Embedded Systems Project Proposal

Avengers Assembly: Bradley Johnson and Abele Atresso

Overview:

The Avengers Assembly project aims to develop a handheld GPS receiver capable of displaying essential user position and velocity information, storing multiple locations, and calculating the distance to selected stored positions. This device will enhance navigation capabilities for outdoor enthusiasts, hikers, and adventurers.

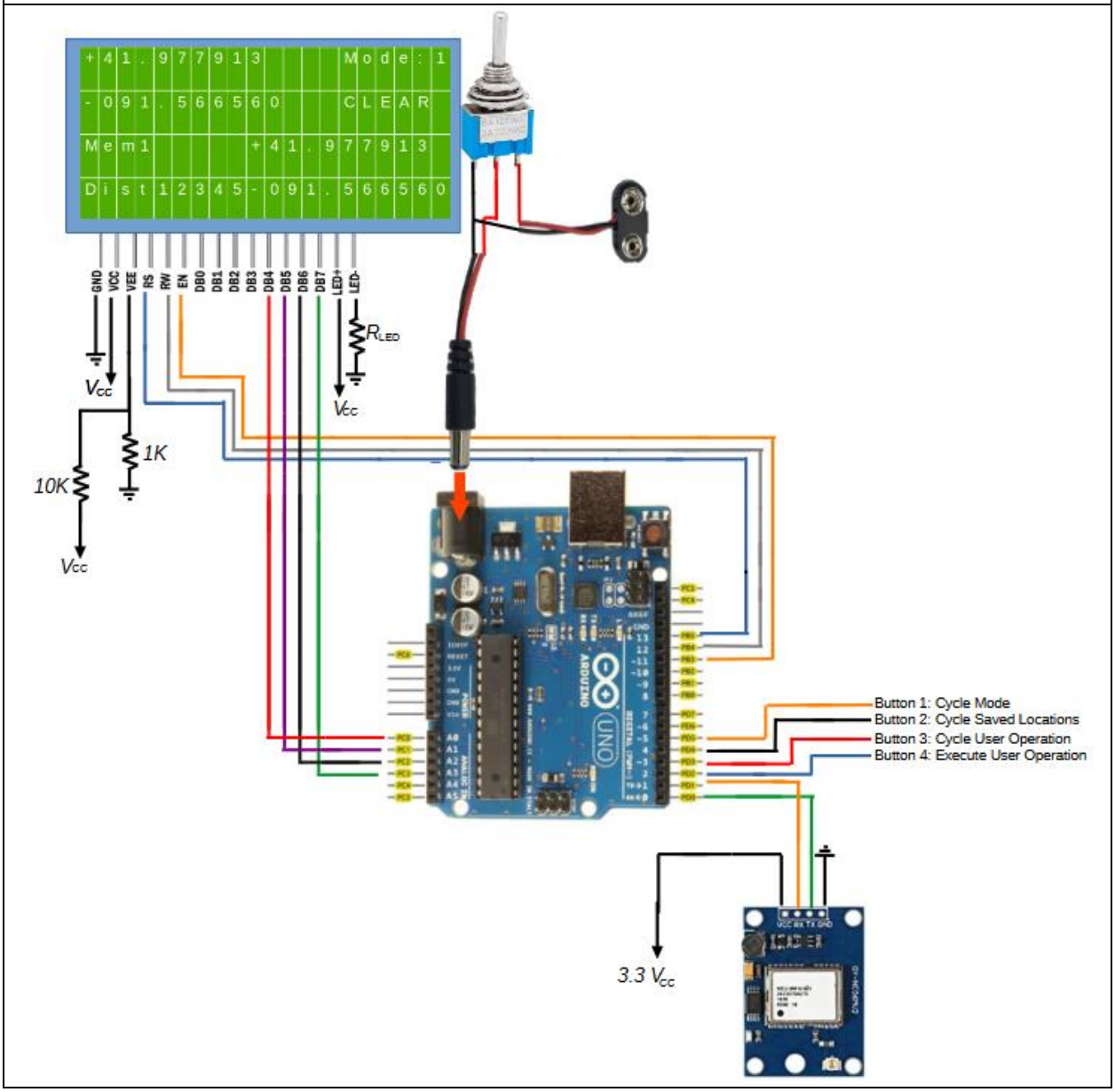
Parts:

