Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2019/2020

COURSE NAME	:	MOBILE ROBOT
COURSE CODE	:	BEH 42203
PROGRAMME	:	BEJ
EXAMINATION DATE	:	JULY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS ***OPEN BOOK EXAMINATION***

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

Q1 *Given that the equation of probabilistic mapping as*

$$p(m|z_{1:t}, x_{1:t}) = \prod_i p(m_i|z_{1:t}, x_{1:t})$$

(a) Describe the mapping process in mobile robotics.

(4 marks)

(b) Discuss the symbols in the equation and describe the function of the equation in the mapping process

(6 marks)

(c) Evaluate the equation above and infer the function of the equation for occupancy mapping.

(5 marks)

(d) Calculate the probability of a cell on a map if a LIDAR sensor detects 30 times HITS and 5 times MISS.

(10 marks)

Q2 Consider the following Particle-filter based-on Bayesian filter equation

$$\boldsymbol{Bel}\,(x_t) = \eta\, p(z_t|x_t) \int p(x_t|x_{t-1}, u_t)\boldsymbol{Bel}\,(x_{t-1})dx_{t-1},$$

(a) Discuss the symbols in the equation.

(6 marks)

(b) Describe the Particle-filter algorithm for localization.

(6 marks)

(c) Evaluate the mathematical equation and infer the function of the equation for particle filter algorithm.

(13 marks)

Q3 (a) Define grid-SLAM.

(6 marks)

(b) A Rao-Blackwellization grid-SLAM equation is given by

$$p(x_{1:t}, m|z_{1:t}, u_{0:t-1}) = p(x_{1:t}|z_{1:t}, u_{0:t-1}) \cdot p(m|x_{1:t}, z_{1:t})$$

Define its symbols meaning.

(4 marks)

(c) Analyze the function of equation Q3(b) for grid-SLAM algorithm.

(10 marks)

(d) Number of effective particles is given by equation Number of effective particles is given by equation $n_{eff} = \frac{1}{\sum_i \left(w_t^{(i)}\right)^2}$. If resampling is done when $n_{eff} < 0.5$, i = 3, t = 2, $w_{t=2}^{(i=1)} = 0.5$, $w_{t=2}^{(i=2)} = 0.5$, what is the value of $w_{t=2}^{(i=3)}$ so that resampling must happen?

(5 marks)

Q4 (a) *Define A* path-planning.*

(2 marks)

(b) Discuss the process of Dynamic Window Approaches for path-planning.
(3 marks)

(c) Evaluate the 5 differences between A* and *Dynamic Window Approaches* for path-planning.

(10 marks)

(d) A typical problem of Dynamic Window Approaches (DWA) is given by Figure Q4(d). Analyze the reason of this problem and provide a solution.

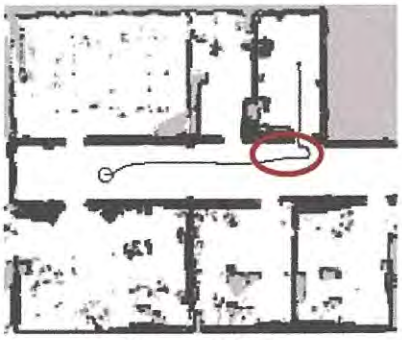

Figure Q4(d)

(10 marks)

-END OF QUESTIONS-