Sailing robot electronic system tutorial

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1 Sensors

1.1 Inertia Measurement Unit

Inertia Measurement Unit (usually called IMU) is a passive electro-mechanical sensor that measures linear and angular motion with gyroscope and accelerometer. Integrated with magnetometer and barometer, IMU can provide orientation information for the boat.

Task.1 Find the data-sheet of Polulu AltIMU-10 v3 and try to answer the following:

- What is the interface of this sensor?
- What is the operating voltage range of this sensor?
- Draw the orientation of this chip in xyz coordinate.

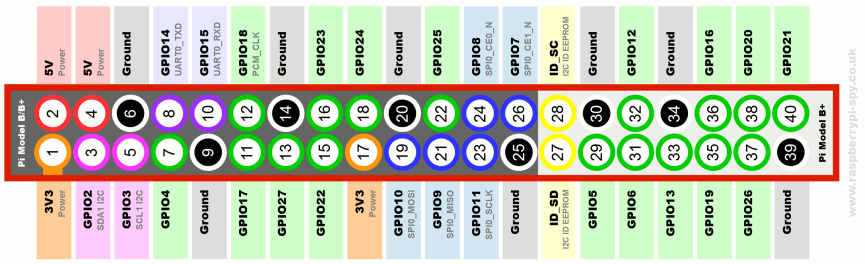

Figure 1: GPIO layout of Raspberry Pi Model B

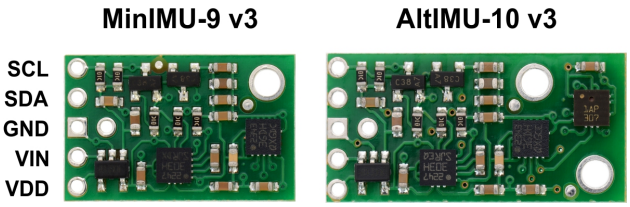

Figure 2: Pin layout of AltIMU-10 v3

Task.2 Use the given Raspberry PI GPIO and AltIMU-10 v3 layout

- Draw the connection line between Raspberry and IMU
- Explain what is SCL, SDA, GND, VIN and VDD
- Search GitHub wiki page to verify your answer

Task.3 Design considerations for IMU on boat

- Can we use gyroscope reading directly for heading?
- Where in the boat is the best place for IMU? Explain with reasons.
- Can we compensate the IMU reading errors? If so, how to do that?

1.2 Global Positioning System (GPS)

Global Positioning System is a satellite based navigation system which can provides location information to users. It now have been widely used in many applications including our autonomous boat.

Task.1 Find data sheet of Uputronics u-blox MAX-M8Q and try to answer:

- What is the interface of this sensor?
- What is the operating voltage range of this sensor?
- What is the horizontal position accuracy of this sensor?

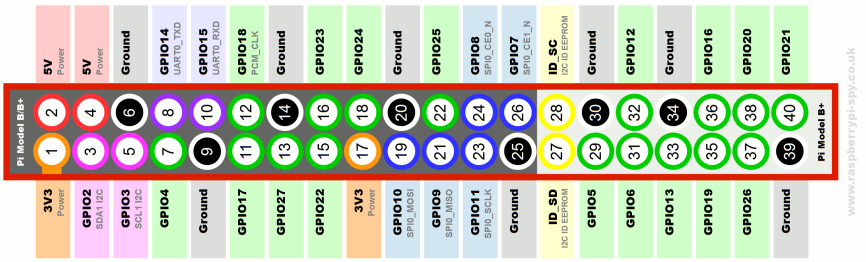

Figure 3: GPIO layout of Raspberry Pi Model B

Figure 4: GPS chip

Task.2 Use the given Raspberry PI GPIO and GPS layout

- Draw the connection line between Raspberry and GPS
- Explain what is TX, RX, GND, EN and TP

- Search GitHub wiki page to verify your answer

Task.3 Design considerations for GPS

- Where in the boat is the best place for GPS? Explain with reasons.
- In what kind of price range, we have the best design trade-off between price/performance?

