

# Mission Description

## 1. Overview

In this Capstone Design course, each team is required to design and build a mobile robot system that can accomplish the given mission autonomously with no human intervention. The mobile robot system includes a vehicle platform equipped with actuators (for mobility and interactions) and sensors (for perception and navigation). The system also must include computer algorithms for vehicle autonomy including sensor data processing, automatic control and associated decision making. Students are required to design and develop the system in a virtual simulation environment using software tools such as SolidWorks, Coppeliassim and ROS with OpenCV.

All the teams must submit their work and all the source code to be evaluated **by noon the day before the final demo session starts (by 12:00 on June 3)**. The submitted code will be run by the class TAs and evaluated in the final demonstration session on June 4.

## 2. Mission Course

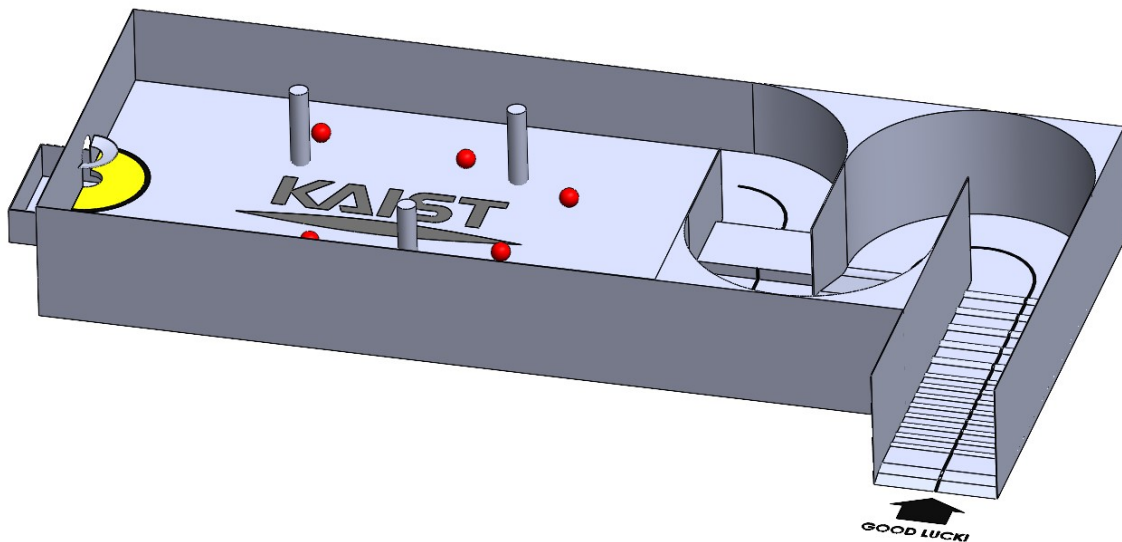


Figure 1 Mission Course

The mission course consists of two zones: the entrance zone and the ball-harvesting zone. In the entrance zone, there are speed bumps, a slope and an obstacle block. It begins with two sets of speed bumps having different shape and spacing, followed by the slope of 20 degrees upward. In the final straight path segment in the entrance zone, there is an obstacle block.

The end of the entrance zone leads into the opening of the ball harvesting zone. In the ball harvesting zone, there are multiple obstacle poles and a number of balls to be collected. The goal region is located at the other side of the zone, opposite to the opening. In the goal region, there is a goal hole on the floor at its center. Also, there is a hoop above the floor which has a hole in the center.

### 3. Mission Tasks

Initially, the mobile system will be located at the designated start position near the opening of the entrance zone. Each team will have a maximum 10 minutes to complete all the mission tasks. Once started, no intervention is allowed during the entire run until the mission is completed or the designated time limit is reached.

