TITLE PROJECT

Continued from page Arduino Flight Computer Design 9-10-19

Objective

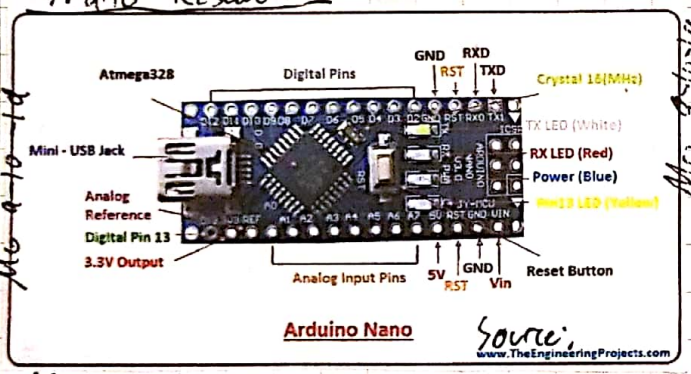
The objective of this project is to use the arduino based C++ language & IMU sensors to develop a computer that can know it's relevent position, orientation, direction of travel, velocity, and acceleration to create a 3D plot of the flight computers path.

Materials List

- Arduino Nano (3 for $13.99 on Amazon)
- MPU-9250 gyroscope accelerometer magnetometer ($8.49 on Amazon)
- NEO-6M GPS module ($12.99 on Amazon)
- BMP-280 barometer ($11.10 on Amazon)
- Breadboard & Jumper Wire kit ($16.86 on Amazon)

Total cost: $63.43

Nano Research



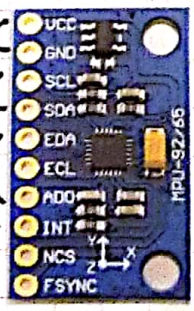
Nano Diagram

Source: The Engineering Projects.com

Pin Descriptions

Vin - 7-12v power supply
5v - regulated power supply
3.3v - minimum voltage from regulator
GND - ground pins
Reset - Resets board when supplied power
A0-A7 - analog pins for measuring analog voltage
Rx, Tx - Serial com. Transmission & recieving
13 - Built in LED pin
AREF - reference voltage for input voltage
PWM - pins 3, 5, 6, 9, 10, 11 (Pulse Width Modulation)
Interrupts - Pins 2, 3 stops program & runs specific code

MPU-9250 Research



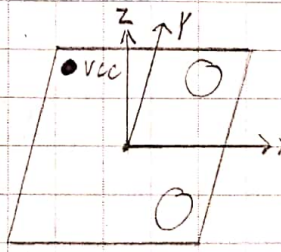
Power (
I2C (
SPI (
Interrupt -

Note: AFS is selected scale range in the program

Accelerometer

Full scale range:

		AFS
±2g -	16384 LSB/g	0
±4g -	8192 LSB/g	1
±8g -	4096 LSB/g	2
±16g -	2048 LSB/g	3



Accelerometer Axis 9-10-19

Accelerometers do not require calibration but are usually run through a filter to remove vibrations

Continued to page

SIGNATURE MO

DATE 9-10-19

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DATE

PROPRIETARY INFORMATION

PROJECT

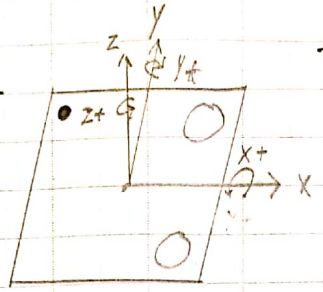
TITLE

Continued from page

Gyroscope

Full Scale Range:

	AFS
± 250 °/sec - 131 LSB/(°/s)	0
± 500 °/sec - 65.5 LSB/(°/s)	1
± 1000 °/sec - 32.8 LSB/(°/s)	2
± 2000 °/sec - 16.4 LSB/(°/s)	3



Gyro Axis 9-10-14

Calibration

Generally, gyros are calibrated at the start by calculating an average offset when the gyro is still then subtracting this from the input data

Magnetometer

Full scale range:

