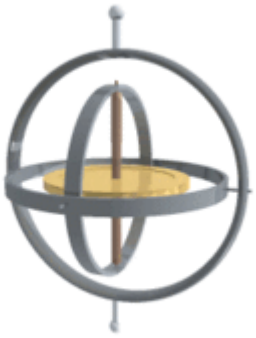
The Technologies of AR. Drone Quadcopter

Gyroscopes



"A gyroscope is a device for measuring or maintaining orientation, based on the principles of conservation of angular momentum." Gyroscopes can be very perplexing objects because they move in peculiar ways and even seem to defy gravity. These special properties make - gyroscopes extremely important in everything from your bicycle to the advanced navigation system on the space shuttle. A typical airplane uses about a dozen gyroscopes in everything from its compass to its autopilot. The Russian Mir space station used 11 gyroscopes to keep its orientation to the sun, and the Hubble Space Telescope has a batch of navigational gyros as well. Gyroscopic effects are also central to things like yo-yos and Frisbees!

Precession

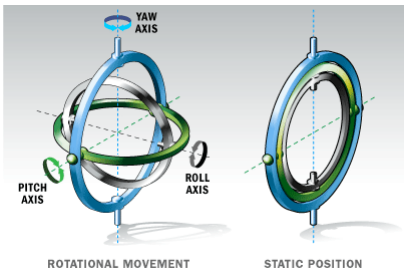
This is the gravity-defying part of a gyroscope. The following video shows you the effects of precession using a bicycle wheel as a gyro:

http://www.youtube.com/watch?v=IEwAry0GARw

The most amazing section of the video, and also the thing that is unbelievable about gyroscopes, is the part where the gyroscopic bicycle wheel is able to hang in the air like this:

How can it do that?

This mysterious effect is precession. In the general case, precession works like this: If you have a spinning gyroscope and you try to rotate its spin axis, the gyroscope will instead try to rotate about an axis at right angles to your force axis, like this:



Uses of Gyroscopes

The effect of all this is that, once you spin a gyroscope, its axle wants to keep pointing in the same direction. If you mount the gyroscope in a set of **gimbals** so that it can continue pointing in the same direction, it will.

This is the basis of the **gyro-compass**.

If you mount two gyroscopes with their axles at right angles to one another on a platform, and place the platform inside a set of gimbals, the platform will remain completely rigid as the gimbals rotate in any way they please. This is this basis of **inertial navigation systems** (INS).

In an INS, sensors on the gimbals' axles detect when the platform rotates. The INS uses those signals to understand the vehicle's rotations relative to the platform. If you add to the platform a set of three sensitive **accelerometers**, you can tell exactly where the vehicle is heading and how its motion is changing in all three directions. With this information, an airplane's autopilot can keep the plane on course, and a rocket's guidance system can insert the rocket into a desired orbit!

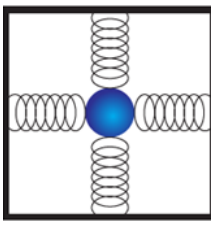
The iPhone and iPad used to move the AR. Drone also uses Gyroscopes to help determine when the user moves the tablet or phone device. The iPhone and iPad utilise a microscopic, electronic version of a vibrational gyroscope, called a MEMS gyroscope.

Accelerometer

Definition of Acceleration

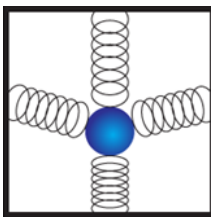
Acceleration is the rate of which velocity changes with time. On a one dimensional plane, acceleration is the rate at which an object picks up speed or slows down.

How do they Work?



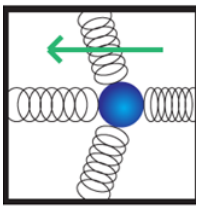
The accelerometer is basically a mass, suspended by a spring. The measurement you are getting from the device is the amount these springs are flexing.

This is an illustration of an accelerometer, they are not actually constructed this way, this is just to aid your understanding! Here you can see the mass (in Blue) is suspended by four springs attached to the frame. At the moment all these springs are zero, which means no force is being applied to the mass relative to the frame, but this is not what you see when your accelerometer is sitting on the desk next to you.

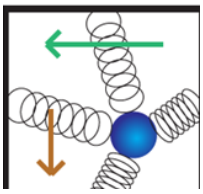


You actually see something like this?

This is because gravity is acting on the mass and is pulling it down. The accelerometer is measuring 1 g because that is the amount of gravity you experience on the surface of the earth. So when you have an accelerometer and you think you are measuring nothing, you are actually measuring the force of gravity.



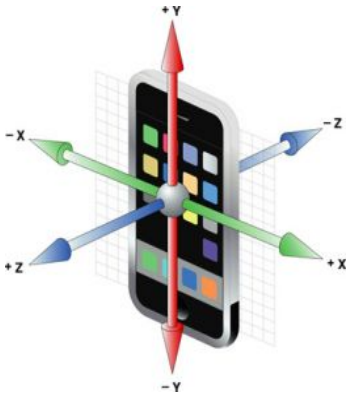
The accelerometer also measures movement, so if you move the accelerometer from side to side the result looks like this.



However, usually you will never see these results, it's more likely you see them all mashed together. This looks like a big mess. In computer technologies the mass and the spring are replaced with very small and sopisicated computer devices which are very accurate.

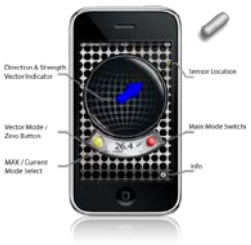
Using an iPhone or iPad Accelerometer

Where ever the iPhone, iPod or iPad is positioned and if it isn't moving, then the internal accelerometer will be able to measure its orientation relative to the ground.



In the simplest case, if you lay your device flat on a level table then it will detect a force of one gravity (g) downwards and an acceleration of zero in the two horizontal directions.

If you subject the device to other forces, for example if you shake it, it can detect and measure the magnitude and direction of the forces acting on it. This enables the iPad or iPhone to work out if it is being held in landscape or portrait orientation and enables it to change the screen layout accordingly.



When the iPad or iPhone is being used to navigate the AR. Drone tilting the device up and down will move the Drone forwards and backwards and tilting left and right will move the Drone left and right. The three accelerometers (X – axis, Y – axis and Z – axis) will detect how far and how fast you move and this will be replicated on the Drone.

Demonstration of Accelmeter app on iPad