1. Arduino – ATMega328p microcontroller
2. HD44780 Controlled 20x4 LCD for display
3. Control Stick for user input (included in lab kit)
4. NEO-6M GPS module for positioning
5. Power Switch and 9V battery for power management
6. Additional components such as buttons and headers for connectivity
7. Custom-designed 3D printed case for enclosure and protection

Hardware:

The LCD will be wired in the same way as it was for Lab 4 and Lab 5. The microcontroller that drives the LCD is the same, so the only changes will be via software. The NEO-6M module will have its VCC connected to 5V, its GND to the common GND of the Arduino, its Ax pin to the Rx Arduino pin, and its Tx pin to the Tx Arduino pin. Further study of the NEO-6M datasheet revealed that additional resistors are not needed for the serial data lines of the NEO-6M, though it should be connected to the 3.3V power supply instead of the 5V lone. Figure 1 (Next page) shows the proposed Arduino pinout configuration. The 4 control buttons will use both hardware and software debounce and use pins PD5, PD4, PD3, and PD2.

Figure 1


+41.977913 Mode:1
-091.566560 CLEAR
Mem1 +41.977913
Dist12345 -091.566560
GND VCC VEE RS RW EN DB0 DB1 DB2 DB3 DB4 DB5 DB6 DB7 LED+ LED-
R_{LED}
V_{CC}
1K
10K
Button 1: Cycle Mode
Button 2: Cycle Saved Locations
Button 3: Cycle User Operation
Button 4: Execute User Operation
3.3 V_{CC}

Box:

The box for the final product will be 3D printed similarly to the preliminary design shown in Figure 2. Ideally, the box will be built such that the batteries can be easily changed. The 4 squares are sized to hold 4 buttons. The big rectangle will house the 20x4 LCD display flush with the face of the box. The smaller rectangle will house the power switch. The three circles around the edge of the box are for screws to secure the two halves together (though the box does have enough tension to snap together).

