware with 900MHz only listed in the frequency category, as 2.4GHz has become a significantly larger portion of the ELRS market."

b.

2. Ali Express **Wi-Fi HaLow Demo Board 802-11-ah Portable Gateway (730MHz - 930MHz) + NVIDIA Jetson + Look for USB + Device gets IP address when connected to internet. Cheap.**



a.

3. **Doodle Labs Protocol:** (Obsolete) This seems to be the easiest option for base station to rover communication, especially if we can use it with Python. Might be expensive.

Solutions

The screenshot shows two main sections: "Uncrewed Aerial Vehicles" and "Ground Robotics".

Uncrewed Aerial Vehicles: Features a small icon of a quadcopter and a "Learn More" button.

Ground Robotics: Features an icon of a robotic arm and a "Learn More" button.

Reliable, Low-latency Mesh Networks for UGVs, AMRs and other Mobile Robotics: This section is highlighted with a pink border. It contains a heading, a brief description, and a bulleted list of features.

Description: Doodle Labs' mesh radios are designed for scalable networks for any type of system, like UGVs, AMRs and mobile robots, in any kind of situation, like last-mile delivery to smart warehouse automation.

Features:

- ✓ Dynamic Mesh for hundreds of nodes
- ✓ Use case-optimized form factors
- ✓ Budget-friendly to be deployed at scale

[Comms Solutions for GROUND ROBOTS →](#)

- a. [Mini Mesh Rider Radio](#)
- b. [Technical Data Sheet](#)

If we decide to use this remote device we will use this guide to pair Mesh Rider Radio with the NVIDIA Jetson Nano: [Guide](#)



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Components

2x Wireless Wifi router: [Here](#)

2x Antennas (Omnidirectional for Rover + Base station tripod which is linked to Laptop):
[Here](#)

NVIDIA Jetson Xavier (Balance between power consumption and data process): [Here](#)

[Chosen]NVIDIA Jetson Orin NX (High processing power and high energy consumption): [Here](#)

Different communication protocol (In case WiFi fails we have manual control)

The critical systems should also be controlled with an RC transmitter through a 900MHz link.

Transmitter for Safety and security Kill Switch: [Here](#)

Communication should be to the controller attached to the rover (Kill switch)

Base station components

Tripod: still need to find one William is on it

William Imk if you find one and post a link: [Here](#)

Next Steps:

- ~~Decide components to use based on past teams that pairs with the NVIDIA Jetson Xavier NX.~~
- ~~Research technical documentation~~
- ~~Review datasheets and software packages~~
- ~~Contact manufacturers for package details~~

- Search for existing Python modules and libraries
- Test internal antenna performance before considering external options

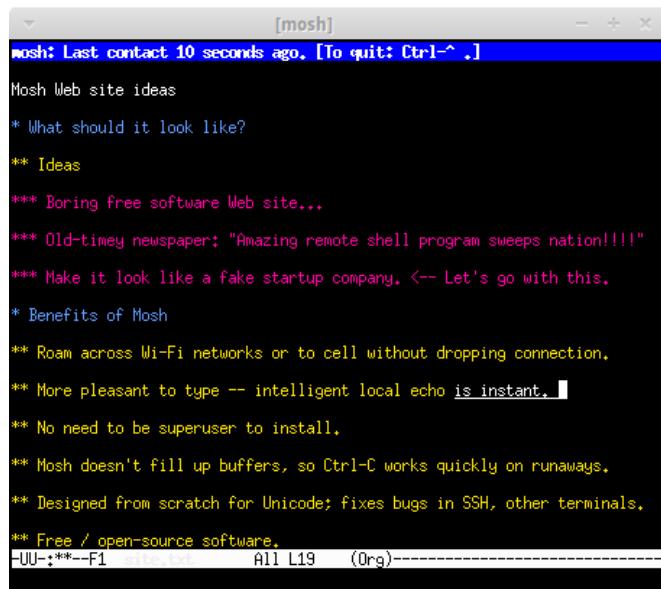
Resilient Connections

Jamila Pangilinan

10/23/24

*all softwares are available for free download; manufacturability won't require any outsourcing and physical parts; no weight

1. Mosh (Mobile Shell)



The screenshot shows a terminal window titled '[mosh]'. The text displayed is the help documentation for the 'mosh' command. It includes sections on 'Mosh Web site ideas', 'Benefits of Mosh', and various usage examples. The terminal window has a dark background with light-colored text.

```
mosh: Last contact 10 seconds ago. [To quit: Ctrl-^ .]

Mosh Web site ideas
* What should it look like?
** Ideas
**** Boring free software Web site...
*** Old-timey newspaper: "Amazing remote shell program sweeps nation!!!!"
*** Make it look like a fake startup company. <-- Let's go with this.

* Benefits of Mosh
** Roam across Wi-Fi networks or to cell without dropping connection.
** More pleasant to type -- intelligent local echo is instant.
** No need to be superuser to install.
** Mosh doesn't fill up buffers, so Ctrl-C works quickly on runaways.
** Designed from scratch for Unicode; fixes bugs in SSH, other terminals.
** Free / open-source software.

-FU-:***-F1 site.txt      All L19  (Org)-----
```

(example of how system will appear)

Range:

