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***SENSORS***

This report is regarding sensors. sensor is a device, module, machine, or subsystem whose purpose is to detect events or changes in its environment and send the information to other electronics, frequently a computer processor. A sensor is always used with other electronics. Sensors are used in everyday objects such as touch-sensitive elevator buttons and lamps which dim or brighten by touching the base, besides innumerable applications of which most people are never aware.

## Types of sensors:

1. GPS/GNSS
2. IMU
   1. Accelerometer
   2. Gyroscope
3. Wheel speed sensor

# 1.GPS/GNSS

## 1.1.GPS and its uses

* Global Navigation Satellite System (GNSS) refers to a constellation of satellites providing signals from space that transmit positioning and timing data to GNSS receivers. The receivers then use this data to determine location.
* GPS is one of the GNSS which provides us the information for preparing accurate surveys and maps, taking precise time measurements, tracking position or location, and for navigation
* The main uses of GPS are:
  + Location — Determining a position.
  + Navigation — Getting from one location to another.
  + Tracking — Monitoring object or personal movement.
  + Mapping — Creating maps of the world.
  + Timing — Making it possible to take precise time measurements

## 1.2. Types of GPS Trackers and factors hindering it

* There are basically three types available: plug in, hardwired and battery operated. Typically, these units take the information they gather and use a cellular connection to share it. Remote users can then access the GPS tracking data with a cell phone app or via a secure web connection
* Portable GPS, Pocket GPS, In-Dash Receivers, Fitness and cycling trackers, Marine GPS are a few of many tracking devices used
* Some factors that can hinder GPS accuracy include:
  + Physical obstructions
  + Atmospheric effects
  + Ephemeris Numerical
  + miscalculations
  + Artificial interference
* Accuracy tends to be higher in open areas with no adjacent tall buildings that can block signals. This effect is known as an urban canyon

## 1.3. Types of GNSS

* + - There are four global GNSS systems – GPS (US), GLONASS (Russia), Galileo (EU), BeiDou (China).
    - There are 24 GNSS satellites in the baseline satellite constellation positioned in six earth-centred orbital planes with four operation satellites and a spare satellite slot in each orbital plane
    - There are basically three types available: plug in, hardwired and battery operated. Typically, these units take the information they gather and use a cellular connection to share it. Remote users can then access the GPS tracking data with a cell phone app or via a secure web connection

# 2. Inertial Measurement Unit- IMU

An IMU is a specific type of sensor that measures angular rate, force and sometimes magnetic field.

IMUs are composed of a 3-axis accelerometer and a 3-axis gyroscope, which would be considered a 6-axis IMU.

## 2.1. Accelerometer

* + - An accelerometer is an electronic sensor that measures the acceleration forces acting on an object, in order to determine the object's position in space and monitor the object's movement
    - The two types of acceleration forces that are measured by the accelerometer are: static forces and dynamic forces. Static forces are forces that are constantly being applied to the object (such as friction or gravity). Dynamic forces are “moving” forces applied to the object at various rates (such as vibration, or the force exerted on a cue ball in a game of pool). Therefore, accelerometers are used in automobile collision safety systems.
    - A piezoelectric accelerometer utilizes the piezoelectric effect (piezoelectric materials produce electricity when put under physical stress) to sense change in acceleration. commonly used in vibration and shock measurement. best suited to vehicle crash testing. increases its resistance in proportion to the amount of pressure applied to it
    - Capacitive accelerometers use change in electrical capacitance to determine an object’s acceleration. When the sensor undergoes acceleration, the distance between its capacitor plates changes as the diaphragm of the sensor moves.
    - Most accelerometers are miniscule, and they are often referred to as Micro-Electro-Mechanical Systems (MEMS) accelerometers. Because of their size and affordability, they are embedded in a myriad of hand-held electronic devices. In phones and tablets, the accelerometer is responsible for “flipping” the screen when the device is rotated

## 2.2 Gyroscope

* + - A gyroscope is a device used for measuring or maintaining orientation and angular velocity. It is a spinning wheel or disc in which the axis of rotation (spin axis) is free to assume any orientation by itself
    - It is used to detect the deviation of an object from its desired orientation.
    - Applications of gyroscopes include inertial navigation systems, such as in the Hubble Telescope, or inside the steel hull of submerged submarine, smart phones
    - A gyroscope would be used in an aircraft to help in indicating the rate of rotation around the aircraft roll axis.
    - Different types of gyroscopes are:
      * hemispherical resonator gyroscope
      * vibrating structure gyroscope
      * dynamically tuned gyroscope
      * Fibre optic gyroscope
      * Ring laser gyroscope

## 2.3 Accelerometer vs. Gyroscope

* + - The main difference between the two devices is simple: one can sense rotation, whereas the other cannot.
    - the accelerometer can gauge the orientation of a stationary item with relation to Earth's surface. When accelerating in a particular direction, the accelerometer is unable to distinguish between that and the acceleration provided through Earth's gravitational pull.
    - The typical two-axis accelerometer gives users a direction of gravity in an aircraft, smartphone, car or other device. In comparison, a gyroscope is intended to determine an angular position based on the principle of rigidity of space.

# 3.Wheel Speed Sensor

## 3.1. What is a wheel speed sensor?

* + - A wheel speed sensor or vehicle speed sensor (VSS) is a type of tachometer (an instrument measuring the rotation speed of a shaft or disk, as in a motor or other machine)
    - In anti-lock brake system (ABS) Wheel speed sensors (also known as wheel sensors) detect the speed of the wheels and supply this information to the ABS or ESP control unit in the form of an electrical signal.
    - Due to this variety of applications, wheel speed sensors make a direct contribution to driving dynamics, driving safety, driving comfort and reduced fuel consumption and emissions.
    - Based on their mode of functioning, wheel speed sensors are classified into active and passive sensors

## 3.2. Passive Wheel Speed Sensors

* + - If a sensor works without an additional power supply, then it is called "passive".
    - Variable Reluctance
      * The variable-reluctance magnetic sensor has a permanent magnet pickup core and coil surrounding the magnet. These are typically found on pre-2003 vehicles.
      * The rotation of the reluctor ring increases and decreases the magnetic field between the notch and the tooth to generate a voltage in the coil.

## 3.3. Active Wheel Speed Sensors

* + - If a sensor becomes "active" only when a power supply is connected to it and if it then generates an output signal, it is called "active".
    - Magneto Resistive
      * A magneto resistive sensor has a sensing element that contains an output module that is mounted on a substrate and magnetic material. These magnetic rings are often located on the seal of the bearing.
      * he magneto resistive sensor’s main advantage is the ability to sense direction and operate with a wide air gap. The sensor is more stable in high-vibration conditions and operates more efficiently than the reluctance sensor.
    - Wheel speed detection from standstill.
    - Pulse wheels are not used, so that the power transmission joints are simpler
    - The sensor design is smaller and lighter
    - Good insensitivity to vibration and temperature fluctuation