The Auto Correction System

Inertial Measurement Unit: MPU-6050
Micro-Controller: Arduino-UNO

In a nutshell: The MPU (motion processing unit) – 6050 does exactly what its name suggests - it can sense how it is being moved. However, this does not mean that it can create a map of its path because it can only detect changes in its linear velocity and angular position. Now the unit can send out information about these changes; this information is useless for an auto correction system unless it is used to control the craft's orientation. Therefore, information given by the MPU must be sent to a device that will process that information to control the control-surfaces of the craft. A device that can perform this kind of task is called a micro-controller (the Arduino in this case). The Arduino micro-controller is programmable, making it useful for other things too. However, this makes it slightly less compact.

Measurement:

- MPU-6050 has an in-built accelerometer and gyroscope.
- Accelerometer – This device is used in so many devices including your smart mobile phone, how do you think it knows up from down and can orient the display on the screen accordingly? All the accelerometer can do is measure linear acceleration or changes in speed. Imagine a ball suspended in the middle of a box by springs on all four sides. If the box is then pushed, you will notice that the inertia of the ball causes tension and compression on the springs. If you were to take the readings of these forces you would be able to calculate the acceleration that the box experienced when it was pushed. The same idea applies for an accelerometer except it does not look like that (because the "box" example is highly inefficient and bulky).
  An accelerometer looks more like Figure 1.1: where the 'Seismic mass' represents the ball in the example and the housing is the object who's change in liner velocity we are trying to measure. The Seismic mass is composed of silica (a semiconductor) that when moves changes the capacitance of the two green bars in the diagram that surround it which corresponds to a change in the voltage across them. The blue fingers from the Seismic mass and the green ones surrounding them make up a differential (trimmer) capacitor which is a capacitor with an adjustable capacitance.

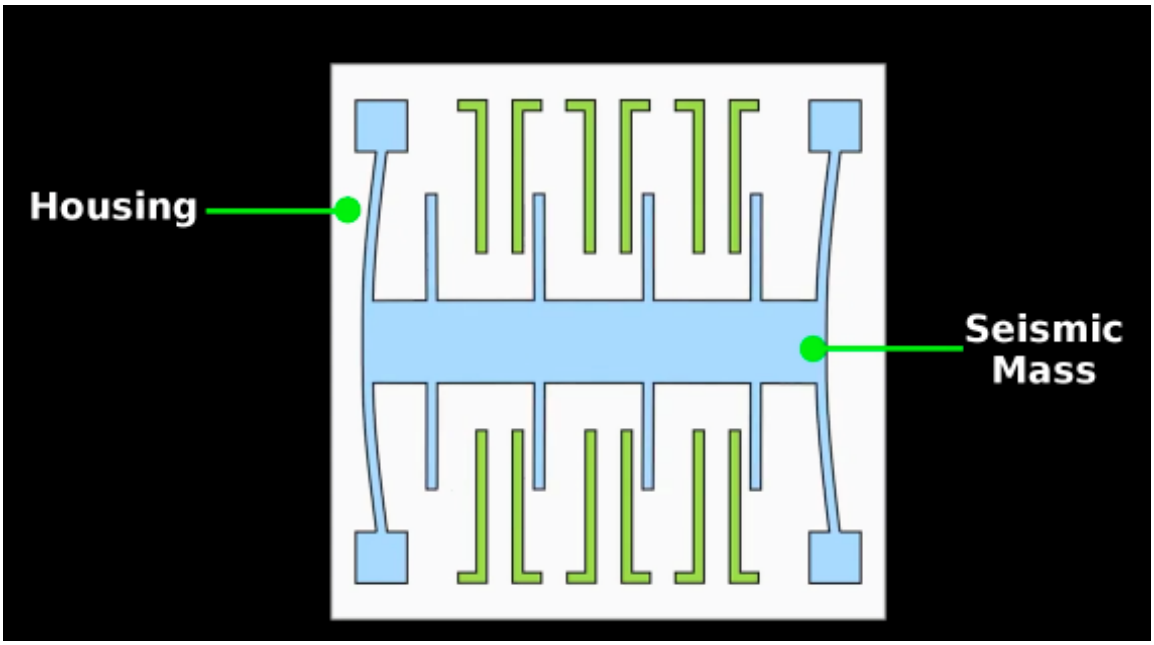

Fig 1.1

In the case of our air-craft, this device is very good at telling up from down because the acceleration due to gravity would act on it in the same way that a force pushing it upwards without gravity would.

- Gyroscope – When telling up from down, the accelerometer can do its job quite well. However, it is not enough when we want to also measure changes in the craft's angular position. For this job, we use a 'gyroscope'. You see this when you spin a top and the International Space Station uses the concept to be stable and prevent itself from spinning. What's special about this device is that it resists changes to its angular position and measurement of the opposing force can tell you how the angular position has changed. Why it can resist these changes is a bit complicated but put simply, the angular momentum vector points along the axes of rotation which means it is always perpendicular to the plane an object is rotating along and if you apply a torque to it, the torque will point in a direction perpendicular to the vector, therefore opposing its motion.

For a plane, there is a name for each of its 3 possible angular velocity vectors that point along each of the 3 axes on a Cartesian coordinate system(x/y/z) or (x1/x2/x3) they are yaw, roll and pitch. Figure 1.2 shows what each one is.

