

mGRUE

minION Graphical Remote Unit Emulator

User Manual

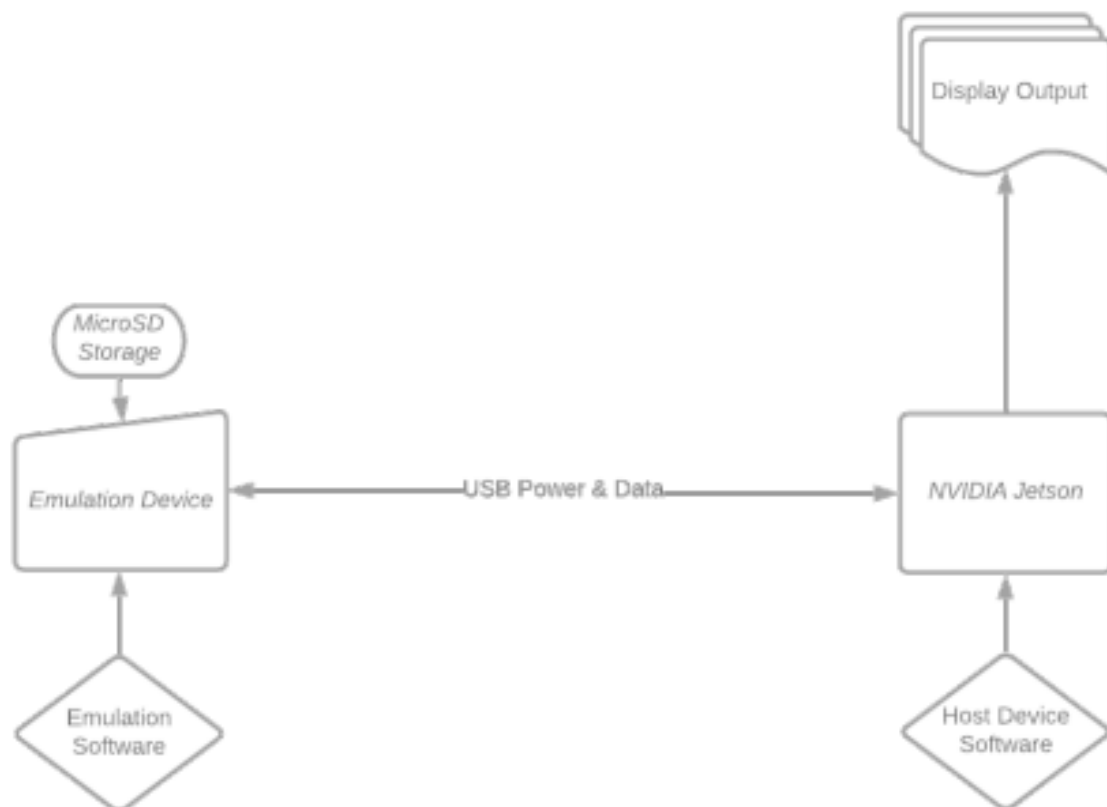


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Introduction

About

This project acts as an extension to the [SMARTEn mobile DNA analytics system](#), which was created through a collaborative effort between the SCoRe group, the Networked Systems Research (NSR) group, Dr. Lauren Sassoubre, and Dr. Ian Bradley of the University at Buffalo. Dr. Jaroslaw Zola, the principal investigator (PI) of the SCoRE group, commissioned the minION Graphical Remote Unit Emulator (mGRUE) project in order to overcome a number of limitations that the SMARTEn system had when it came time to present his work. The first limitation of the SMARTEn system is its dependency on the [MinION sequencer from Oxford Nanopore Technology](#), which has a minimum price of \$1,000 USD per unit. The second limitation was the fact that the sequencer also takes an invariable amount of time to sequence genetic information to a host computer. This means that Dr. Zola could potentially keep an audience waiting upwards of an hour for the sequencer to finish a scan. Using MinION sequencers pose a high cost and time investment, which make it an unsuitable candidate to use during live software demos of the SMARTEn system.