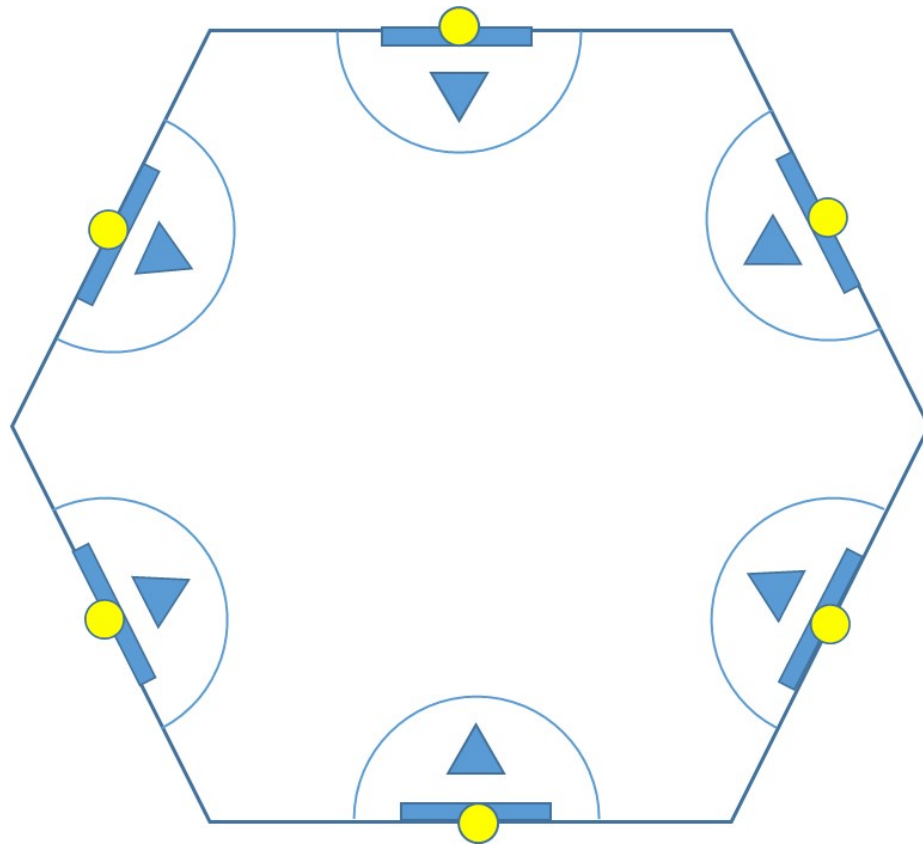
In the entrance zone, the mobile robot system must be capable of passing through all the obstacles and getting to the end of the zone within a designated time limit. The vertical acceleration at the highest point of the vehicle platform will be measured while passing over the bumps and the obstacle block. The maximum acceleration will be used to evaluate the performance of anti-vibration and ride comfort. If the time limit is reached before leaving the entrance zone, the run will be terminated and the mobile robot will be spawned at the opening of the ball-harvesting zone.

In the ball-harvesting zone, there will be five red balls randomly placed on the floor. The mobile robot system must be capable of bringing them into the goal. Points will be awarded based on the number of balls collected through the goal hole. Higher points will be awarded for a ball through the goal hole in the hoop (high goal) than a ball through the goal hole on the floor (low goal). Some partial points will be awarded for a ball brought inside the goal area, but not in the hole.

## 4. Bonus Mission

After the main mission, there will be a bonus mission of collecting the balls in a battle mode. Each team is required to collect as many balls as possible within a given time. Points will be awarded based on the number of balls collected.

The bonus mission area has a hexagonal shape, and each team has its own goal region on each side of the hexagonal area. When the mission starts, all the robots will appear simultaneously. There will be an unknown number of balls at random locations in the mission area.



**Figure 2 Bonus mission**

5 minutes will be given to complete this bonus mission. Each team has its own goal area and earns points for the number of balls brought into its own goal area until the time limit is reached.

## 5. Mission Scoring

Scoring Measures	Maximum Points	Descriptions
<b>Time efficiency*</b>	<b>20</b>	The time to finish the mission will be measured and ranked: 20 pts for the first place, 18 for the second, 16 for the third ... The time spent in the entrance zone will be separately measured and a penalty of -0.1/sec is given after 90 seconds (in real-time) from the start.
<b>Energy efficiency*</b>	<b>20</b>	The energy spent to finish the mission will be measured and ranked: 20 pts for the first place, 18 for the second, 16 for the third ...
<b>Ride-Comfort &amp; Anti-vibration</b>	<b>20</b>	The maximum vertical acceleration at the highest point of the mobile system will be measured and ranked: 20 pts for the first place, 18 for the second, 16 for the third ...
<b>Ball harvesting</b>	<b>30</b>	Each ball through the hole in the hoop (high goal): 6 Each ball through the hole on the floor (low goal): 4 Each ball in the goal area but not in the hole: 2
<b>Creativity</b>	<b>10</b>	Subjective measure for evaluating the creativity in design and mission strategy
<b>Total</b>	<b>100 (+<math>\alpha</math>)</b>	$\alpha$ : Bonus mission scores (TBA) will be added.

