1) How Fast Can You Run?

Program

gps6m.py

```
from machine import UART

_KNOTS_TO_M_PER_S = 0.514444

class GPS6M:
    def __init__(self, uart: UART):
        self._uart = uart

    def try_read_speed_m_per_s(self):
        # simpler error handling in case of invalid msg or cast
        try:
            msg = self._read_line()
            msg_values = msg.split(',')
            if msg_values[0] == "$GPRMC":
                return (float(msg_values[7]) * _KNOTS_TO_M_PER_S)
            else:
                raise Exception

        except:
            return 0.0

    def _read_line(self):
        flag = 0
        msg = ''
        while(flag == 0):
            x = self._uart.read(1)
            if(x != None):
                x = ord(x)
            else:
                raise Exception("No gps msg received")

            if(chr(x) == '$'):
                msg = ''
            if(x == 13):
                flag = 1
            else:
                msg = msg + chr(x)
        return(msg)
```

speed_tester.py

```
import st7796
from gps6m import GPS6M
from machine import Pin, Timer

_READ_PERIOD_MS = const(100)

_RGB_BLACK = st7796.RGB(0, 0, 0)
_RGB_WHITE = st7796.RGB(255, 255, 255)

class SpeedTester:
    def __init__(self, gps: GPS6M, start_button: Pin, stop_button: Pin):
        self._gps = gps
        self._top_speeds = [0.0, 0.0, 0.0]
        self._recording_top_speed = 0.0
        st7796.Init()
        st7796.Clear(_RGB_BLACK)
        self._start_button = start_button
        self._stop_button = stop_button
        self._read_timer = Timer()
        self._start_button.irq(trigger=Pin.IRQ_FALLING,
handler=self._start_handler)
        self._stop_button.irq(trigger=Pin.IRQ_FALLING, handler=self._stop_handler)

    def _start_handler(self, pin: Pin):
        self._read_timer.init(mode=Timer.PERIODIC, period=_READ_PERIOD_MS,
callback=self._read_handler)

    def _stop_handler(self, pin: Pin):
        self._read_timer.deinit()
        lowest_top_speed = min(self._top_speeds)
        index = self._top_speeds.index(lowest_top_speed)
        if self._recording_top_speed > self._top_speeds[index]:
            self._top_speeds[index] = self._recording_top_speed

        # Reset top speed for the next recording
        self._recording_top_speed = 0.0
        self._update_lcd()

    def _update_lcd(self):
        offset = 0
        for i in range(len(self._top_speeds)):
            st7796.Text2("     ", 0, offset, _RGB_WHITE, _RGB_BLACK)
            speed_str = str(self._top_speeds[i])
            st7796.Text2(speed_str, 0, offset, _RGB_WHITE, _RGB_BLACK)

            offset += 50

    def _read_handler(self, timer: Timer):
        speed = self._gps.try_read_speed_m_per_s()
        if speed > self._recording_top_speed:
            self._recording_top_speed = speed
```