- Range was not found to be quantifiable by meters
- Said to have connection range of typically 60,000-61,000 UDP ports which is relatively high considering that the range for IANA dynamic or private ports are 49,152 to 65,535

Design Complexity:

- Can connect to multiple rovers or drones from a single interface
- Can manage separate sessions
- Only facilitates communication not manage the device themselves

Ease of Operation:

- Programming is simple and layout of system provides user with errors written out

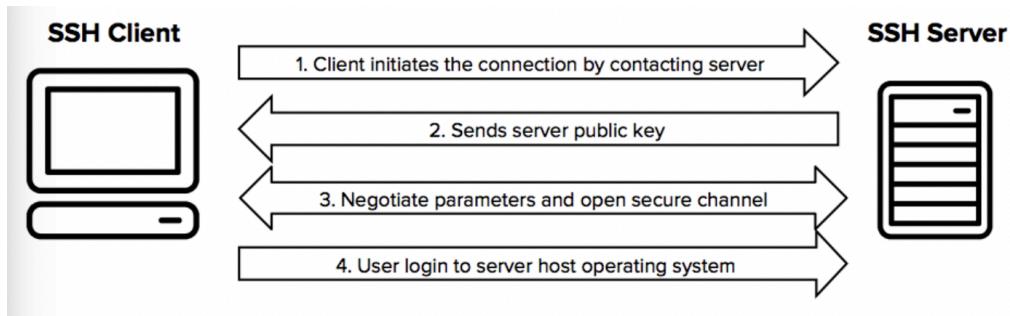
Data Processing:

- Supports automation scripts that can manage different components of rovers or drones, allowing for modular code that can be reused across different projects and devices

Other comments:

- Meant as replacement for interactive SSH terminals
 - Responsive for long-distance links
 - No specific range but as long as there is IP connection, it is still more resilient in comparison to say SSH communication systems
2. TMUX
- If network connection is lost, terminals will continue running; can SSH back in and reattach to those terminals
 - Useful for long-running jobs on a remote system
 - **Free** software
 - Decouples programs from main terminal, protecting them from accidentally disconnecting
 - Dependent on SSH connection

3. SSH (Secure Shell)



(demonstration of how encryption works for SSH)

- Enables secure system administration and file transfers over insecure networks

- Utilizes encryption to protect connections between client and server
- **Free** installation
- Can be implemented on multiple servers
 - Tecia SSH: available on Windows, Unix, Linux
 - PuTTY: client for Windows and Linux
 - OpenSSH: server for Unix, Linux
- Range can be long distance, but it is heavily reliant on the availability of a network connection and IP connection
- If SSH is establish in dynamic/private ports, then the range can be fairly high but does not have a definite quantity
- Sessions can remain active even over unstable connections; resume work with no interference in progress
- Secures multiple connections: remote command execution, file transfers, and tunneling for other protocols

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- Mosh is meant to relay commands to client in real time that allows for better roaming--significant for a moving rover that is out of line of sight at times
- Recovers from network interruptions without loss of progress
- Maintains efficient real-time control and monitoring even with lower network quality
- Mosh utilizes UDP which does not establish connection and guarantee delivery of data but this allows for less risk of latency which can be crucial to the responsiveness of the rover to inputted commands
- Lost data will not be sent again but faster recovery due to this difference from TCP

- Rover computer and local computer needed to connect between mosh server and client
- Download mosh on both computers (Linux most likely)
- Input code to perform actions with information given by other groups

<https://mosh.org/mosh-paper.pdf> (*I will read later)

Network Configurations - (Alan)

RF Communications

- **Cost:** Low to Mid-Range, about 100-500 dollars, but it is possible to keep it below 400 depending on the specific materials we use

- **Manufacturability:** A manageable set-up, just requires some learning through tutorials or any other learning resource.
 - Arduino: Widely supported with simple programming
 - Raspberry Pi: More powerful, can help avoid issues with complex tasks/obstacles.
 - ESP8266/ESP32: Good for Wi-Fi integration and IoT applications.
 - Antenna: Can provide an improved range for preference
 - Power Source: Batteries or USB power supply.
 - Prototyping Board: Breadboard for easy connections, or PCB for a more permanent solution.
- **Weight:** This is not an issue with RF Communications as it is below 2kg and I wouldn't expect it to exceed 2kg.
- **Range:**
 - NRF24L01: Low-cost, 2.4 GHz modules for short-range communication.
 - LoRa Modules: For long-range, low-power applications.
 - HC-12: A simple 433 MHz RF module for moderate distances.
- **Design Complexity:** It is straightforward, you just need to look out for components and perform wiring, and programming, however, it can be self-taught therefore it makes it simple.
- **Ease of Operation:**

Benefits

- Wireless communication
- Low Power Consumption
- Robustness
- Versatility

Flaws

- Limited Bandwidth
- Range Limitations: Can struggle through some obstacles, but it is still effective and I don't believe it would be a problem.

- **Data Processing**

- Real-Time Data Transfer
- Is effective in receiving Data from Sensors
- Note: Latency is a partial environmental issue, but it can be fixed/avoided.

Researching Linux

- LoRa Compatible
- RF Communications
- Raspberry Pi - Compatible with other divisions
- Does Linux Work With Jetson?
- GNU Radio Research
- Hardware Support Research
- How To Use Linux
- Python Research

How to set-up a WSL Linux