\* Regarding the time/energy rank, the team rank will be determined firstly by the ball harvesting mission score and secondly by less time/energy. For example, if “team A scored 3 goals in 5 mins” and “team B scored 2 goals in 3 mins”, team A will get a higher time rank.

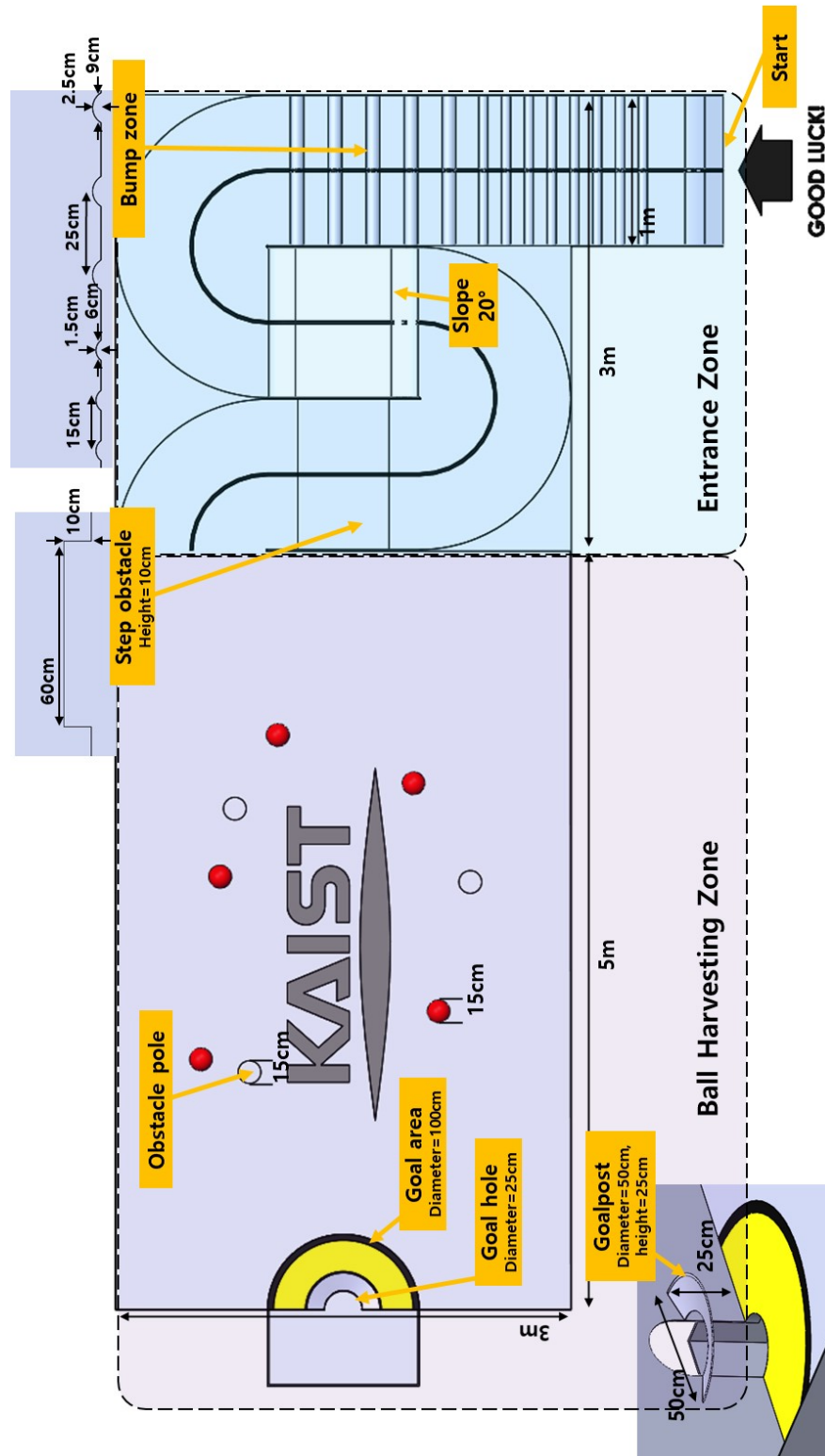


Figure 2 Course Layout and Size Measurements