Topical Issues Examples Sheet 2012/13

Dr Robert Harle

Tracking

1. The Bat system is a ToF system where the tag acts as a transmitter.

(a) Explain how sync is obtained
(b) Describe how to invert the system so that the tag is a receiver
(c) Discuss the advantages and disadvantages of this alternative approach.

2.

(a) Describe the principles underlying the Kalman Filter. Why is it so commonly used?
(b) What does the H matrix in the Kalman Filter represent?
(c) Explain (at a high level) how a Kalman Filter can be used to incorporate ZUPTs within an Inertial Navigation System.

3. Consider a PDR application that fuses foot-based inertial measurements with a floorplan using particle filters (as per lecture 3).

(a) Distinguish between a strapdown inertial system and a PDR system. Why are PDR systems more successful in tracking over longer time periods?
(b) Distinguish between the localisation and tracking phases of the filter. What are the typical computation requirements of each?
(c) A naive approach to checking whether a particle crosses a wall is to compare the step vector with *every* wall vector in the floorplan. Suggest a more efficient implementation.
(d) Explain why the resample phase is necessary and how you could use it to dynamically reduce or increase the number of particles.

4. You have decided to sack the pilots of your private jet and buy the 'fully autonomous' upgrade. You are pleased to see in the brochure that the system "fuses data from a camera turret and opportunistic radio sources to provide accurate navigation even if GPS signals are lost for extended periods of time". Explain how these sensors can be used to provide navigation information such as velocity, bearing, orientation, etc. The brochure goes on to boast that "the system is intelligent, learns about its surroundings over time, and gets more accurate with use". Discuss at a high level how such a scheme might work. Under what conditions/scenarios might you still want to keep a parachute handy and why? (Hint—consider transatlantic trips, and all possible weather conditions.).

5. Imagine that you are tasked with designing an iPhone-like device that must be able to position itself at all times (indoors and out). Discuss the solutions you could use and the accuracies you might expect indoors and out.

GPS

6. List at least three error sources for the civilian GPS system and explain: (i) how they contribute an error to the system (physical mechanism, etc); (ii) the typical error (or range in error) they cause to a pseudorange measurement; and (iii) what (if any) mitigation steps can be taken to reduce their effect.

7. Describe the three segments of GNSS and explain what key information is transferred between each segment. Discuss what could happen to the quality of your GPS receiver position fix if the ground segment was destroyed/disabled (consider the effect on the system after 1 hour, 1 day and 1 month).

8. Explain the key differences between the military and civilian GPS signals. Give the benefits and issues associated with carrier-phase positioning. Under what circumstances could a civilian GPS receiver outperform a military GPS receiver in terms of absolute positioning accuracy?

9. State the radio positioning equation used by GNSS receivers and define each term. Explain why four satellites are required to determine a 3D position fix. There is a small chance that any satellites atomic clock could develop a fault which reduces its performance, resulting in unstable and unpredictable timing errors in the satellite broadcasts. Explain the effect this would have on a positioning solution and propose a scheme, given the availability of 5 satellites, to cross check whether one of the satellites has a broken clock.

10. Propose a scheme that would allow you to jam other people's civilian GPS receivers while still making use of civilian GPS signals for positioning yourself (your jammer and your GPS receiver are both mounted on the roof of the same vehicle).

RFID

11. Discuss the merits and demerits of using long-range passive RFID tags to track people wherever they go.

12.

(a) Show in detail the steps taken by the BTWA and the QTA to identify the tags 10101, 10001, 00001 and 11111

(b) Discuss what an eavesdropper who is out of range of the tag signal but in range of the redaer can detect from these schemes.

13. Discuss the potential uses of UHF RFID by a supermarket. Include practical and legal considerations in your answer.

14. Describe how the hash-lock and randomised hash-lock schemes work. Discuss their strengths and weaknesses for RFID.

Kinect

15. Explain how the Kinect manages to solve a very complex AI problem in real time, without regular recalibration and yet with high accuracy.

Big Data

16. Compare and contrast the GFS and HDFS distributed file systems

17. Discuss the types of failures you would have to contend with when building your own big data processing plant. Provide examples of how these have been solved by companies like Google and Amazon.