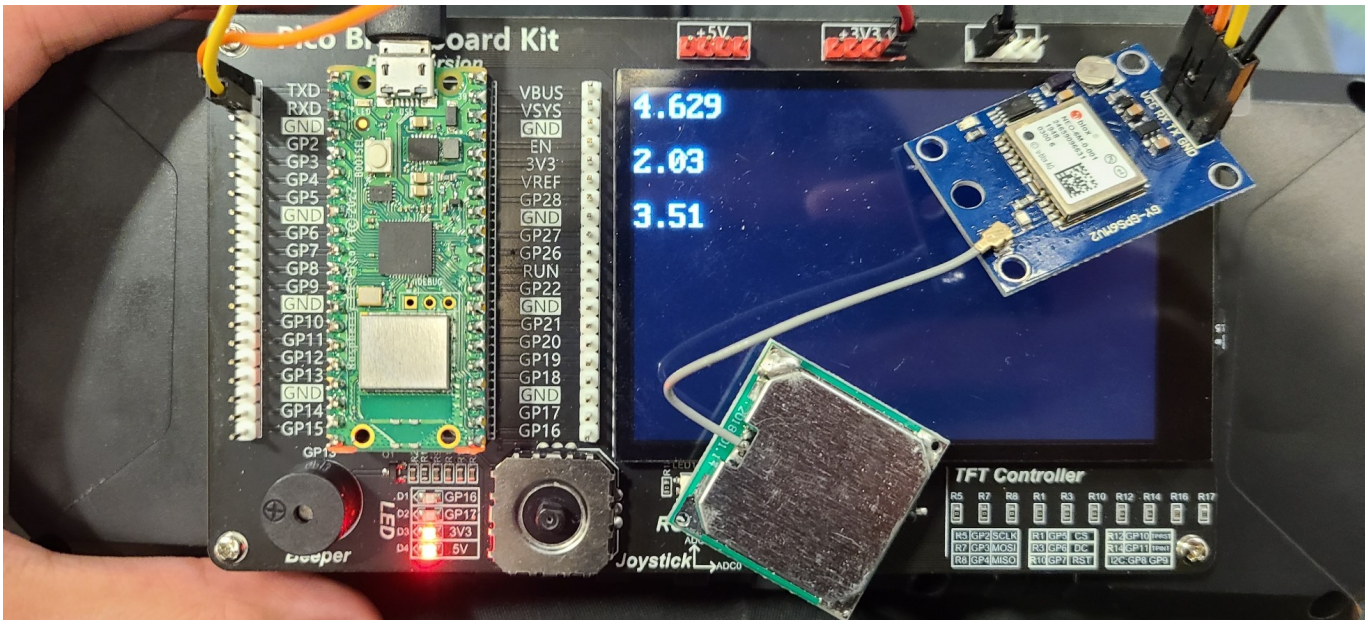
main.py

```
from gps6m import GPS6M
from machine import Pin, UART
from speed_tester import SpeedTester

if __name__ == "__main__":

    # Init peripherals
    gps_uart = UART(0, 9600)
    gps_uart.init(9600, bits=8, parity=None, stop=1, tx=0, rx=1)
    gps = GPS6M(uart=gps_uart)

    start_button = Pin(15, Pin.IN, Pin.PULL_UP)
    stop_button = Pin(14, Pin.IN, Pin.PULL_UP)

    # Instantiate speedtester object
    tester = SpeedTester(gps=gps, start_button=start_button,
stop_button=stop_button)

    while True:
        continue
```

Test

Results after hooking the Pico board up to a battery and doing an unsuspicious short jog outside at night while dressed in black

(Results in meters/second)



2) Bluetooth & Motor Speed

Program

motor.py

```
from machine import PWM, Pin

class UnidirectionalMotor():
    """Unidirectional Motor"""

    MIN_SPEED_PCT = const(0)
    MAX_SPEED_PCT = const(100)
    MIN_DUT_CYCLE_PCT = const(50)
    SEC_TO_NS_FLOAT = const(1_000_000_000)
    PWM_FREQ = const(20_000)
    PWM_PERIOD_NS = SEC_TO_NS_FLOAT / PWM_FREQ
    PWM_FACTOR = float(PWM_PERIOD_NS / (MAX_SPEED_PCT - MIN_DUT_CYCLE_PCT))
    PWM_OFFSET = round((float(MIN_DUT_CYCLE_PCT / MAX_SPEED_PCT)) * PWM_PERIOD_NS)

    def __init__(self, pwm_gpio: int):
        self._pwm = PWM(Pin(pwm_gpio, Pin.OUT))
        self._pwm.duty_ns(0)
        self._pwm.freq(self.PWM_FREQ)

    def set_speed_pct(self, speed_pct: int):
        if not (self.MIN_SPEED_PCT <= speed_pct <= self.MAX_SPEED_PCT):
            raise ValueError("Invalid unidirectional speed percentage: {}, must be
within {} and {} inclusive.".format(speed_pct, self.MIN_SPEED_PCT,
self.MAX_SPEED_PCT))

        # DC motor doesn't spin below 50% duty cycle
        # Current work around is to scale and offset it
        self._pwm.duty_ns(round(speed_pct * self.PWM_FACTOR) + self.PWM_OFFSET)

    def turn_off(self):
        self._pwm.duty_ns(0)

class BidirectionalMotor():
    """Bidirectional Motor"""
    MIN_BI_SPEED_PCT = -UnidirectionalMotor.MAX_SPEED_PCT
    MAX_BI_SPEED_PCT = UnidirectionalMotor.MAX_SPEED_PCT

    def __init__(self, cw_gpio: int, ccw_gpio: int):
        self._cw = UnidirectionalMotor(pwm_gpio=cw_gpio)
        self._ccw = UnidirectionalMotor(pwm_gpio=ccw_gpio)

    def set_speed_pct(self, speed_pct: int):
        if not (self.MIN_BI_SPEED_PCT <= speed_pct <= self.MAX_BI_SPEED_PCT):
            raise ValueError("Invalid bidirectional speed percentage: {}, must be
within {} and {} inclusive.".format(speed_pct, self.MIN_BI_SPEED_PCT,
```

```
self.MAX_BI_SPEED_PCT))

        if speed_pct < 0:
            self._cw.turn_off()
            self._ccw.set_speed_pct(abs(speed_pct))
        else:
            self._ccw.turn_off()
            self._cw.set_speed_pct(speed_pct)

if __name__ == "__main__":
    """Test Script"""
    motor = BidirectionalMotor(cw_gpio=16, ccw_gpio=17)
    while (True):
        motor.set_speed_pct(int(input("Set DC servo motor speed percentage:
".format(motor.MIN_BI_SPEED_PCT, motor.MAX_BI_SPEED_PCT))))
```

