Vcc Vision Centric Challenge 2017 - Traverse

A Robofest® (www.robofest.net) Challenge for Advanced High School and College Students
Lawrence Technological University, Southfield, Michigan

V1.31 1-23-2017 (Official Version, changes after 1.3 are in **red**)

Computer vision gives robots the ability to see. In order to learn and promote research & development on computer vision and autonomous mobile robotics, we challenge college students as well as talented high school students with the following vision based robot competitions during the Robofest® 2017 season.

1. Team Age Divisions

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

2. High School (Sr. Division) Challenge

Traverse a binary tree to find ***one*** goal node. If a goal node is found (any part of the robot must be on or over the goal node paper), the robot must spin 360 degrees on the goal node, then travel back to the root node, and report the depth of the goal node in the tree after spinning 360 degrees on the root node. To be a valid spin, any part of the robot must be on or over the node after spinning.

A letter size paper represents a node in the binary tree. Branches are dashed lines taped on the floor. All colors such as floor, nodes, and branches are unknown until the competition day. Figure 1 as an example, yellow papers are for nodes, white dashed lines on gray floor color are connecting nodes, and blue paper is the goal node. The binary tree has only one goal node or none.

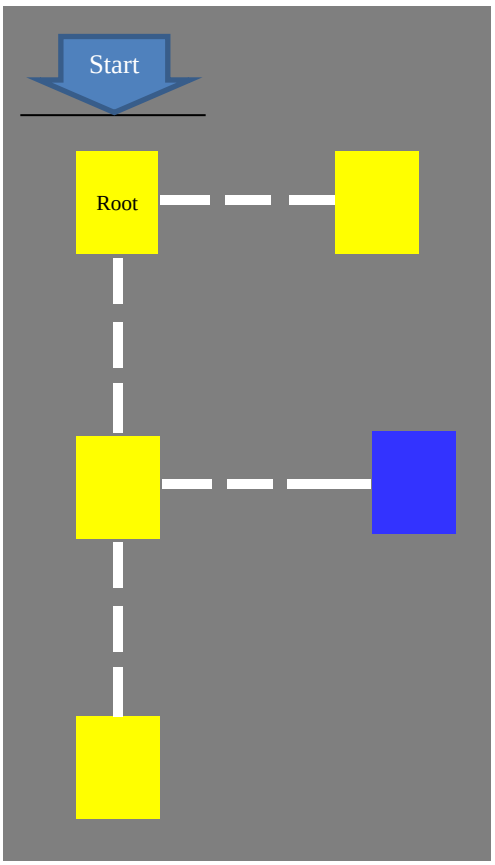


Figure 1. Goal node at depth 2

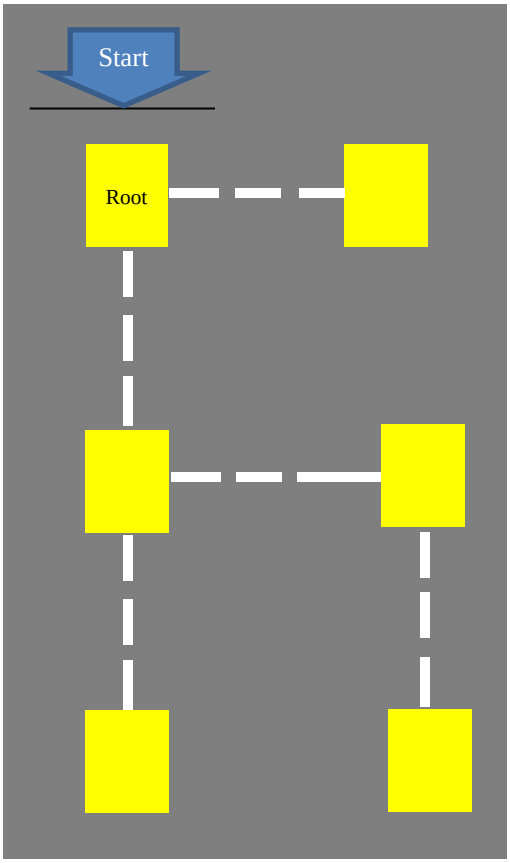


Figure 2. No goal node in the tree

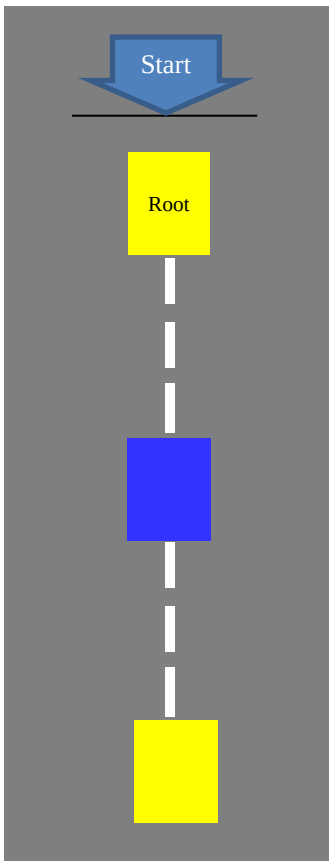


Fig 3. Goal node at depth 1

Since the depth of the blue node is 2 in the example, your robot is supposed to display number 2 after spinning around 360 degrees on the root node.

In Figure 2, since there is no goal node, the robot is supposed to display “-1” at the root node, after visiting **ALL** other nodes. Note that the binary trees used for this competition can be non-full and/or non-complete. Fig. 1 is full but not complete. Figure 2 and 3 are neither complete nor full. Special line-like binary trees shown in Fig 3 will be *mostly* used for Sr. competitions. A robot does not need to visit all the nodes. See FAQ Q7.

