Vision Centric Challenge 2019

S-SLAM: Simple SLAM

(Simultaneous Localization and Mapping)

A Robofest® (www.robofest.net) Challenge for Pre-college and College Students

Lawrence Technological University, Southfield, Michigan

V0.21 9-29-2018 (*International* Version)

Computer vision gives robots the ability to see. In order to learn and promote research & development of computer vision and autonomous mobile robotics, we challenge college and talented high school students with vision-based robot competitions during the Robofest® 2019 season. SLAM is a key robotics software function that creates a map on the fly while marking the robot location on the map.

1. Challenge Synopsis

The objective is to traverse a binary tree by visiting every node that can be identified with a color (Sr) or shape (College). The robot must then come back to the root (starting) node, stop, spin 360 degrees, and display a map showing the binary tree traversed. In the map, each node's color or shape must be clearly identified. The root node must be labeled as "Root". It is highly recommended to update and display the map whenever the robot visits a new node in order to get partial points in case the round was not fully successful. Lighting conditions of the venue are also unknown until the competition day.

2.1 Sr. Division

Letter size color papers are used for nodes. The edge lines are solid. Only the root node color is unique. An example course is shown in Figure 1. Example maps to be drawn by the robot for the course shown in Figure 1 are shown in Figure 2.

2.2 College Division

For nodes, letter size white papers with shapes printed on them will be used. Each paper will only have one shape. The color of the shapes is unknown. Only the root node shape is unique. The possible shapes used are listed with names in Appendix 3. The edge lines can be either solid or dashed; possibly narrower than Sr. division lines. An example course and 3 example drawings are shown in Figure 3 and 4 respectively.

