Getting Started with Magnetic Field Sensor V1.0

Prerequisites
- Teensy 3.2 Board
- Micro-USB to USB Cable
- Magnetic Sensor PCB
- Computer with Ubuntu 16.04 or 18.04 installed
- Adafruit 128x32 OLED Screen

ROS Installation and Setup
1. Download and install Robot Operating System (ROS)
   - Download version "Kinetic Kame" for Ubuntu 16.04 or version "Melodic Morenia" for Ubuntu 18.04. Both versions should work with the magnetic sensor.
   - When installing, be sure to do the "Desktop-Full Install" option
2. Complete the installation and the first tutorial on the website, which will describe how to setup a ROS workspace (use catkin, not rosbuild).
3. In a new terminal, type each of the following to install all rosserial drivers:
   - If using ROS Kinetic:
     - sudo apt-get install ros-kinetic-rosserial-arduino
     - sudo apt-get install ros-kinetic-rosserial
   - If using ROS Melodic:
     - sudo apt-get install ros-melodic-rosserial-arduino
     - sudo apt-get install ros-melodic-rosserial

Programming the Teensy
1. If you ever need to program the Teensy, you will need to install a few additional things.
   - Install Arduino 1.8.9 for Linux (specifically this version or older, newer versions may not yet work with the Teensy).
   - See this guide https://www.pjrc.com/teensy/td_download.html about how to setup Teensyduino on Ubuntu. If you are unfamiliar with the command line and/or Ubuntu, installing the udev rules might be confusing. Ask Dom for help if you are stuck with this. You will also need to modify the Arduino settings for uploading a sketch to the Teensy.
   - Add ROS libraries to Arduino using this guide: http://wiki.ros.org/rosserial_arduino/Tutorials/Arduino%20IDE%20Setup
   - Add libraries for the OLED display: https://github.com/adafruit/Adafruit_SSD1306. Teensyduino should hopefully already have downloaded these.
   - Add libraries for graphics: https://github.com/adafruit/Adafruit-GFX-Library. These should be included with Teensyduino as well.
   - Add libraries for the magnetic field sensor chip. These should already be included in the Arduino project folder.
   - Open the Arduino file MagSensorROS.ino included with this help file. Compile and program the Teensy with the program.

Connecting the Sensor

1. Plug in Teensy to USB port on computer
   - Teensy should power on. Status LEDs for PWR and DATA should light up. OLED screen should display magnetic field values.
2. Type the following into the terminal:
   - roscore
3. Open a new terminal and type the following:
   - rosrun rosserial_python serial_node.py /dev/ttyACM*
   - If you know the exact serial port of the Teensy, you can replace the * in /dev/tty/ACM* with the exact value, otherwise this version will simply search for the first device to match the preceding characters. If your device does not connect after this command, try using the exact device name. If you do not know the exact device name, search for all possibilities using ls /dev/ttyA* in the terminal.
   - Status LED for ROS should light up after typing this command. OLED screen should stop updating. This is done because the display I2C communication protocol is very slow and we want to maximize sensor sampling rate on the ROS computer.

Visualizing and Recording Sensor Data

1. Make sure sensor is connected using the instructions from the section above
2. [Graphing Data] Open a new terminal and type the following:
   - rqt_plot
     - In the "Topic" text box, type "Magnetic_Field". The magnetic field values from the sensor should begin plotting. You can customize the plot appearance and scaling using the guide found here: http://wiki.ros.org/rqt_plot
3. [Text Output Data] Open a new terminal and type the following:
   - rostopic echo /Magnetic_Field
     - A text stream of the magnetic field data should appear in the terminal window
4. [Recording Data] Open a new terminal and type the following:
   - rosbag record -a
   - This will record all published topics in a bag file. For more information on how to use rosbag visit http://wiki.ros.org/rosbag/Commandline

Tips and Tricks

1. ROS uses many terminal windows. Installing a different terminal emulator like "Terminator" will help to manage many terminal windows at once.
2. Bash aliases are your best friend. You can alias <rosrun rosserial_python serial_node.py /dev/ttyACM*> to something simple, such as rosUSB or startMagSensor.

Additional Items

1. Gerber and Eagle Schematic/Board files for the PCB are included in this folder. Feel free to change the design if you want.
2. Source code for the Teensy is available in the folder. The TLV493D sensor communication uses open source libraries and the data sheet is for the sensor is included.
3. Currently, there is a slight bug in the open-source software for communicating with the TLV493d sensor. It appears that the sensor will have spikes in noise randomly when reading

zero field. For some reason, the spikes in noise disappear almost completely when the sensor is reading a field >5mT. We are still working on this bug, but the sensor data is accurate. The sensor was compared versus an expensive, calibrated sensor from Senis (see https://www.gmw.com/magnetic_measurements/Senis/3-axis-digital.html) and there was very little difference found in readings up to 20mT.