**IMU Embedded Software Development Roadmap**

Synchronization

1. Explore functionality
   1. Does positive edge on INT2 trigger FIFO write when MASTER\_CONFIG is set up to use SensorHub?
      1. For 1 IMU, connect GPIO to INT2 and apply known number of positive edges, then check if number of datasets in FIFO matches number of positive edges applied
         1. If too many datasets, then FIFO may be triggering on INT2=high rather than on edges. Try reducing duration of pulse and identify duration needed to get just a single dataset.
         2. If no datasets, FIFO is not triggering. This may be because the IMU is expecting to read from an external sensor. Try setting up one “external sensor” (i.e. assigning a slave address, etc.), but don’t connect a device. If this still does not work, try setting up one I2C interface on the microcontroller as a slave and connect it to the IMU I2C out.
   2. How frequently do the accelerometer and gyro ADCs update? Do the updates occur when the FIFO is triggered, or do they occur according to the ODR?
      1. Configure the IMU with a low ODR and trigger the FIFO at a higher rate, then observe whether the data recorded in the FIFO buffer exhibits a pattern of consecutive repetitions
         1. If yes, ADCs likely update according to ODR -> set high ODR (e.g. 6.6 kHz) during normal operation to get most accurate timing
         2. If no, ADCs update on FIFO trigger, ODR setting irrelevant
2. Configure PWM output from microcontroller to trigger INT2
   1. If FIFO triggers on INT2 high, set duty cycle so that each pulse triggers one dataset. Otherwise, duty cycle can be any reasonable percentage.
3. Extend to multiple IMUs

Numerical Integration Code

1. Implement Simpson’s Rule integration of gyro measurements as discussed
   1. Use MCU-generated timestamps based on PWM frequency

Storage and Application of Calibration Parameters

In addition to the numerical integration operations, the MCU will be responsible for performing the computations necessary to convert IMU measurements in LSB units into physical units with appropriate transformations to compensate for biases, scale factors, nonorthogonality, and nonlinearity. At a minimum, gyro nonorthogonality and nonlinearity must be compensated (all others can be performed offline).

UART and Data Handling Interface

UART will be used to communicate with the data handling unit and will also require computation time

1. Respond to data handling commands (start, stop, etc.)
2. Buffer implementation

Assess Computation Time

1. Can the IMU perform the necessary computations in time?
   1. If not, implement DMA, other measures (e.g. communication bus from Skog et al. (2014))

PCB Changes

1. Make necessary changes to PCB, preferably **without changing dimensions**
   1. Additional connections necessitated by synchronization architecture (e.g. PWM or crystal oscillator connection to INT2 as appropriate, dummy connection to IMU I2C out if needed)
   2. Changes necessitated by implementation of custom bus, if applicable
   3. Review layout for best practices
2. Send off PCB for manufacturing

Calibration Mode Code

When calibrating the IMUs, we will need to report gyro measurements directly to the data handling unit. The data handling unit will also need a special calibration mode to handle data from the IMU during calibration.

Data Handling Unit Code