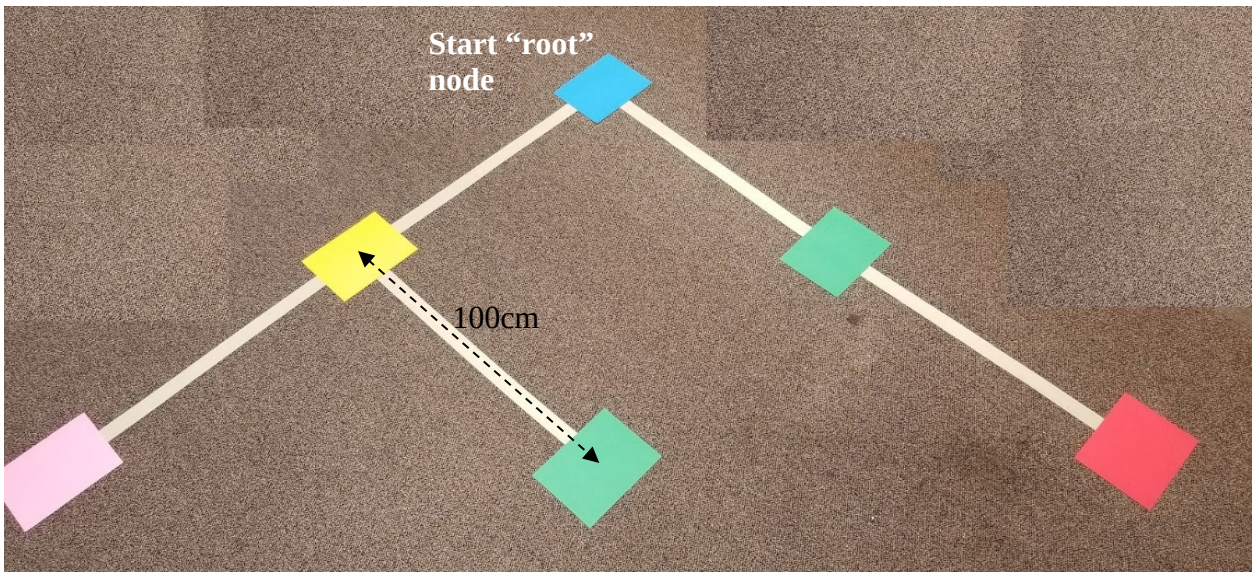


Figure 1. A Sr. S-SLAM course example

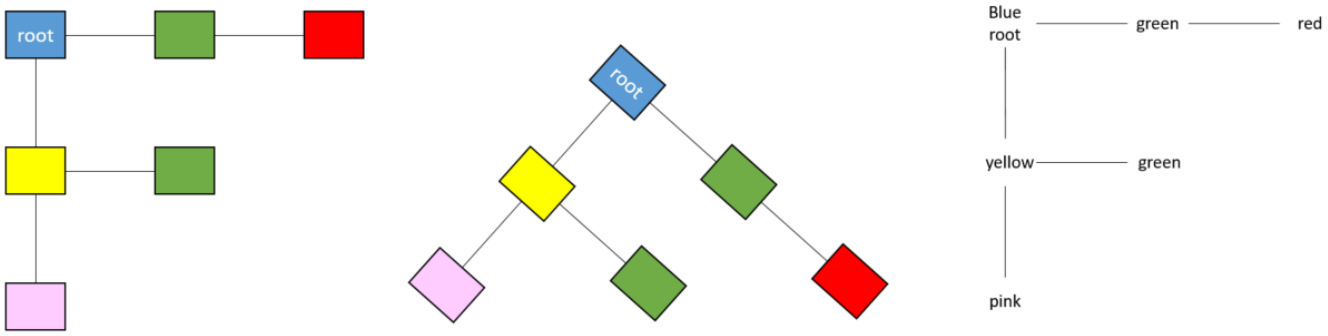


Figure 2. Three possible drawings expected to be displayed by the robot for the Figure 1 example course

