Mobile Robotics Final Exam

> Answer the questions in the spaces provided on the question sheets. If you run out of room for an answer, write on the back of the paper.
> **Put your name in pinyin on top of every page!**

Name: _____

Question	Points	Score
1	2	
2	8	
3	7	
4	4	
5	2	
6	5	
7	2	
8	2	
9	13	
10	1	
11	10	
Total:	56	

There are in total 59 (sub-) questions. More than half of them can be answered with a short sentence or less. So you should spend less than 30 minutes for those 33 easy questions and then still have more than two minutes for each of the more difficult questions. The total number of points is 150, so every point contributes 0.667% to your overall score.

2   1. Name five means of locomotion for mobile robots.

> **Solution:** Wheels, Tracks, Legs, Flying (Quadrotors), Flying fixed-wing, Swimming, Diving (thrusters), Fish-like, Snake-like, Jumping

2. Transforms

1   (a) Define the term: Translation

(a) ——————— **The motion of a point in a reference frame.** ———————

1   (b) Define the term: Rotation

(b) ————————————————— **...** —————————————————

1   (c) Define the term: Transform

(c) ————————————————— **....** —————————————————

3   (d) How many degrees of freedom does a transform have in 2D. Name them all!

(d) ——————————— **3: (x, y, theta)** ———————————

2   (e) Imagine a new camera system. The designers decided to put the x and z axes in the imager plane: x-axis downward and the z-axis left. Which direction is the y-axis pointing to in a right-hand coordinate system? More info: You are standing behind the camera, looking at the camera and the scene the camera is taking at the same time. The camera is looking forward - the same direction as you.

> **Solution:** to the back (towards me)

3. Transform math

You are given $_{R[X]}^{G}T = \left\{ \begin{matrix} _{R[X]}^{G}t \\ _{R[X]}^{G}R \end{matrix} \right\}$ and $_{R[X+1]}^{R[X]}T = \left\{ \begin{matrix} _{R[X+1]}^{R[X]}t \\ _{R[X+1]}^{R[X]}R \end{matrix} \right\}$.

1   (a) ...

      (a) ——————————————— **....** ———————————————

6   (b) ...

> **Solution:**
>
> ...

4. ROS

<u>4</u>   (a) Some questions about messages and ROS and so on...

<u>2</u> 5. Name the four major elements of the reference control scheme from the "Autonomous Mobile Robots" book.

<u>5</u> 6. What is the difference between **random** and **systematic** errors? How can they be handled in robotics?

<u>2</u> 7. What are the two main advantages of a quadrature encoder over a regular (single) encoder?

8. Gyroscope

<u>1</u>   (a) Which property do we hope to measure with this sensor?

     (a) —————————————— **Orientation** ——————————————

<u>1</u>   (b) What does a Rate Gyroscope measure?

     (b) —————————————————— **...** ——————————————————

9. Sonar
Assume a robot with a sonar ranger. The ranger has a maximum distance of 7.5m. Assume the speed of sound to be 300 meters per second.

1   (a) Which medium is used to transmit the signal?

       (a) _____ **Air** _____

6   (b) What is the frequency with which we can get information from the sonar ranger? Provide the formula for calculation, too!

> **Solution:** $t = 2d/c$
> $d = 7.5m$ $c = 300m/s$
> $f = 1/t$
> $t = \frac{2 \cdot 7.5m}{300m/s} = \frac{1}{20}s$
> $f = 20\text{Hz}$

6   (c) Assume a robot driving with two meters per second. What distance does the robot drive between two readings of the sensor?

> **Solution:** $t_{robot} = t = \frac{1}{2}s$
> $v = 2m/s$
> $d = vt_{robot} = 2\frac{m}{s}\frac{1}{20}s = 0.1m$

10. RGB-D Cameras

1   (a) What does RGB-D stand for?

11. Algorithms

$\boxed{1}$ (a) What does RANSAC stand for?

$\boxed{6}$ (b) Shortly describe how RANSAC works.

$\boxed{3}$ (c) ...