ECE-GY 6483: Real Time Embedded Systems
Embedded Project Writeup (Fall 2023)
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Introduction: In this project, we implemented a basic real-time distance tracking algorithm using the MBED OS in PlatformIO which calculates approximate distance traveled in feet, and approximate step cycles taken.

Video Demonstration: https://youtu.be/oxfWvjw6qH8
GitHub: https://github.com/DehitTrivedi/EmbeddedChallenge2023

Components Used:
- STM32F429 Discovery board.
- I3G4250D gyroscope.
- 2.4" QVGA TFT LCD.

Figure 1: STM32F429 Discovery Board

Definitions:

MOSI	Master out slave in
MISO	Master out slave out
SCLK	Serial clock
SPI	Serial peripheral interface

Table 1: Abbreviations.

Methodology: Using the MBED platform, we have chosen the PF_9, PF_9, and PF_7 pins for the MOSI, MISO, SCLK lines respectively. These choices were made based on the pin configuration for the I3G4250D gyroscope in the STM32F428ZI datasheet. Upon initializing the main() function, we set the SPI format to accept 8 bit data with a high steady state clock, with frequency of 1 MHz. After setting the mode and initializing variables, we enter the while loop.

Every 10000 cycles (50 ms), the raw z axis angular velocity data is extracted using read_gyroscope_data() and then multiplied by a sensitivity value given to us in the data sheet which is then appended to a buffer. After every 20 iterations of this process, the sum of the buffer is divided by 20 to get the average value. Next, the data is converted to linear velocity and then used to calculate approximate step distance and step cycles, which are then printed to the built-in 2.4” QVGA TFT LCD screen. To reset the stored values displayed on the screen, press the reset button on the STM board. Refer to figure 1 for a visualization of our code logic.