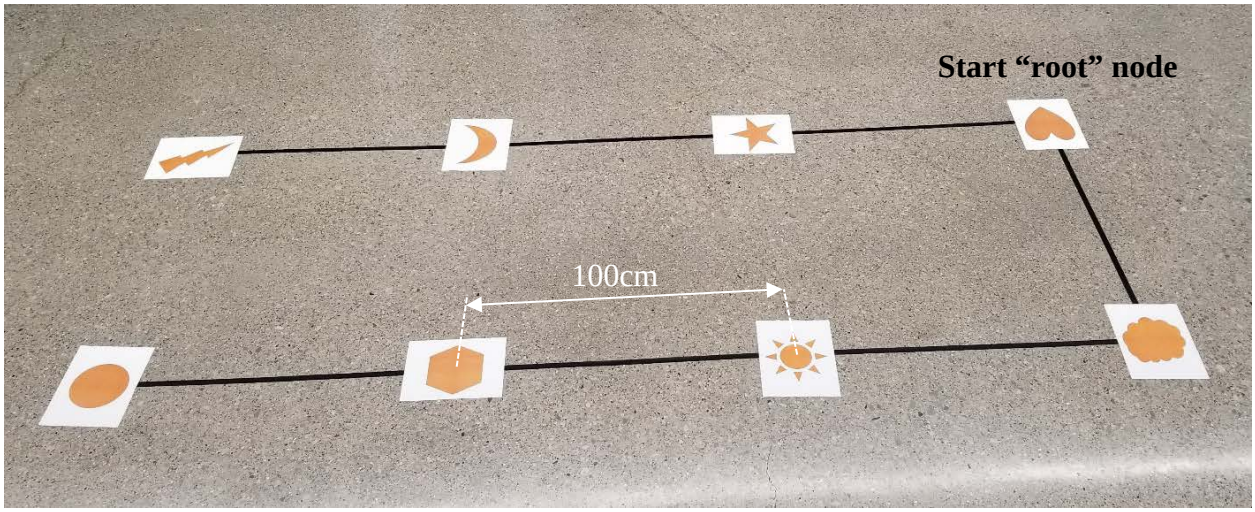


Figure 3. A College S-SLAM course example

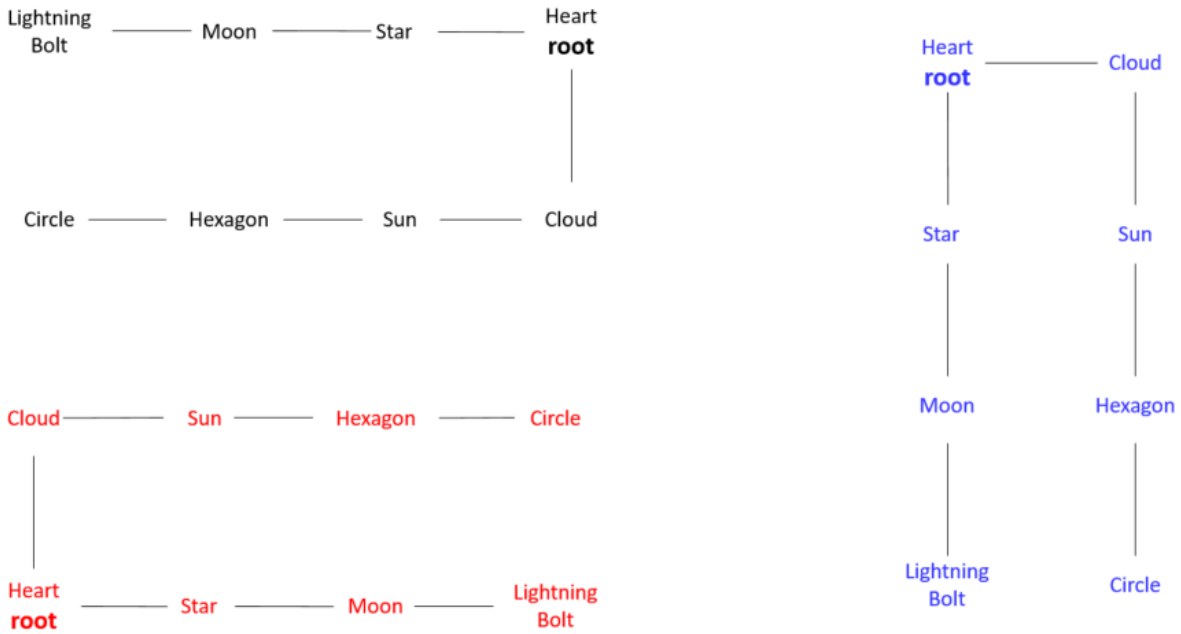


Figure 4. Three possible map examples drawn by the robot for the example course shown in Figure 3

2. Course Setup Information

- Lighting conditions on the course are unknown and possibly dynamic.
- The floor color and texture are unknown
- Margin space between walls or other courses will be at least 1.5 meters
- The length of the edge line (distance between nodes) will be 100cm (paper-center to paper-center as shown in Figure 1 and 3) or between 70cm and 78cm (paper-edge to paper-edge). The exact color and width of the tape for the edge line is also unknown.
- Nodes:
  - A node can have only an edge.
  - If a node has two edges, the angle between two branch edges is 90 ± 5 degrees. For example in Figure 1, the red paper can be a root node. The yellow paper cannot be a root node.
  - The node papers will be taped on the floor. Orientation of letter size paper will be arbitrary.
  - Letter size color papers used for **Sr. Division**: www.officedepot.com/a/products/170719/Neenah-Astrobrights-Bright-Color-Paper-8
  - A PDF file containing all the shapes for the **College Division** (colored in Orange) as a sample can be downloaded on the web at http://www.robofest.net/2019/Vcc19collegeShapes.pdf .

3. Competition Procedures and How to score & decide winners

- Each team will run 3 rounds.
- For each round there will be 30 minute allotted as work-time after unveiling the items described in Section 6.
- After the 30 minute work-time, all robots will be impounded (quarantined) before starting each round.
- After all the robots are impounded, the official competition course for each age division will be setup
- For each round, each robot has a maximum of **2** minutes to complete the mission.
- The team will verbally tell the starting orientation of the robot.
- The Judge will start the robot program at the starting location. Teams are NOT allowed to touch the robot after impounding. The team must provide verbal or written instruction to the Judge indicating how to start the robot. Note that Judges will not calibrate the vision system. Robots must be calibrated before impounding or have a means of dynamic calibration.
- To complete a successful round, the robot must spin about 360 degrees at the “root” node and then display a complete and correct map to the Judge. When the robot stops after spinning, any part of the robot must be on the root paper.
- Judges will record the following for each round: (1) actual nodes visited by the robot, (2) nodes displayed on the computer screen. For (2), Judges will take a photo of the map on the computer screen. See Appendix 1: Example Score Sheet format for a round and Appendix 2 for examples of scoring displayed maps.
- The winner will be decided by the number of successful rounds. The first tie breaker is the total number of nodes the robot successfully visited for 3 rounds. The 2nd tie breaker is the total number of correct nodes displayed on the maps. The 3rd tie breaker is to rerun until a winner is decided. New nodes can be introduced for the reruns and a 5 min preparation time will be given for the reruns.

4. Violations

Violations that will terminate the run include:

- Team players touch the robot
- Robot is completely out of the course (1.5 meter away from the course)
- Illegal signal to the robot

Judges may record partial scores when the run is terminated.

5. Unveiling Items and Procedures

- After check-in and before starting a round: the floor, floor color, edge line color and width, sample nodes to be used, and lighting condition will be known to every team.
- There will be 3 rounds. Before starting each round, there will be 30 min work-time. The Judge will unveil all the nodes used including a starting root node for each age division just before the work-time. Each team will get a set of all the node papers used.

- After all the robots are impounded, the actual course will be set up. The exact location & orientation of each node will be unveiled.

