1 Introduction

The MinSegShield M2V5 Dual Axis MinSeg Kit[1] (MinSeg Self-Balancing Robot (SBR) Kit), presented in Fig. 1 was developed for balancing robot control (upright position) educational experiments using low-cost hardware. It is composed of an Arduino Mega 2560, two N20 DC Motors with magnetic encoders (1336 counts in 4x quadrature (334 encoder counts)), a DRV8833 Motor Driver, and a MPU9250 IMU sensor (3 axis gyroscope, 3 axis accelerometer, and a magnetometer). The MinSeg also provides a Simulink Arduino toolbox designated as Rensselaer Arduino Support Package Library (RASPLib). RASPlib allows you to program the Arduino and control the MinSeg SBR Kit in real-time through Simulink.

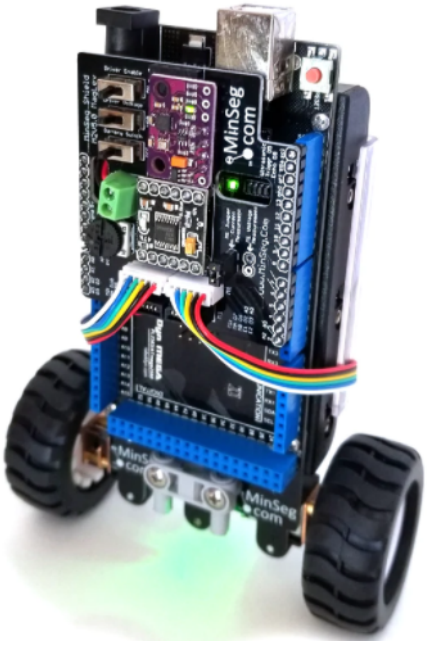

Figure 1: MinSegShield M2V5 Dual Axis MinSeg Kit (MinSeg SBR Kit).

2 MinSeg SBR Kit Simulink-Arduino Setup

2.1 Install the Arduino Toolbox for Simulink

To install the Matlab & Simulink Support Package for Arduino Hardware, follow the steps below:

- Open Matlab;
- Click on **Home (Tab)** -> **Add-Ons**;
- In the Add-On Explorer window, search for "**Simulink Support Package for Arduino Hardware**"; (You can also find the package by selecting "Hardware Support Packages" under the "Filter by Type");
- Install the "**Simulink Support Package for Arduino Hardware**";
- The "**Hardware Setup**" step is not mandatory.

[1] https://minseg.com/collections/minseg-kits/products/minsegshield-m2v5-dual-axis-balance-minseg-kit-new- accessed 16 May, 2022

2.2 RASPlib

In order to use the RASPlib to control the MinSeg SBR kit, follow the steps below:

- Download the RASPlib[2];
- Unzip the downloaded file and extract the "RASPlib" folder and the "startup.m" file to your project directory;
- Open the "RASPlib.slx" file (it should like as presented in Fig. 2). Note that, in this file, you will find all the functions/blocks available for any MinSeg Kit;
- For the MinSeg SBR kit, use the following functions/blocks (**OpenLibrary** -> **MinSegShield M2V5**):
  - two **Mega 2560 PWM Frequency Selected** (one for pins 6,7,8 and one for pins 9, 10) for Arduino's PWM setup, and the blocks available in **OpenLibrary** -> **MinSegShield M2V5** to set the motor's input voltage and read the motor's encoder.
  - to acquire data from the inertial sensor use the block **SoMPU6050Gyro** to read gyroscope data and the block **SoMPU6050Accel** to read accelerometer data. Both blocks are compatible with both MPU6050 and MPU9250 sensors.
- You can also check the available demo: **OpenDemo** -> **MinSegShield M2V5**.

Tip: For a new project, use the **OpenDemo** -> **MinSegShield M2V5** file as a starting point, i.e. open a RASPlib demo, save it in your project directory, and implement the control model.

3 Program the MinSeg SBR Kit and Balance Instructions

To run the Simulink file using the external hardware, you need to set the following options in Simulink:

- Configure the Hardware Board to "**Arduino Mega 2560**" under the Hardware tab;
- Identify the COM port number (**Hardware** tab -> **Hardware Settings -> open the Target hardware resources setting list -> Host-board connection**).

