Gls{gnss} known (satellites in this case) and

Countries, United States

gls{gnss} are the mostly used technology for outdoor localization. The gls{gnss} development starts with a military project, presently known as gls{gps}, of department of defense (DoD) of the United States, which later on was made available to civilian use. Initially, the GPS made available to civilian use was purposefully degraded, about 100m, using selective availability (SA), which was removed later on. At present, consumer grade GPS is able to obtain an accuracy in the range 1m to 10m cite{Peak2010}. For specialized applications such as surveying the centimeter level acuracy is possible cite{pace1995global}. In addition to the GPS, Russia’s Global Orbiting Navigation Satellite System (GLONASS) and the European Union’s Galileo are global operational GNSSs.

This thesis is focused on the GPS, due to its usage dominance in applications worldwide . A brief working of GPS is given next. section{The GPS system}The GPS system consists mainly of three segments namely space segment, control segment and user segment cite{pace1995global, hofmann2012global}. egin{itemize} item Space Segment: It consists of the GPS satellites which sends radio signals from space. There are total 24 satellites in six orbital planes.

GPS satellites transmit two codes: the Precision or P-code and the Coarse Acquisition or C/A-code, designed for military and civilian purpose respectively. C/A-code are less accurate, easier to acquire but easier to jam than the P-code. item Control Segment: This control segment consist of five satellite tracking stations located around the world. It tracks the GPS satellites and provides them with periodic updates, correcting their ephemeris constants and clock-bias errors only daily basis. item User

Segment : The segment consists of the GPS receivers, the one located in the user's devices. GPS receivers convert satellite signals into position, and velocity estimates. end{itemize}The GPS receiver calculates its position using multilateration. Multilateration requires a minimum number of reference points with their location known (satellites in this case) and the distance between the visible satellites and the GPS receiver (user interested in finding the location).

To estimate the distance, the GPS receiver generates a set of codes identical those transmitted by the system's satellites and calculates the time delay between its codes and the codes received from the GPS satellites by determining how far it has to shift its own codes to match those transmitted by the satellites. Then the travel time is multiplied by the speed of light to estimate distances between the receiver and the satellites. In theory, the distance and positions of only three satellites are needed to calculate a 3D position. In practice, fourth satellite is necessary to solve the timingoffset problem between the clocks in a receiver and those in a satellite. There are two important factor affecting GPS position accuracy.

First, the errors inherent in the GPS signals themselves mainly contributed by satellite clock and ephemeris errors, atmospheric delays, multipath, and receiver noise which includes receiver kinematics and receiver hardware quality. Second, the satellite geometry, which plays an important role in underlying multilateration technique. Generally, farther apart the visible satellites are, the better accuracy a receiver will have.