6. Team Age Divisions

- Senior (Advanced High School): maximum **3** members per team
- College: maximum **2** members per team

7. Robot Requirements

- Must be completely autonomous. (Any type of remote control by a human driver or remote computer is not allowed). The main controller can be a laptop, notebook, tablet, Raspberry PI, or even a smart phone. The main controller must be on the robot all the time.
- Any robot platform with up to 2 cameras is allowed. No other external sensors are allowed. Internal encoders for motors are permitted.
- Any programming language may be used.
- Width must be less than 2ft.
- Length must be less than 3ft.
- Height (including camera) must be 2ft or less.
- Weight: no limit
- The robot may *not* automatically expand its dimension larger than the specified max values.
- Camera angle: no restriction. You may use motors to move the camera. Wide angle lens can be used.

8. Prizes

Winners receive trophies. Each high school team member of the winning team may receive $2,000 LTU renewable scholarship. Monetary prizes for college students - 1st place: $200, 2nd place: $100, 3rd place: $50. We will send the prize money through PayPal.

9. Competition Dates

- World Championship at LTU in Michigan
  - Saturday, May 18, 2019, 8:00am ~ 4:30pm
  - The practice field will be set up on May 16, 2019, in the afternoon. (See Tentative Schedule on the web)
- Other locations/dates: To be announced at www.robofest.net

10. Miscellaneous Information

- Go to https://www.robofest.net/index.php/current-competitions/vision-centric-challenge for more info and possible rule updates
- Questions regarding rules, registration, or L2Bot lease: Contact Prof. Chung at cchung@LTU.edu
- The event is open to the public. Admission is free. Parking is free.

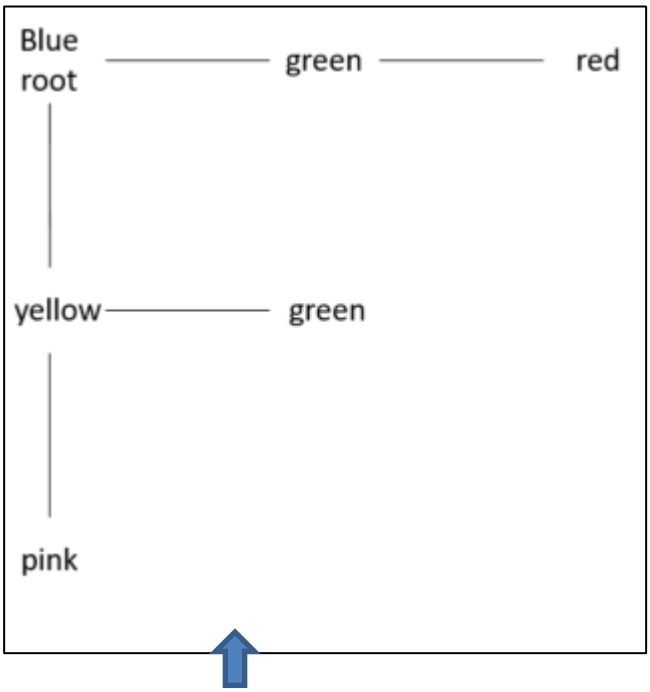
Appendix 1. Robofest® Vcc S-SLAM Scoring Sheet *(Example)*

Division: Senior / College Team Name: _____

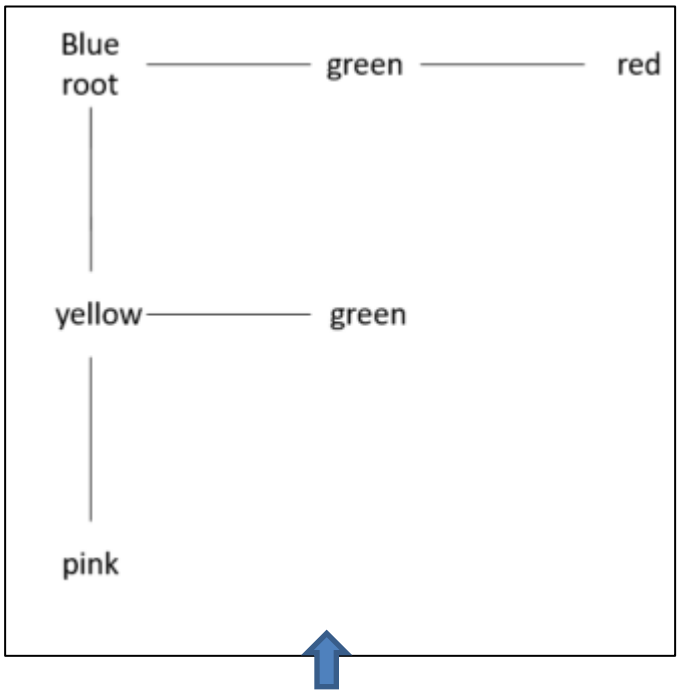
Team School / Organization Name: _____ Team Number: _____

