Topical Issues Examples Sheet I

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1. (RFID) Consider long range passive RFID tags.

    (a) Explain the principles of backscatter-coupling such tags use.

    (b) Discuss the practicalities of using such tags to track people wherever they go.

    (c) Show in detail the steps taken by the BTWA and the QTWA algorithms to identify the tags 10101, 10001, 00001 and 11111.

    (d) Discuss what an eavesdropper who is out of range of the tag signal but in range of the reader can detect when during the singulation algorithms in the previous part.

2. (RFID) Discuss the potential uses of long-range passive RFID by a supermarket. Include practical and legal considerations in your answer.

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

4. (IoT) What is the grand vision of IoT and why have we not achieved it?

5. (IoT/BLE) A hospital wishes to track all of its employees around the building and proposes using wearable BLE beacons, each set to regularly advertise a unique ID. They deploy networked listeners at known locations around the building. They wish to be able to locate everyone to within 10 m every few seconds.

    (a) Contrast the choice of having wearable beacons and fixed listeners rather than wearable listeners and fixed beacons.

    (b) Theoretically, what is the maximum number of advertisements that could be heard by a given listening beacon in a second? Why is the number much smaller in practice?

6. (BLE) For the mesh architecture discussed in lectures, explain why the complex routing protocols designed for mesh networks were not used.

7. (BLE) When in a connection, two BLE devices use frequency hopping to communicate reliably. When advertising, a BLE device sends the advertising packet on each of three dedicated channels in turn.

    (a) Explain at a high level what frequency hopping is and how it provides resilience to interference from both BLE and non-BLE sources.

    (b) Why does advertising not use frequency hopping?

    (c) Explain why there are three advertising channels (rather than two or four, etc) and why they are where they are in the radio band.

8. (Core location) 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.

9. (Inertial Nav) Consider a PDR application that fuses foot-based inertial measurements with a floorplan using particle filters (as per lectures).

    (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) Traditionally the filter cycle is propagate-correct-resample. Some implementations resample less frequently (i.e. run multiple cycles without resampling). Discuss the advantages and disadvantages of this.

10. (Particle Filter) Particle filters are commonly used for blob (object) tracking in computer vision. Explain how this might work, assuming we want to draw a bounding box around each blob. Note that the blobs could mutate their shape (e.g. a person bending down). How could you deal with multiple objects obscuring each other? (*Hint: a common choice of particle state is (x,y,w,h,vx,vy), where (x,y) represents the object sentre, (w,h) the dimensions of the bounding box, and (vx,vy) the particle velocity*).