COMPUTER SCIENCE TRIPOS Part II – 2017 – Paper 9

14 Topical Issues (RKH)

Consider a corridor with spotlights embedded along its length in the ceiling. When a user is walking along the corridor the ambient light sensors found in their smartphone will show a peak whenever passing under a spotlight. By thresholding the ambient light sensor we can form a *spotlight detection* sensor, with two states: {under a spotlight, not under a spotlight}. This question considers how this sensor may assist positioning along a corridor.

(*a*) Recursive Bayes filtering is to be used to fuse the sensor measurements to estimate location. Describe the steps and key assumptions made by this filter. Mathematical equations are not required for full marks.   [4 marks]

(*b*) A corridor is 21 m in length with 6 spotlights, numbered 1–6. They are spaced evenly at x=3, 6, 9, 12, 15, 18 m, where x runs along the corridor and x=0 is the corridor start. Due to a fault lights 4 and 5 are off.

   (*i*) Sketch the measurement model for the spotlight detector. Sketch the belief distribution for $\mathbf{bel}(x)$ for the user's location obtained when the detector is turned on and immediately detects a spotlight.   [3 marks]

   (*ii*) Describe a suitable motion model assuming the smartphone's inertial sensors are used to perform *Pedestrian Dead Reckoning* (PDR) with a constant step length. Sketch $\mathbf{bel}(x)$ obtained after the phone reports three steps have been taken.   [4 marks]

   (*iii*) Sketch the new $\mathbf{bel}(x)$ obtained when the light positioning sensor now indicates the user is under a spotlight. Explain its relationship to the previous $\mathbf{bel}(x)$.   [3 marks]

(*c*) A *Grid filter* is an implementation of a recursive Bayes filter where the $\mathbf{bel}(x)$ distributions are approximated by histograms. Compare the suitability of such a filter for this problem compared to Kalman and Particle filters, paying particular attention to any parameters and their effects.   [6 marks]