To program the MinSeg SBR Kit, the Simulink has two modes available:

- **Monitor & Tune** - Program the Arduino and allows data monitoring during the simulation time set in the Simulink. In this mode, the wire connection between the MinSeg SBR kit and the computer is required;
- **Build, Deploy & Start** - Program the Arduino as an external device, i.e., do not allow data monitoring and no wire connection is required (wire connection required only for program the Arduino).

To start the MinSeg SBR kit, follow the instructions:

- Check if batteries are properly installed in the correct orientation;
- The switch buttons, shown in Fig. 3, must be in the following order:
  - Driver Enable -> On;
  - Driver Voltage -> Batt;
  - Battery Switch -> On.
- Press and hold the reset button (top left);

[2] https://www.mathworks.com/matlabcentral/fileexchange/62702-rensselaer-arduino-support-package-library-rasplib-accessed 16 May, 2022

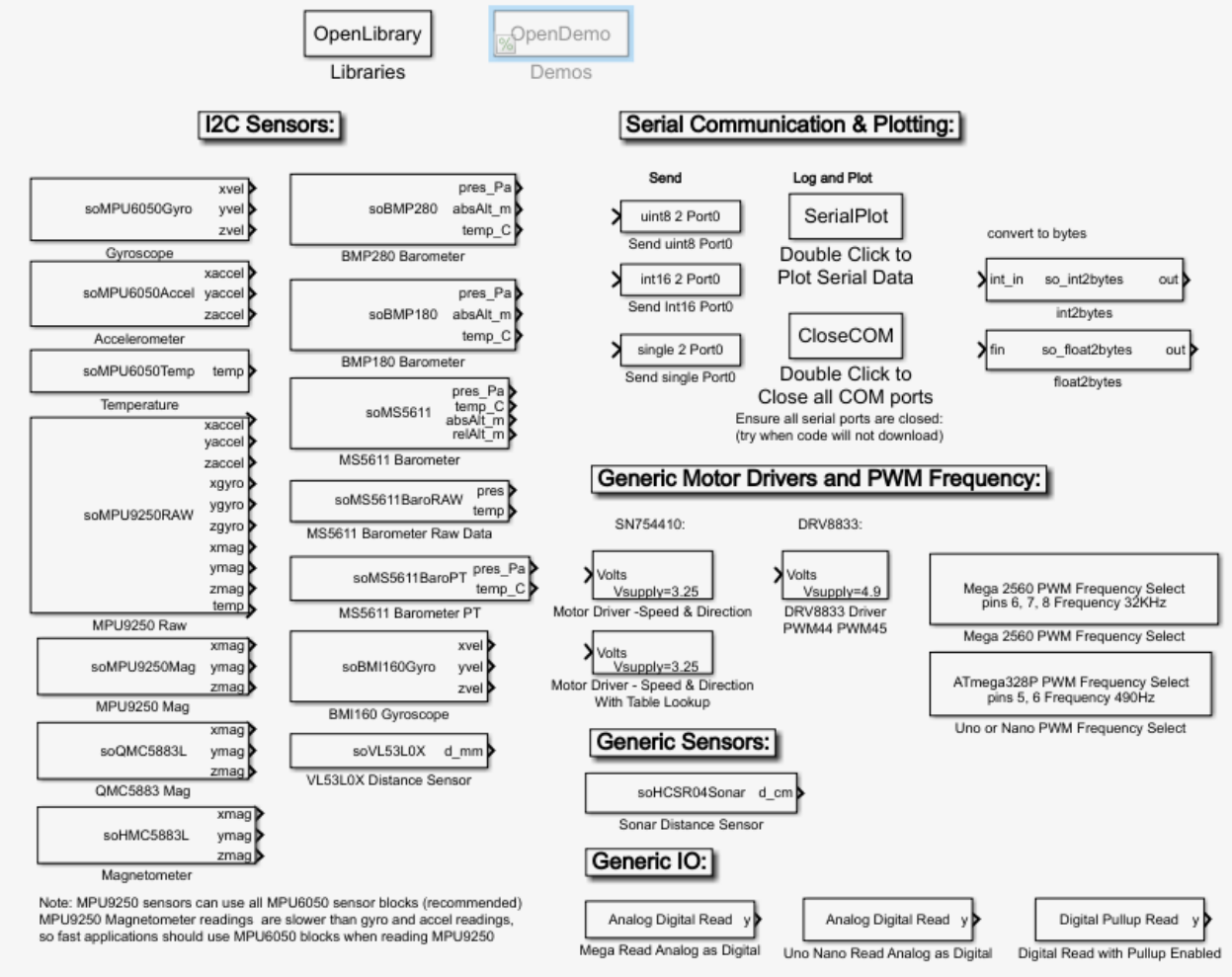

Figure 2: RASPlib.

- Release the reset button in the upright position and hold that position for 1 second (the position where the MinSeg SBR kit is started is considered as its referential position);
- You can restart the control by pressing and release the reset button.

To stop the MinSeg SBR kit, turn the **Battery Switch** off.

Tip: to reprogram the Arduino, turn the **Driver Enable** switch off. It will allow you to program the Arduino with the motors off.

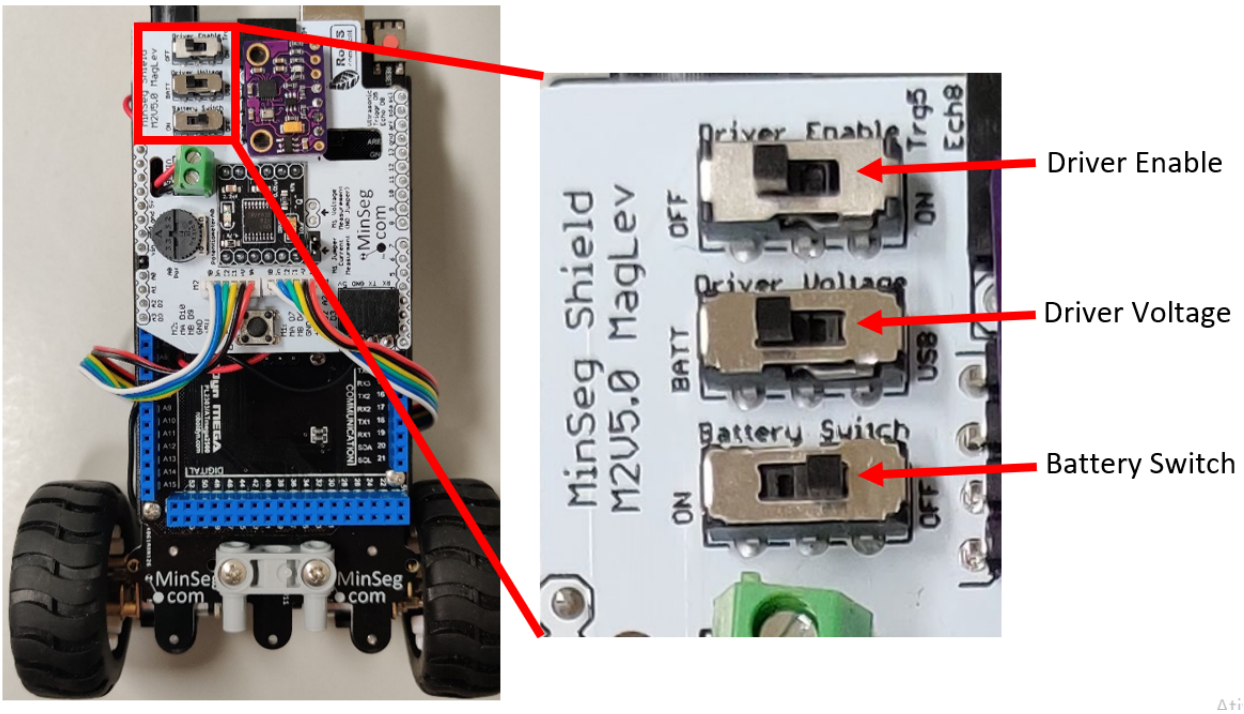

Figure 3: Switch buttons available in the MinSeg SBR Kit.