1.3 Wind direction sensor

Wind sensor use magnetometer and two pieces of magnets to detect the wind direction. We use built in magnetometer of AltIMU10-v3 so that we have interchangeable sensors to reduce the workload and improve the system redundancy.

Task 1. Quickly review the answer in IMU part:

- What is the interface of this sensor?
- What is the operating voltage range of this sensor?
- Draw the orientation of this chip in xyz coordinate.

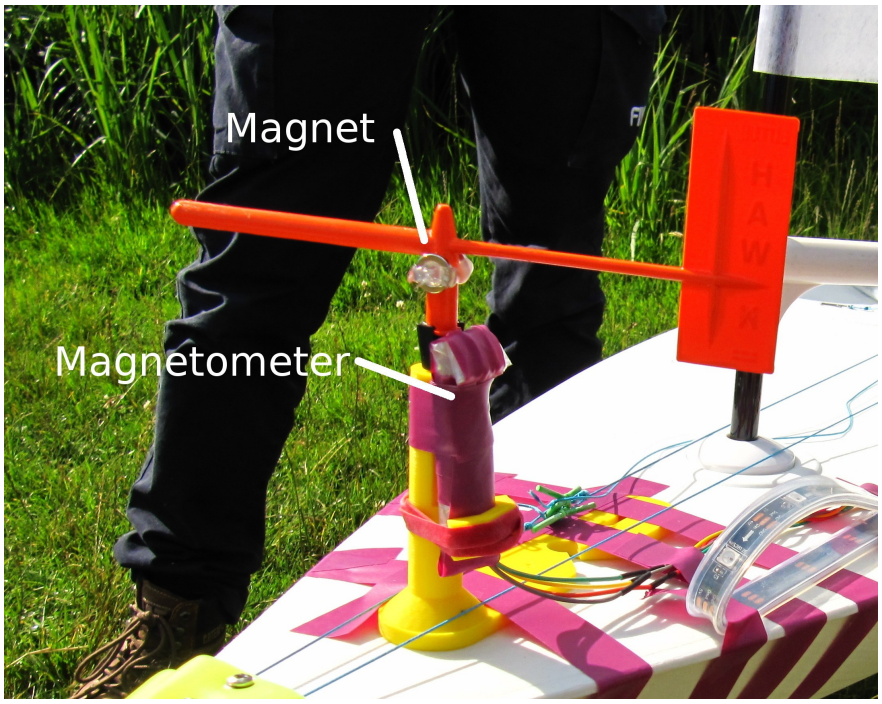

Figure 5: "Hand made" wind direction sensor

Task 2. Design consideration

- What is requirement of the wind vane?
- How can you improve our current design?

1.4 Wind speed sensor

Wind speed sensor is not used on boat. We have an analog maplin wind speed sensor used in conjunction with Arduino UNO.

Task 1. Find data sheet of this sensor

- Rotate the sensor and listen carefully the switch in side.
- What do you think how this sensor works?
- What is the relationship between pulse and wind speed?

Task 2. How to improve the performance of this sensor?

- How ultra-sonic wind speed sensor work?
- Does it realistic to use ultrasonic sensor on sailing robot?
- What is the best design trade-off ?

2 Actuators

2.1 Sail winch servo

Figure 6: Who am I?

Task 1. Servo control

- How can we control a servo?
- What is range of this servo in turns/ degrees?
- What signal we send can make servo move to neutral position?

Task 2. Interface and design consideration

- How raspberry interface with servos?
- What is hardware and software PWM?
- How powerful our winch servo should be?
- If we are designing a four metres long boat, how can we scale it up?

2.2 Rudder servo

Figure 7: Who am I?

Task 1. Servo control

- How can we control a servo?
- What is range of this servo in turns/ degrees?
- What signal we send can make servo move to neutral position?

Task 2. Interface and design consideration

- How raspberry interface with servos?
- What is hardware and software PWM?
- How powerful our winch servo should be?
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3 Peripherals

3.1 USB camera

3.2 WiFi access point

Try to work out the WiFi password and login Raspberry Pi.