Stationary Tracking Systems

The stationary tracking systems were the first to become popular for virtual reality applications, emerging in the 1990s [Meyer et al. 1992] [Rolland et al. 2001]. Mechanical tracking, electromagnetic tracking, and ultrasonic tracking systems, because of their stationary nature, are not very popular for AR today. Nevertheless, these systems are useful to understand some basic principles of tracking

1) Mechanical tracking

Mechanical tracking, which is probably the oldest technique, builds on mechanical engineering methods that are very well understood. Usually, the end-effector of an articulated arm with two to four limbs is tracked. This requires knowledge of the extent of every limb and measurement of the angles at every joint. Joints can have one, two, or three degrees of freedom in orientation, which are measured using rotary encoders or potentiometers. From the known length of the limbs and the angular measurements of the joints, a mathematical formulation of a kinematic chain can be set up to determine the position and orientation of the end-effector.

This approach delivers high precision and a fast update rate, but the freedom of operation is severely limited by the mechanical structure. However, movement constraints of the limbs may prevent the arm from reaching the full range of orientations. Thus, mechanical tracking can be seen as an outside-in setup with a severely restricted workspace. For AR, it is undesirable to have the articulated arm in the field of view, where virtual or real objects should be placed.

2) Electromagnetic Tracking

Electromagnetic tracking uses a stationary source producing three orthogonal magnetic fields. Position and orientation are measured simultaneously from magnetic field strength and direction using small tethered sensors equipped with three orthogonal coils. Decreasing field strength with distance and tether length of the sensors typically limit the operating range to a hemisphere of 1-3 m diameter.

3) Ultrasonic Tracking

Ultrasonic tracking measures the time of flight of a sound pulse traveling from source to sensor. If a separate (wired or infrared) synchronization channel is available, three measurements are sufficient for trilateration. Otherwise, additional measurements are necessary. Multiple ultrasonic sensors can pick up a signal simultaneously, but multiple sources must send their pulses sequentially to avoid interference. This factor, together with the modest speed of sound, limits the update rate to 10–50 measurements per second, which must be shared for all tracked objects. Further limitations include the requirement of an open line of sight for clear reception, susceptibility to disturbances from loud environmental noises, and dependence of the speed of sound on air temperature

Mobile sensors

Sensors is the device which is used in smartphones to detect various aspects of environment. They sense data for which they are made and works according to that. There are various sensors which are available nowadays in smartphones which is in-built and helps in functioning of the smartphone. Basically, they work for better user experience.

1) Motion Sensors – Motion sensors are useful for monitoring device movement, such as tilt, shake, rotation, or swing. Smartphones identify their orientation through use of an accelerometer. The motion sensors present in accelerometer can be used to detect earthquakes or in medical devices.

2) Environmental Sensors – The Environmental Sensors are used to detect temperature, humidity, heat losses. Basically, it is used to monitor environmental parameters. They come up with sensors like Gas Sensors, Humidity Sensors etc.

3) Position Sensors – The Android smartphone provides two sensors that let you determine position of device- geomagnetic field sensor with combination of accelerometer sensor.

4)Ambient Light Sensor – This sensor works in controlling brightness level of screen. It is available in almost every smartphone ranging from mid to high. If you have put your smartphone to Auto-brightness mode, then when you move out in light, there your phone will automatically boost brightness of the screen. When you come in dark, then with help of this sensor, phone's brightness will become dim. Depending on intensity of light, this sensor manages brightness of the screen.

5) Proximity Sensor – They are available in almost every smartphone at top of the screen. Infrared light flows through this sensor. When any physical object comes in contact with this light, it detects it and reacts towards it. For example, when you talk on your phone and place your phone on your ear, infrared light detects physical object i.e, your ear. Sensing that, screen's light automatically goes off. This saves both battery life and prevents accidental screen touches.

6) Accelerometer Sensor – It is most important sensor which should be available in every smartphone. It helps phone to check its orientation. For Example, if you rotate your phone in landscape mode, then all icons present on screen also moves to landscape mode, and when you want you can change it into portrait mode, this is because of these sensors.

7) Gyroscope Sensor – You must have heard about it's name. Virtual Reality is possible only because of these types of sensors. If you buy VR head set, put your phone inside, then that is only possible because of gyroscope sensors. Even 360 degree pictures or videos and AR (Augmented Reality) is possible only because of these sensors. These sensors helps phone to know that which axis (Angles and Directions) it is using at that point of time in very precise manner. Basically, it adjusts contents of phone according to user.

8) Barometer Sensor - These sensors are not available in every phone, it is available in high range phone. This is used for detecting altitude (height) data. For Example, The health app in

smartphones also uses these sensors. Going up from stairs or moving from ground level to floor level, every detail is given by barometer sensor precisely and data is sent to GPS which then is calculated. It also helps in GPS.

9) Compass Sensor – Compass sensor is very normal and available in every phone, helps in detecting direction like normal compass do.

There are various other sensors which are not too important for Smartphones but still exists.

10) Pedometer Sensor – It count your steps that how much you have walked. It is available in high-end devices and some specific devices only.

11) Hall Sensor – It is basically used in tablets in comparison to phones. If you buy flip case cover for your tablet, and when you open that cover, without pressing any button, light of the screen will automatically starts and it will start tablet and when you close that flip-cover, light will goes off.

12) IR Blaster – It is available in every phone of XIAOMI ranging from low to high. For other companies, it is not available for every phone. These sensors are used to control electronic devices. For Example, you can control TV, AC or any other electronic devices from your smartphone if you have IR Blaster in your phone.