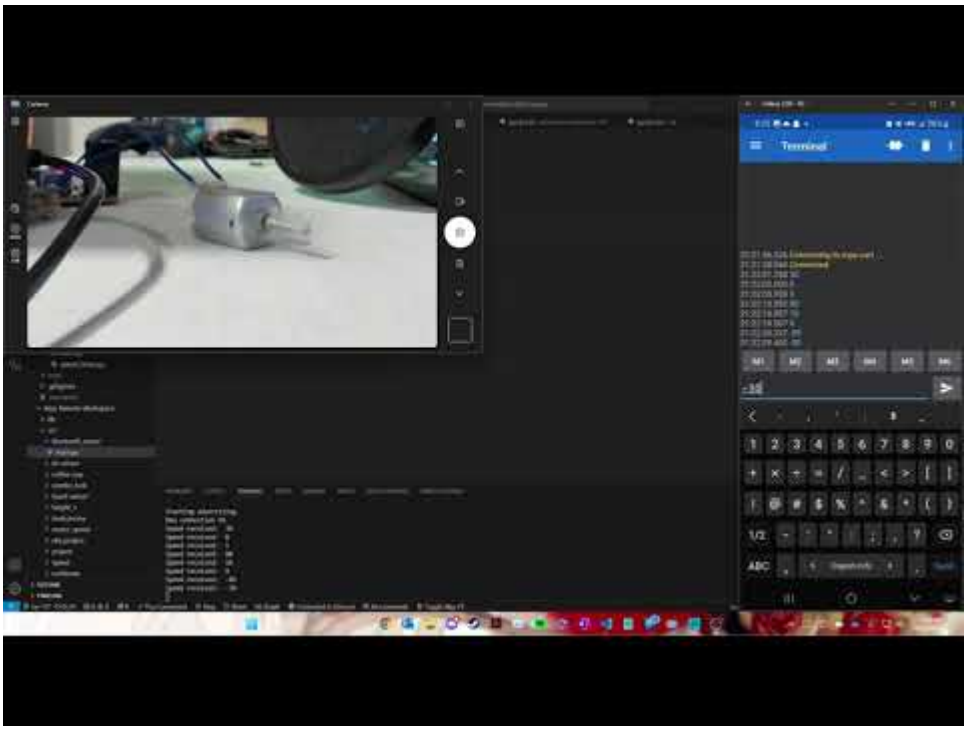
main.py

```
import bluetooth
from ble_simple_peripheral import BLESimplePeripheral
from motor import BidirectionalMotor

motor = BidirectionalMotor(cw_gpio=16, ccw_gpio=17)

def on_rx(data):
    print("Data received: ", data)
    try:
        speed = int(data)
        motor.set_speed_pct(speed)
    except:
        print("Invalid data")

if __name__ == "__main__":
    ble = bluetooth.BLE()
    sp = BLESimplePeripheral(ble)

    while True:
        if sp.is_connected():
            sp.on_write(on_rx)
```

Test

https://www.youtube.com/watch?v=5hEbYrw-jVM

Click image to access video


Terminal