Figure 2

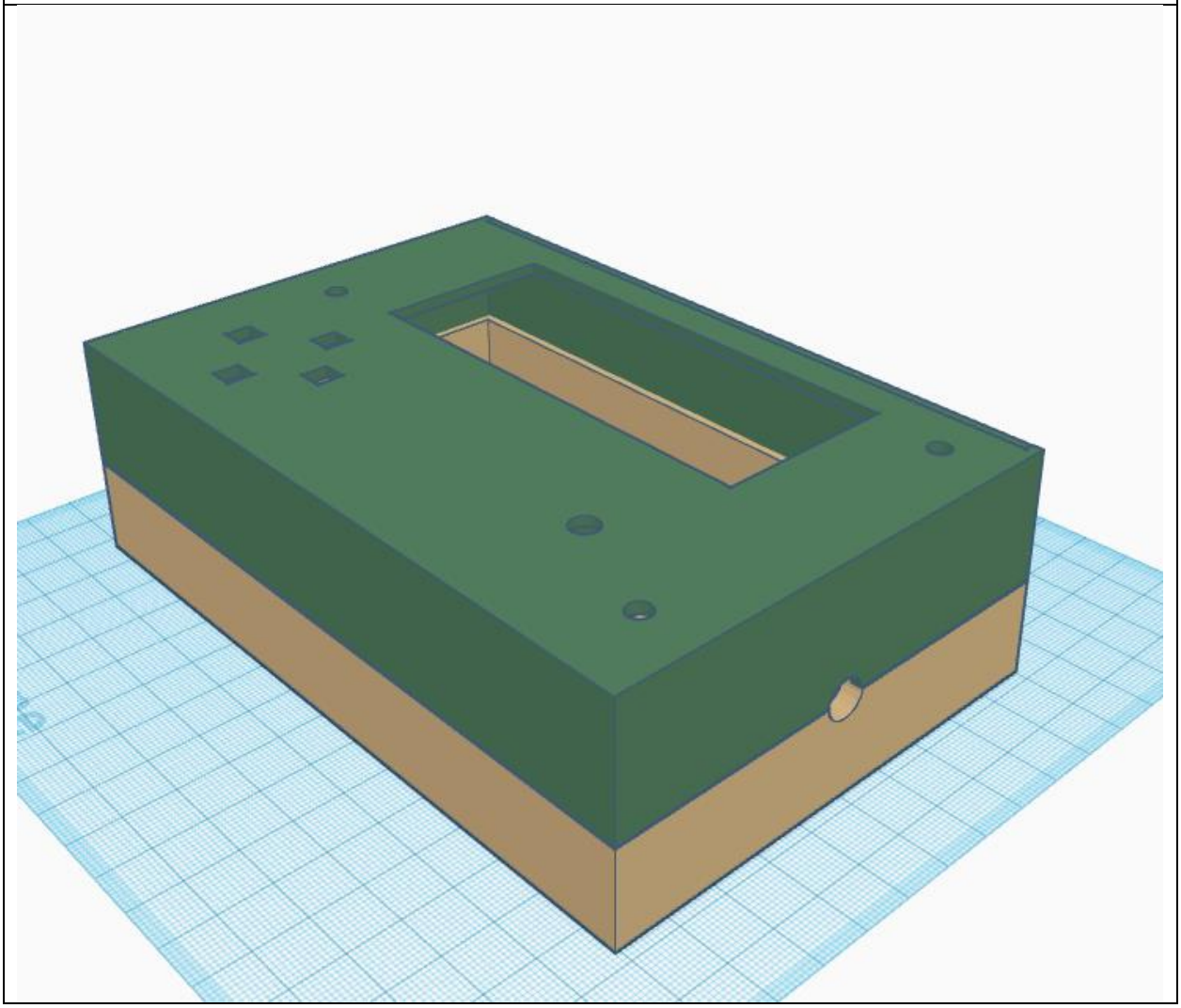
