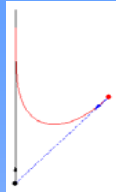


GPS-Based Location Determination

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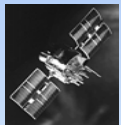
The Classical Pursuit Problem:

Fox needs to continuously adjust its heading and velocity according to its position relative to Rabbit's. We are using robots equipped with DGPS to explore this problem.



What is GPS?

GPS (Global Positioning System) enables a Earth-based receiver to approximate its position at anytime. The 24 GPS satellites orbit with a period of 12 hours and continuously broadcast PRN (Pseudo-Random Noise) codes over the L1 and L2 frequency bands. These codes are unique to each satellite and enable the receiver to determine its location, typically within 10 meters. The entire system is operated by the U.S. Air Force.



The first GPS satellite was called GPS Block I. Launched in 1978, it was a developmental satellite



How does it work?

By processing the information included in satellite transmissions, a GPS receiver can estimate its distance from each satellite. Using this pseudo-range measurement, one can draw an imaginary sphere centered at the satellite. Assuming the satellites' and receiver's time clocks are perfectly matched, three satellites are required to compute the position. However, due to an unavoidable clock-bias in the receiver's clock, an additional satellite is required to accurately locate the receiver.

Differential GPS:

Differential GPS systems have two components: a reference station and a rover station.



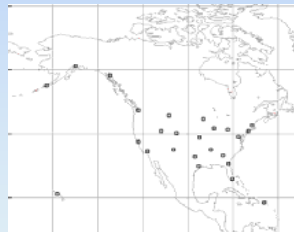
A reference station knows its exact location and broadcasts a correction message.

DGPS Correction Message



A rover station uses the correction message to improve its GPS accuracy.

Another DGPS system is **WAAS** (Wide Area Augmentation System). It consists of approximately 25 ground reference stations. Two master stations collect data from the reference stations and create a GPS correction message. The corrected differential message is then transmitted through one of two geo-stationary satellites.



WAAS reference stations



A robot equipped with a WAAS enabled GPS receiver

Accuracy:

Typical accuracy for both Differential and WAAS GPS is less than 3 meters.

Objectives:

Implement a closed-looped system that takes GPS location data as input and produces the necessary output drive signals to model the behavior of Fox in the Classical Pursuit Problem.

Procedures and Results:

Solve the simpler Stationary Tracking Problem, meaning the translation velocity of Fox will always be zero.

Simulated both the Classical Pursuit Problem and the Stationary Tracking Problem.

Gathered data to determine the accuracy of the two GPS receivers:

	Millennium	Superstar II
Average Lat_degrees	38.99009352	76.93661713
Average Lon_degrees	38.99008552	76.93662704
Stdev Lat_Meters	0.063130107	0.27678612
Stdev Lon_Meters	0.654463236	0.986441237
Lat_Meter Diff	0.888472145	
Lon_Meter Diff	0.85829342	

This data is collected with the two GPS receivers at the same location over a period of about 15 minutes.

Installed hardware (e.g. compass) and wrote new modules/drivers to interact with the device.

Wrote the stationary tracking MDLe (Motion Description Language Extended) **quark** to solve the problem.

A quark is a programmed control law.

Performed numerous outdoor experiments with the stationary tracking quark and obtained satisfactory results. More specifically, Fox tracked Rabbit with a small degree of error.