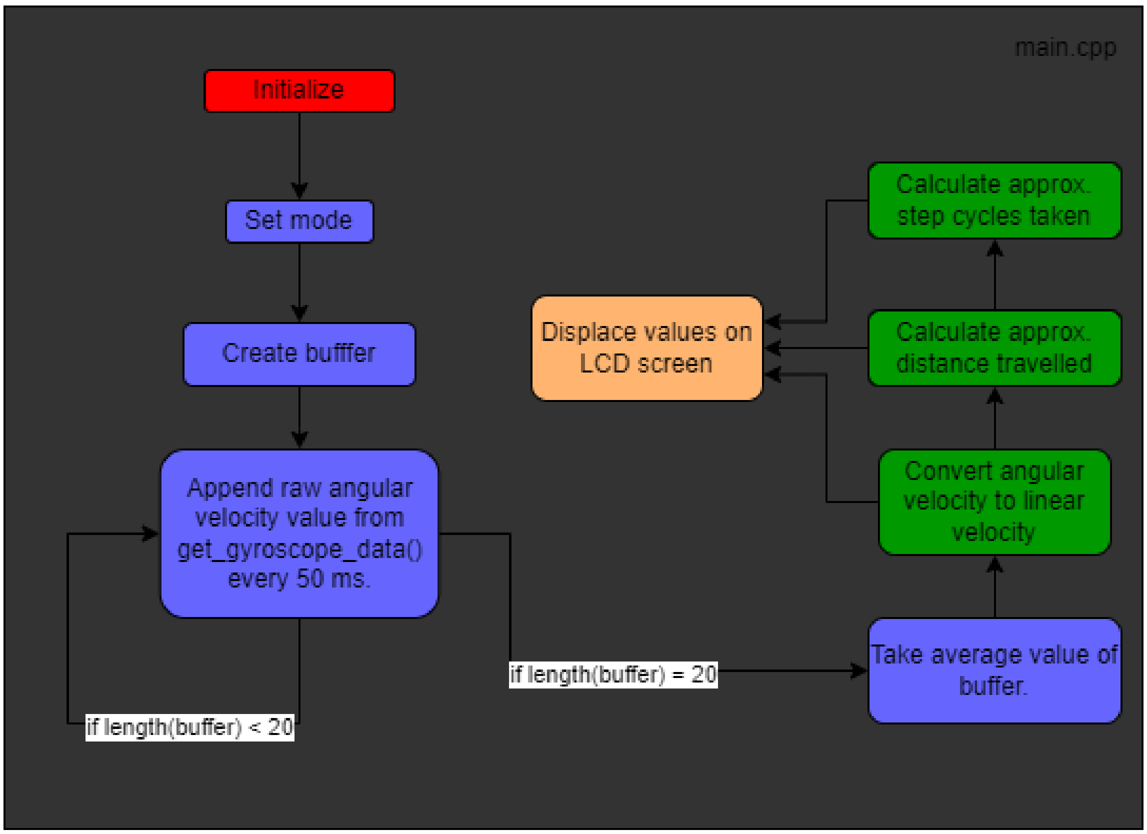

Figure 2: Block diagram for our source code.

Distance Calculation: A leg can be modeled as a swinging pendulum which exhibits oscillatory motion. Our approach for approximating distance traveled using gyroscope values utilizes: leg length of the subject (~3 ft) and a conversion from angular velocity to linear velocity. An assumption that we make is that during walking, both legs exhibit symmetric motion (i.e. no walking abnormalities). The I3G4250D gyroscope records angular velocity values from the X, Y, and Z axes. For our implementation, we chose to use the gyroscope Z-axis, with the board placed on the side of the right ankle like an ankle bracelet and connected to a mobile power bank for portability. Refer to figure two for ankle mounting, figure three and table 1 for angular to linear velocity and distance calculations.

Future Directions: Most commercial distance trackers utilize GPS to calculate distance traveled. However, this technology has a higher price point than that of gyroscopes, which are low cost and easily attainable. Our results demonstrate that we have created a functional prototype which calculates approximate distance traveled using gyroscope values. However, to be able to sell this system as a product to consumers, there are some areas to first improve upon. The first being distance calculation accuracy. For our implementation, we assumed the user had a leg length of ~3 feet, which may not be applicable to all users. Another area to improve upon is the size. The STM Discovery board has unnecessary components for this specific implementation. Thus, in future design implementations, we will spend efforts into procuring parts that fit our design specifications.

Figure 3: STM32 mounted on the right ankle.

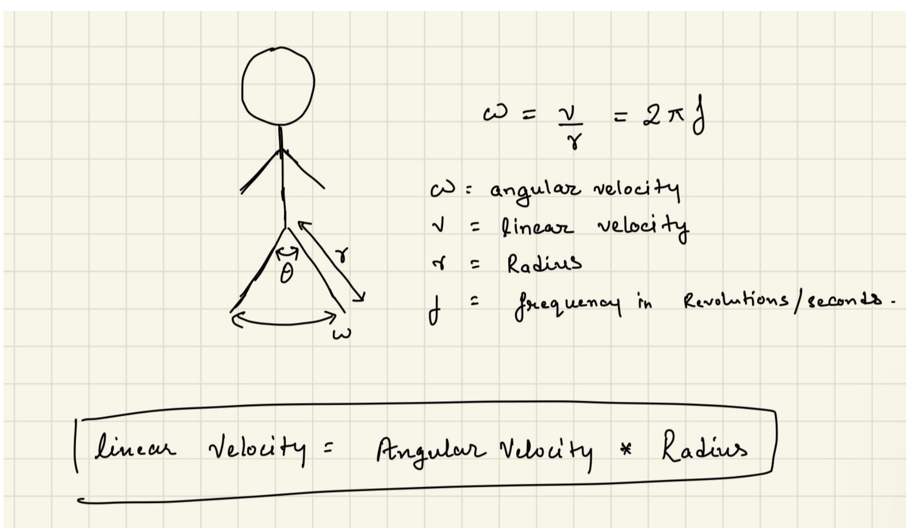

Figure 4: Distance Calculation

$Distance\ (D) = linear\ Velocity(v) \ * \ time(t)$

Table 2: Distance calculation.