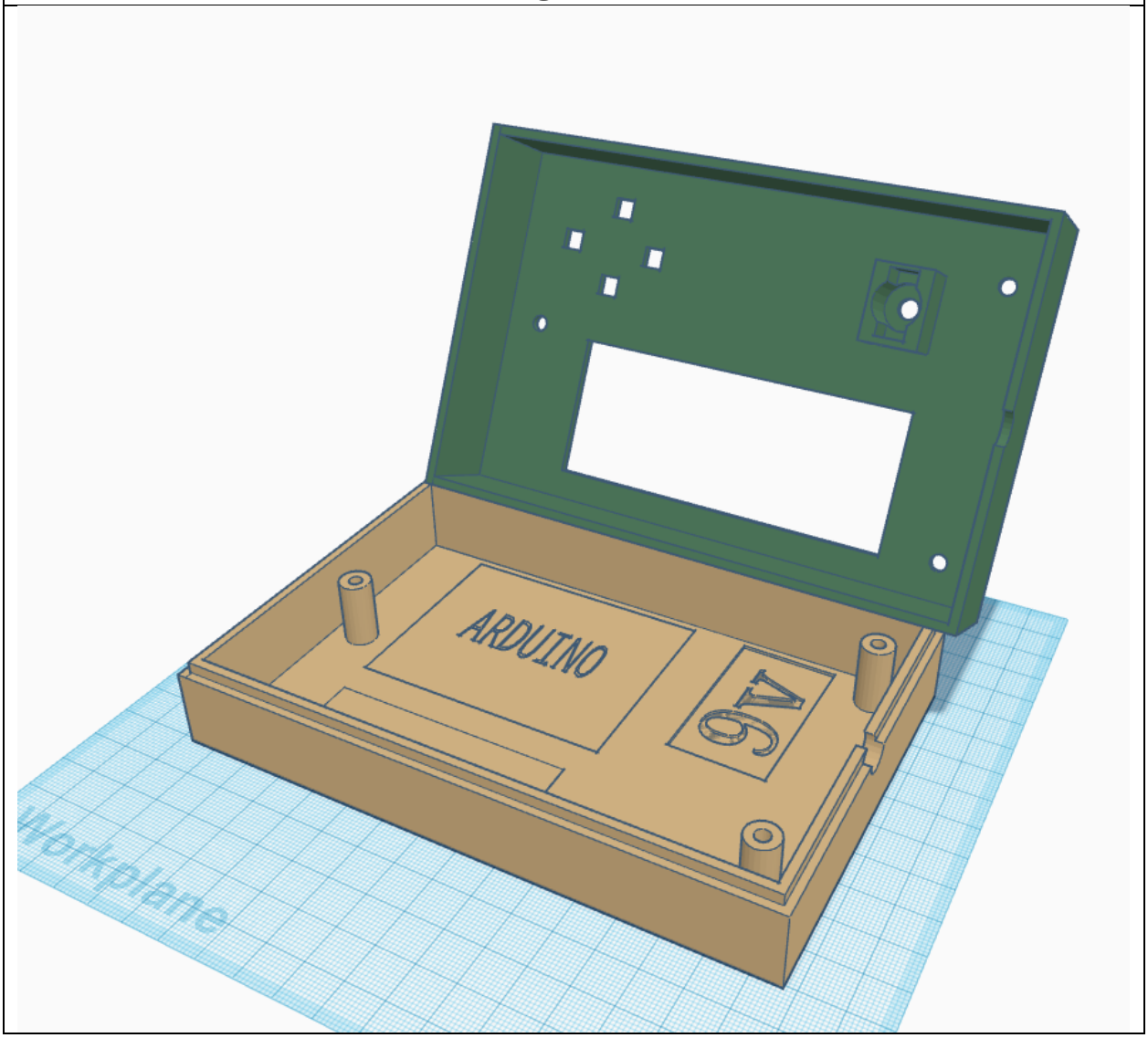


