MF2071 Home Exam

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Question 1

A

My field of studies is Mechatronics, built upon a bachelors degree in Mechanical engineering. Mechatronics is often described as the unity of control systems, computers, mechanical systems and electronic systems. Because of the wide spread of subjects a mechatronics engineer has knowledge of, the engineer might be considered a jack of all trades, master of none. The strength of this focus on being not focused is that the mechatronic engineer is a specialist on integrating all the subjects into one final design.

This home exam, and the work in this course, will be based on the master thesis job I will do at AVL Powertrain Engineering. AVL is the worlds largest independent company focusing on development and testing of powertrains and drivelines and is based in Graz, Austria. This thesis will be done for the AVL branch in Södertälje, Sweden. They want an autonomous car that can be used for testing and research and as a part of that project, they want to investigate which localization and mapping (SLAM) algorithm that is suitable to use from a cost/performance perspective. More specifically, different SLAM algorithms have different performance and different demands on sensors and hardware calculation capacity. Also, some algotihms perform well in simulation but not in the field.

There is both a technical aspect of the information need, the investigation of different SLAM algorithms and their pros and cons, and a subjective aspect in the choice of what makes a "good" algorithm for this specific purpose. For this report, the technical aspect is chosen to be expanded upon since the largest part of the thesis will be the gathering and investigation of different algorithms.

B

Here, the answer is given for a general algorithm that needs to be implemented on some kind of hardware. It is feasable to consider SLAM along with any kind of algorithm that needs to convert physical input to some kind of concatenated information since many of these algorithms share the same broad terms of pros and cons. An algorithm can be viewed and assessed from different perspectives depending. From a computing standpoint it is interesting to know how much computing power is needed to calculate the output of the algorithm and how the computing time increases with increased accuracy. The result of this will in turn be of interest from a hardware standpoint as the processor must be powerful enough to handle the computations. If power consumtion is relevant, then the complexity will be of even more interest. Further, an algorithm can be judged based on the number of inputs it needs. More inputs will result in the need of more sensors which increases the cost of the implementation. Not only that, but the kind of input needed is also of importance since different kinds of sensors

have different costs associated with them. Lastly, SLAM algorithms have different performance in real life and in simulation. This leads to the search question: *Which SLAM algorithms in an autonomous car are suitable from a hardware cost/performance perspective?*

To find relevant information about SLAM, several sources are needed. To find which algorithms are confined within the SLAM umbrella and to get a general overview of the subject, popular information sources such as news articles can be browsed, as well as commercial sources. These information sources can give a broad overview but will not be regarded as primary sources. Conference proceedings can also be used to get an overview. Using the search terms gathered from the popular information sources, scholarly sources can be searched for primary information sources. These might be research papers or scientific books or journals written by researchers in the relevant fields. It is here that the most detailed search query iteration will be done.

This problem is advanced since it covers several different disciplines of science and that research is being done in the subject of localization and mapping of autonomous vehicles right now.

Question 2

A

The kewords from the search question are marked in bold:
*Which **SLAM** algorithms in an autonomous **car** car are suitable from a **hardware** cost/performance perspective?*

B

SLAM	**Car**	**Hardware**
Localization	Vehicle	Sensor
Mapping	Agent	Processor
Sensing	UAV	Input
Modeling	Robot	Data

In this list, the SLAM synonyms are focused on letting the agent using the algorithm know where it is. These synonyms are all related to this, with modeling being the one with the widest definition.

The project is about an autonomous car but SLAM is used in many contexts, hence the synonyms used.

Finally, the hardware part of the project regards both processing power and sensing input needed for the algorithm. These search terms might be too wide but can be used as a starting point that will later be refined.

C

For this assignment, I am using the IEEE Xplore database. The search string used was: **(slam OR mapping OR localization OR sensing OR modeling) AND (car OR vehicle OR agent OR uav OR robot) AND (hardware OR sensor OR processor OR input OR data)**
and

(slam OR (mapping NEAR localization) OR sensing) AND (sensor OR input OR hardware)

D

I tried to use all combinations of my searches and their synonyms. I used this to try to capture the sources that have key information where I can start finding data. The second search string was to get hits on the use of SLAM in other applications than self driving vehicles and possible some results on experimantal algorithms that have not yet been widely implemented.

E

Yes, this can be productive. Searhcing for example abstracts for keywords can be useful to catch instances where the desired data has not been indexed in free text searches. For example, using this search string in the database generates many hits:
("Abstract": (slam OR localization OR mapping) AND (sensor OR hardware))

F

Using the data from the searches, several specific sensor technologies were found, e.g LIDAR and RADAR. The effectiveness of these can be further investigated by improving the search string to look for these specifically, i.e.
(slam OR mapping OR localization OR sensing OR modeling) AND (LIDAR or RADAR) AND (car OR vehicle OR robot)