± 4800 µT - 0.6 µT/LSB

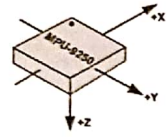
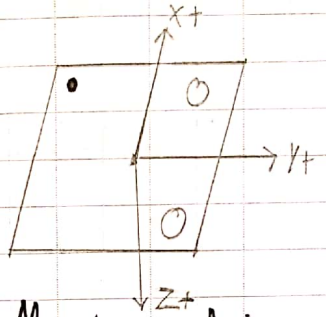


Figure 5. Orientation of Axes of Sensitivity for Compass

MPU-9250 data sheet p.38



Magnetometer Axis 9-6-14

Magnetometers are calibrated by rotating the device on all 3-axis, then calculating a median offset for hard iron error, then finding a scale to multiply by to reduce soft iron error. This depends on the surroundings such as metals & Magnetic fields

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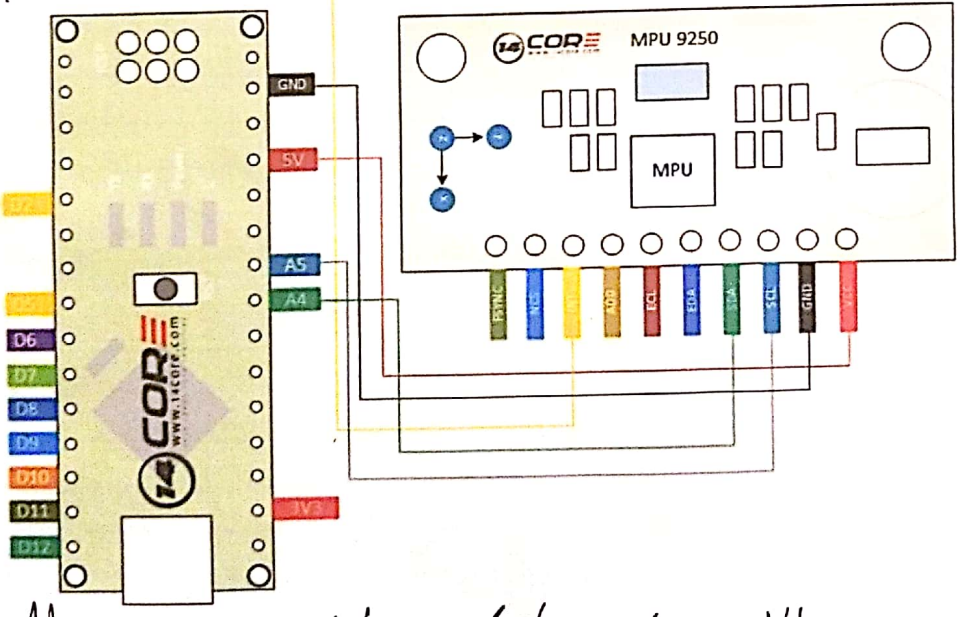

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MPU-9250 Wiring Schematic 14core.com

Continued to page

SIGNATURE Matt Oe

DATE 9-11-14

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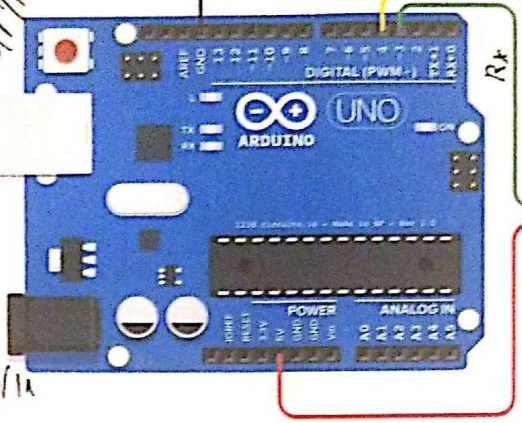
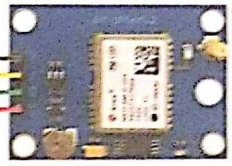
DATE

TITLE PROJECT

Continued from page

Neo-6M GPS Research





NEO-6M Module NEO-6M Arduino Wiring Schematic

The NEO-6M is a 50dB gain GPS module with a passive and active antenna.