Round: *First* *Second* *Third*

Course Diagrams



Mark the nodes visited by Robot

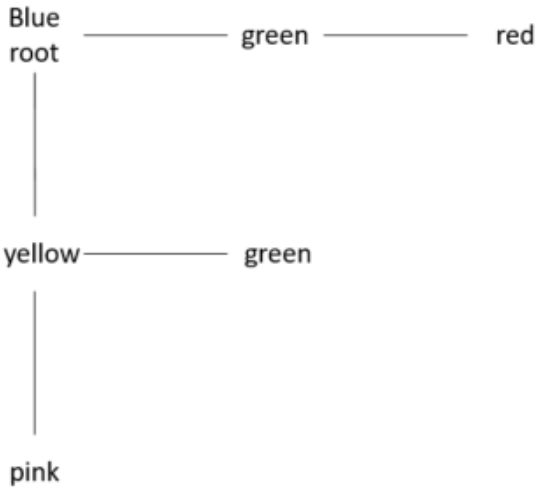
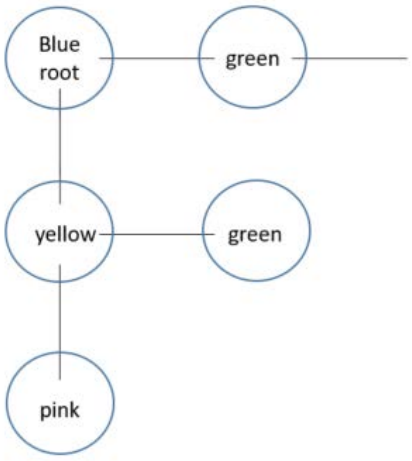
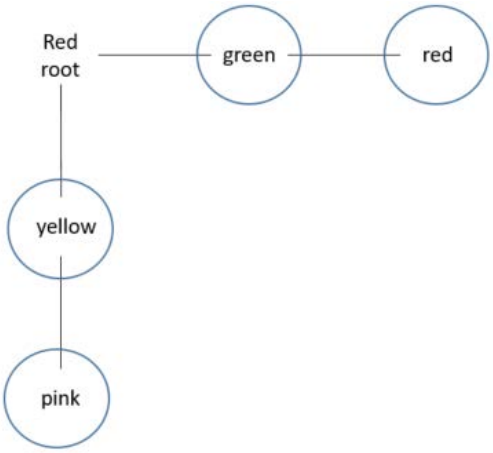
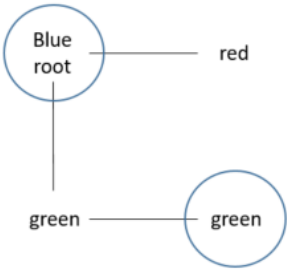
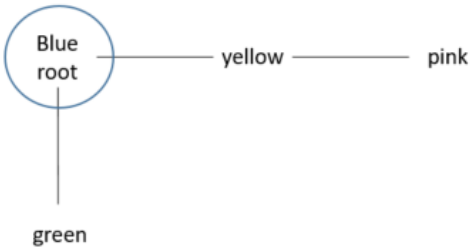
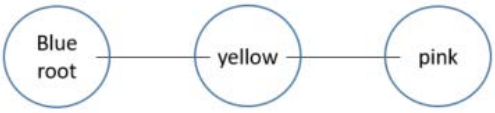


Mark the nodes correctly displayed on the map

Answer the following:

Did the robot come back to the root node?	
Did the robot successfully spin 360 degrees?	
Did the robot stop after spinning and is any part of the robot on or over the root node?	
Is the map generated complete and correct (same as the course)?	
Count the number of nodes the robot successfully visited including the root node at the end. Any part of the robot must be on or over the node. This is the first tie breaker	
If generated map is neither complete nor correct, how many nodes are correct (See appendix 2 for examples)? This is the 2nd tie breaker	

Appendix 2 Examples of scoring displayed maps

No.	Expected	Displayed	Score
1			**5/6**
2			**4/6**
3			**2/6**
4			**1/6** (left and right are important)
5			**3/6**

Appendix 3. Known 13 shapes to be used for College Division

Name (required to use for display)	Shape
Circle	
Square	
Lightning Bolt	
Sun	
Cloud	
Triangle	
Pentagon	
Hexagon	
Cross	
Arrow	
Moon	
Heart	
Star