Figure 3



Software and User Interface:

The user will interface with the device using 4 buttons. Button 1 will cycle between Mode 1 and Mode 2. The other 3 buttons will only have functionality while in Mode 1. There will be a power switch to turn the device on and off.

In Mode 1:

In Mode 1, Button 2 will cycle through saved positions, Button 3 will cycle through user operations, and Button 4 will execute the selected user operation on the selected saved position. The LCD display will show the user's current Lat/Long position to 6 decimals of precision, one of the stored Lat/Long locations to 6 decimals of precision, the memory index of the stored location, the selected user operation, the current mode, and the distance from the user's position to the selected stored location.

When the user presses down on the stick, the device will run the selected operation on the selected memory location.

SAVE: Will overwrite the selected memory location with the user's current position.

CLEAR: Will clear the selected memory location

RESET: Will clear all memory locations

In Mode 2:

The screen will show the current GPS time (GPST) Week Number and second of week SOW, the number of satellite vehicles (SVs) being currently tracked by the receiver module, and the current position. Pushing any button except for Button 1 will have no effect while in Mode 2.

Figure 4

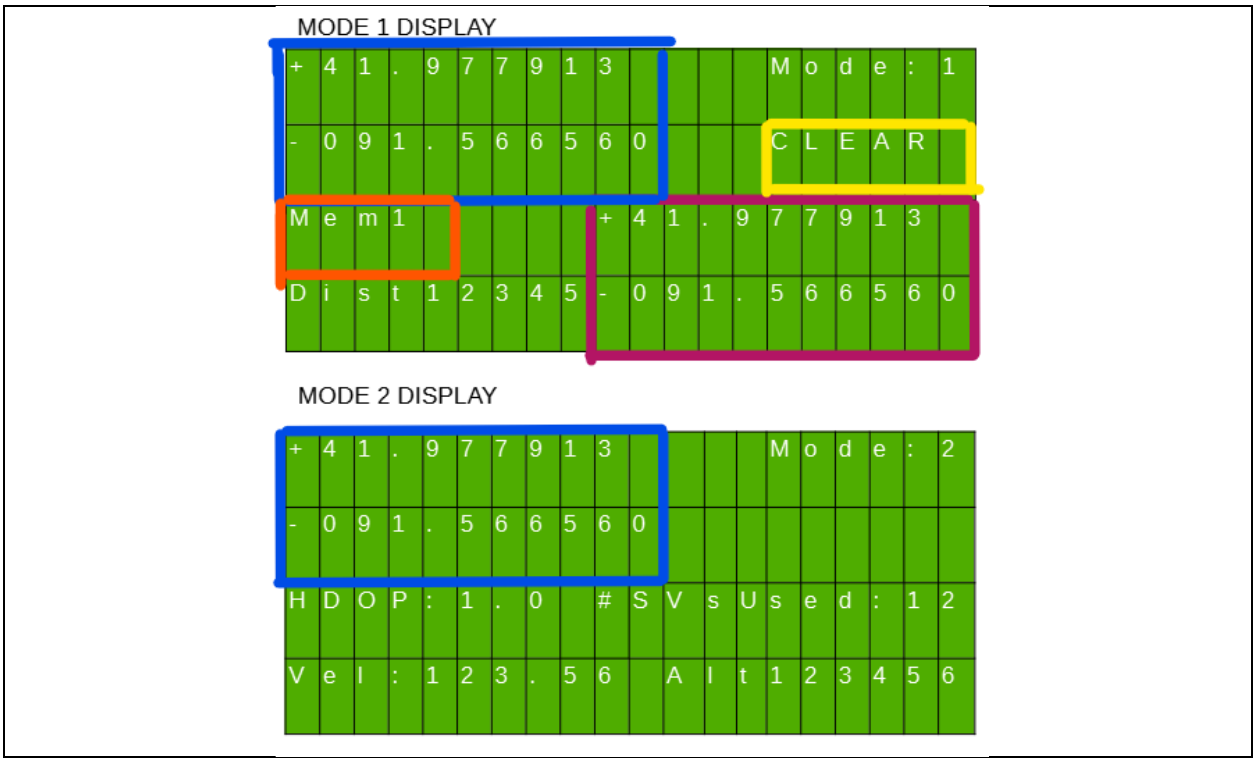


Figure 3 shows a potential layout of the desired data on the 20x4 LCD in Mode 1 and Mode 2. The current mode is shown in the top right. In both modes, the user's position is shown in the area highlighted by the blue box in the figure. In Mode 1, the current selected operation is shown in the area highlighted by the yellow box in the figure, the memory index of the selected stored location is shown in the are highlighted by the red box in the figure, and the current stored location is shown in the bottom right (highlighted by the purple box on the figure. In Mode 1, the distance between the user's position and the selected stored location is shown in the bottom right. This calculation will not consider earth curvature or altitude. It will assume a common altitude (It will assume the user's altitude in meters is common to the stored location for simpler math).

Receiving GPS Data

The NEO-6M GPS module provides NMEA data via UART serial output on its Tx and Rx pins and provides GSV, RMC, GSA, GGA, GLL, VTG, TXT message types. We will use the GSA message to find the user's position, number of SVs used in the PVT solution, the horizontal dilution of precision (HDOP), and altitude in meters. We will use the VTG message to get the user's ground speed in Km/hr. The display will update at approximately 1Hz.

Challenges:

Using serial, interfacing with a new IC, soldering parts together, designing/printing box.

Relevant Datasheets:

ATmega328P:

https://ww1.microchip.com/downloads/en/DeviceDoc/Atmel-7810-Automotive-Microcontrollers-ATmega328P_Datasheet.pdf

HD44780:

https://www.sparkfun.com/datasheets/LCD/HD44780.pdf

NEO-6:

https://content.u-blox.com/sites/default/files/products/documents/NEO-6_DataSheet_%28GPS.G6-HW-09005%29.pdf

NMEA:

https://www.sparkfun.com/datasheets/GPS/NMEA%20Reference%20Manual1.pdf