The development of the mGRUE device along with its host device driver was intended to help solve these issues for Dr. Zola. The mGRUE device along with its embedded application works as an emulator for the MinION sequencer, specifically dealing with the serial communication transfer process of the genetic information. The mGRUE device itself is a Raspberry Pi 4 utilizing a 3.5 inch LCD touch screen display, and running the Raspbian operating system. The mGRUE host device driver serves to communicate with the mGRUE device and receive the genetic information the mGRUE transmits via serial. It will also run on the NVIDIA Jetson Nano, which is currently utilized by the SMARTEn system. The mGRUE implementation of the SMARTEn system will allow for a simulation of the SMARTEn system, without the cost and time bottleneck of the MinION device.

mGRUE Host Device Driver Software Installation

System Requirements

The driver software can run on both Windows and Unix-based operating systems. Users will need to have the Python programming language installed on their device, version 3.6 or higher.

Obtaining the Source Code

The source code for the mGRUE Host Device Driver can be obtained from the [software's Github repository](#).

Installing Software Dependencies

Once the source code is on a user's device, navigate to its project folder using a terminal and run the command `pip install -r requirements.txt` to install all the necessary python packages to run the host device driver.

Usage

Initializing the mGRUE device & application

To initialize the mGRUE device, take a USB-C to A cable and use it to connect to one of the desired host device's USB ports. The mGRUE device supports being powered by USB connection while also being able to send data, so no other cable is required. The mGRUE embedded application will launch automatically once the device boots.

Initializing the mGRUE Host Device Driver software

Begin by using a terminal to navigate to the location of the Host Device Driver's project directory. Once there navigate to the `./driver` directory. If the project is being run on windows run the command `python main.py` with either the `cli` parameter to run the software through a command line interface or the `gui` parameter to run the software using a graphical user interface. Running `python main.py` with the `-h` flag shows a list of options for initializing the driver which include:

`-l` or `—location`

- to set a destination in the device's file system for the records that are received by the mGRUE device. Defaults to directory `./output`

`-f` or `—file`

- to set the path to the file that will be sent to the mGRUE device. Does not have a default, must be specified.

`-r` or `—records`

- to set the number of individual DNA records that are recorded per file output by the Driver. Defaults to 4,000 records.

NOTE: Once the Driver is being run in CLI mode, it needs to be stopped and rerun to change the output file location. However if the driver is in GUI mode, the output file location can be changed between DNA sequence transfers.

Commencing and Pausing DNA transfer emulation

Once both the mGRUE device and the Host Device Driver are initialized, a user should press the "Connect" button on the mGRUE to initiate a connection between the mGRUE and the host device. The status message on both pieces of software should display the status message "Device Connected", indicating that the connection has been successfully established. To start a DNA sequence transfer, a user must then press the "Start Transfer" button on the mGRUE. The status message on both pieces of software should change to "Connected, transferring....", and while the transfer is taking place, the user has the option to pause the transfer by pressing the "Pause" button on the mGRUE. The transfer can then be resumed by pressing the

"Resume" button. Once a transfer is complete the software status messages should change to "Finished Transfer".

Changing the Transfer Speed of the Emulation

Before a transfer is started on the mGRUE or while a transfer is paused, a user has the option to adjust the transfer speed on the mGRUE software. A user can pick between speeds 1-5 which correspond to the following transfer rates from slowest to fastest:

Transfer Speed Metrics		
1	1.33 MB/s ~ 500 rps	100k records in 200 seconds
2	2.65 MB/s ~ 1000 rps	100k records in 100 seconds
3	5.30 MB/s ~ 2000 rps	100k records in 50 seconds
4	7.95 MB/s ~ 3000 rps	100k records in 33 seconds
5	14.6 MB/s ~ 5500 rps	100k records in 18 seconds

Data File Transfer and Replacement

Due to the limitations of the touchscreen and lack of peripherals, the mGRUE device application reads a specific static file as the source of the DNA sequence data that it transfers to the host device. To facilitate a way to change the data file there is an included option in the host driver software that allows a user to transfer a new `data.fn` file to the mGRUE device. When the option `-f` is run, it will overwrite the existing data file with the incoming one. The transfer function does check for file type, but does not check for the validity of file contents. The transfer time should take about as long as a similarly sized data file would take in normal operation.