Blanche – An Experiment in Guidance and Navigation of an Autonomous Robot Vehicle

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1. Figure 3 illustrates the different control loops of the system – briefly describe the different parts of the system. If you should also add an obstacle avoidance system (either reactive or reflexive) – where in Figure 3 would you place it? (3)

2. Figure 7 gives a detailed picture of the position estimation system, which is, according to the author, a real-time system (which means that the control loop should be fed at a constant time interval, e.g. every 50ms) – which part do you think take longest time? How long time does it take to correct the position? When the system has found (calculated) a position fix and if this process takes longer time than the real-time system demands (i.e. that the positions should be available every 50ms) – how will this affect your system? (5+)

3. The author uses dense sensor data (i.e. doesn't make any feature extraction) – why? What is the purpose of the map and why does the map only consists of 2D-data? (3)

4. What does the equation in Section IV:B – Sensor Data tells you? Describe the parts (C, R, r and α) based on a schematic picture of the robot and the sensor system. (4)

5. Summarize the three steps of the iterative algorithm, referred to as the Cox matching algorithm, described in the paper. What are the main ideas and results of the different steps? What error (distance) is minimized in the final step (illustrate this with a figure)? (3)

6. What is the purpose of the linearization done in the second step of the algorithm? How is this linearization carried out? Is the algorithm able to find arbitrary values of the parameters of the b vector - why? (4)

7. The algorithm does a least square fit and by that finds the optimal (within the linear regression theory) translation and rotation of the data set. What is actually gained by iterating the algorithm, i.e. what differs between two iterations? (If there were no differences, the results of two iterations would of course be the same.) (4)

8. When is the algorithm terminated, i.e. when do the iterations stop? (3)

9. In the end of the description of the algorithm the author mentions something about rejecting outliers, what does this mean? Why is this important? What would happen if the outliers where not rejected? (3)

10. The paper also describes how to estimate the uncertainty of the match result, i.e. the variance and co-variances of the estimated parameters (the error in them) – why is this also important to estimate? (See e.g. how the results are later used to update the position of the robot.) What would the consequences be if the estimate of the co-variance matrix is much smaller than the actual errors, i.e. the algorithm wrongly believes that it has delivered a good result? What would happen if the co-variance matrix were much bigger than the actual error? (5)