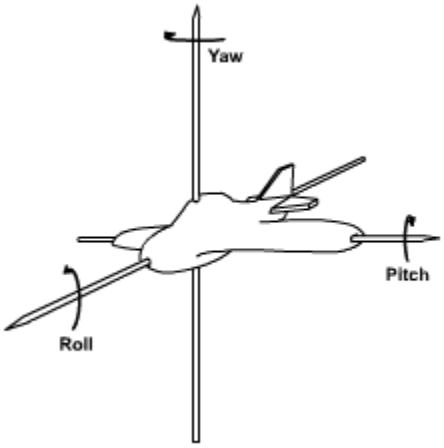

Fig 1.2

So, for the auto correction system, whenever the gyroscope detects a change in the angular position, the information is sent to a micro-controller which then accordingly moves the control surfaces using servos to correct the angular position of the craft.

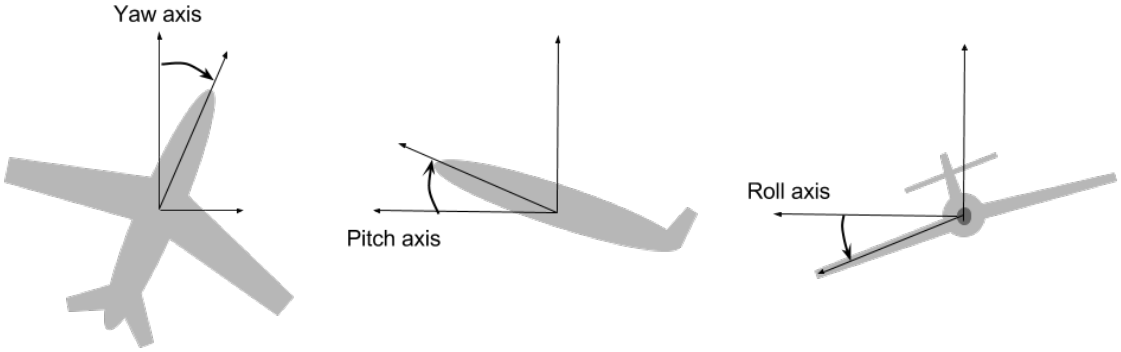

Fig 1.3
better illustrates how the plane rotates about each axis

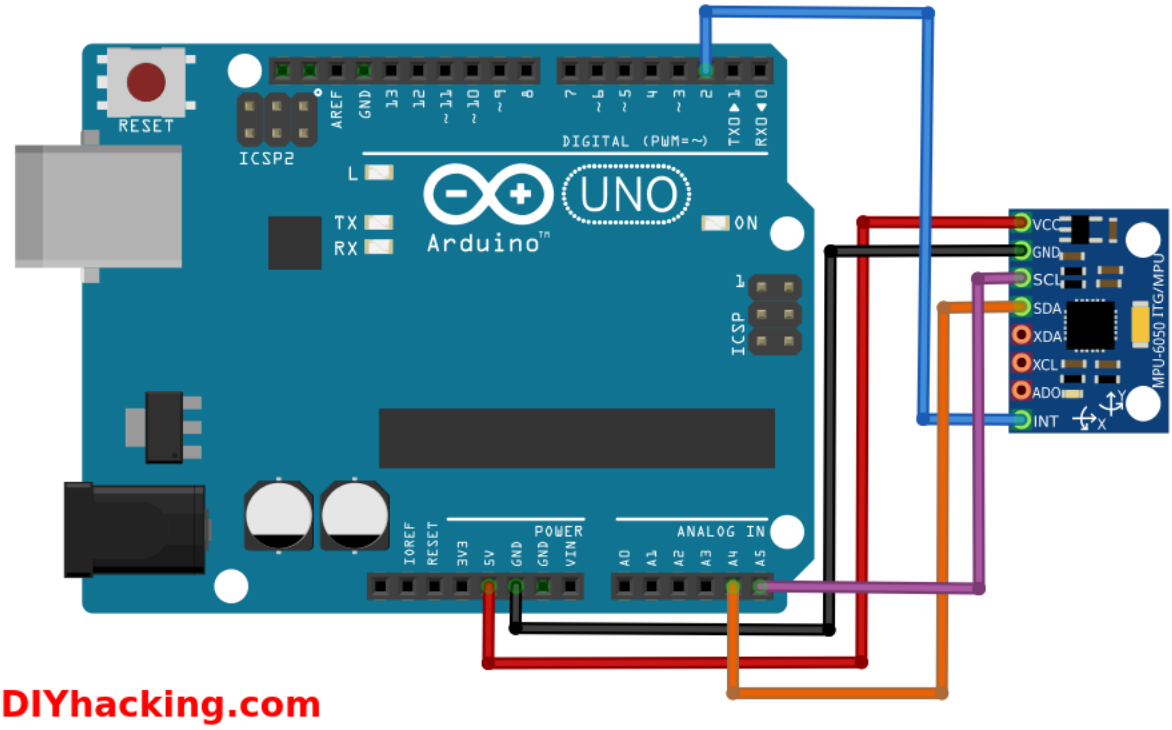

Fig 1.4

illustrates how the arduino-uno is wired to the MPU-6050. This does not include how the arduino is connected to the servos.