Operational Limits:		Sensitivity:	
	Dynamics <4g	Velocity accuracy	0.1 m/s
	Altitude 50,000m	Heading accuracy	0.5 deg
	Velocity 500m/s	Horizontal pos accur.	2.5m

Time to First Fix:		
Cold Start	27 sec	Cold start is when the GPS has no data to start
Warm Start	27 sec	Warm start the GPS remembers last location, almanac, UTC
Hot Start	1 sec	Hot start remembers satellites in view, last location, almanac, UTC
Aided Start	<3 sec	Aided start uses a network connection from radio towers

The GPS also has a USB attached. The NEO can be connected to a computer independently of the arduino to be put through a program such as U-center that will give detailed information on the GPS, such as locked satellites, the current location, # of sattelites, sattelite information (nation, #, location overhead) to also give the estimated accuracy of the lock to the lock type. It can also draw graphs of the locations of the GPS to visualize the error/variety in the location to the nearest meter.

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SIGNATURE Matt Oe DATE 9/11/19

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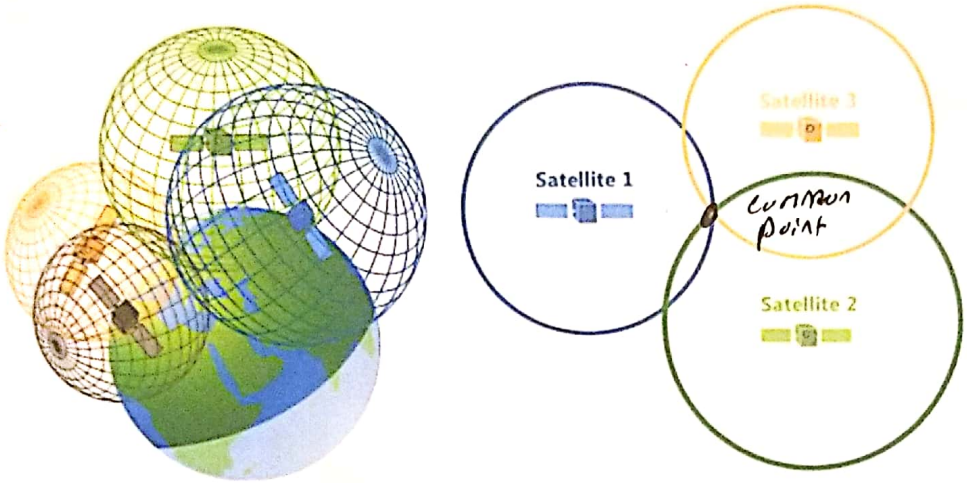
GPS finds location accurately using trilateralization. It's commonly confused that GPS uses triangulation, which uses angles, but they do not. Trilateral uses distances, not angles. The distance is found by the time for the signal to reach the satellite. Then, at least three satellites are needed to find a middle point



Trilateralization Visualized - GIS Geography

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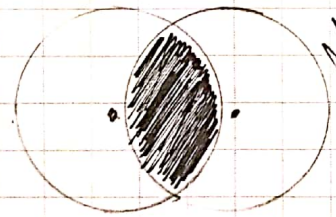
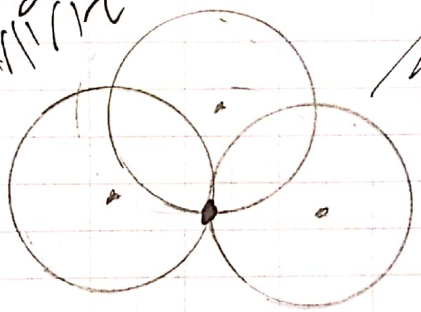
One satellite



Two satellites



Three Satellites (Trilateralization)

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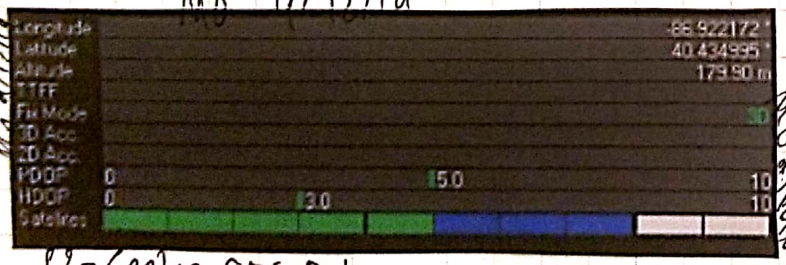

U-Center GPS Data

The default datum for U-Center is WGS-84

Height is referenced from either MSL (mean sea level) or HAE (height above WGS-84 Ellipsoid)

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