Unveiled items before 30 min worktime: floor color, node color, goal node color, line color. Orientation of paper will be always portrait as shown in figures 1~3.

Changes after impounding: shape/size of the binary tree and location of the goal node

3. College Division Challenge

Evaluate a binary expression tree after visiting all nodes. Display the result at the root node. Each node represent either an operator or digit. Binary operators used are +, -, *, and % (mod). Digits used are 0 ~ 9. Like the High School challenge above, all the colors such as floor, nodes, and branches are unknown until the competition day. Operators and digits are printed in black. Figure 4 shows an example of an expression tree for (3*4)+5. If your robot visits nodes using “preorder” traversal algorithm on this expression tree, you will get the prefix (polish) notation of the expression, which is + * 3 4 5. After evaluation, you will get 17, which must be displayed at the root node after spinning 360 degrees. To be a valid return, any part of the robot must be on or over the root node after the spinning. Note that only full binary trees will be used, since binary operators only are used. Please note that the robot must visit right side children node, *, first (from the robot view) as shown in the example. This order is important for the % (mod) operator.

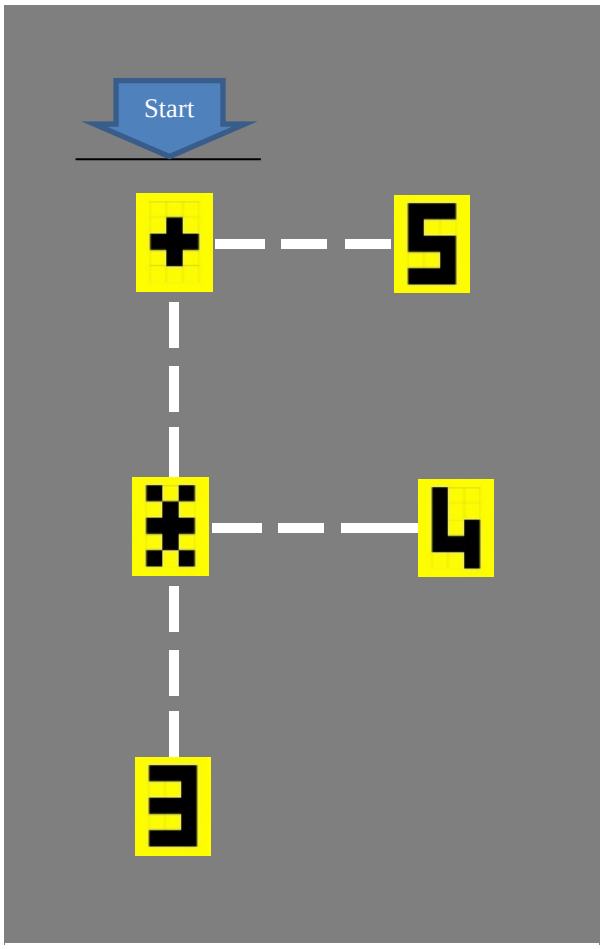


Figure 4. A binary expression tree example

Unveiled items before 30 min worktime: floor color, node color, line color, and orientation of papers (it could be north, west, south, or east direction. Figure 4 shows south orientation, from the view from robot)

Changes after impounding: binary expression tree.

4. Course Setup Instruction

- Minimum distance between nodes: 1 meter
- Maximum line gap for branches: 10 cm
- Thickness of the line: around 4.8cm
- The paths to the children of a node always perpendicular (updated on Jan 23)
- Papers for nodes and dashed lines are taped on the floor or mat.
- Orientation of papers: See 2 and 3 above.
- Unveiled before the 30 minute work-time: See 2 and 3 above.
- Letter size color papers used **as some samples**: www.officedepot.com/a/products/170719/Neenah-Astrobrights-Bright-Color-Paper-8
- A mat with the tree ***may*** be placed on the floor of which the color is unknown.
- The papers will be taped on the floor (or mat) with transparent packaging tape
- Start the robot at the root node with any orientation the team wants

- Lighting conditions on the course are unknown and dynamic.

5. Competition Rules

- Each team will run 3 rounds.
- For each round there will be at least 30 minutes work-time after unveiling a *sample* course.
- All robots will be impounded (quarantined) before starting each "round".
- After all the robots are impounded, real competition field will be setup: See 2 and 3 above.
- For each round, each robot has a maximum of **2** minutes to complete the mission.
- The Judge will start the robot at the starting line with the robot orientation the team wants. 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.
- The winner will be decided by the number of successful rounds. To complete a successful round, the robot must spin 360 degrees at the root node and then display the number to the Judge.
- If multiple teams tie for the number of successful rounds, the teams will rerun with more difficult trees until a winner is decided. Also see FAQ Q7.
- The robot will be considered off course and disqualified from that round if the robot leaves the *field* completely (around 1 meter away from the closest node)
- Team members cannot have any interaction with the robot. For example, giving sound or visual signals to the robot is not allowed.

6. Robot Requirements

- Must be completely autonomous. (No remote control by human driver or remote computer is allowed). Main controller can be a laptop, notebook, tablet, Raspberry PI, or even smart phone.
- Any robot platform with up to 2 cameras is allowed. No other external sensors are allowed. Internal encoders for motors are permitted to use.
- Any programming language can be used.
- Width must be less than 2ft.
- Length: less than 3ft
- Height (including camera): maximum 2ft
- Weight: no limit
- Camera angle: no restriction. You may use motors to move the camera. Wide angle lens can be used.

7. Prize: Winners receive trophies. Each high school team member of the winning team may receive $2,000 LTU renewable scholarship. Monetary prizes (cash gift cards) for college students - 1st place: $200, 2nd place: $100, 3rd place: $50

8. Competition Dates

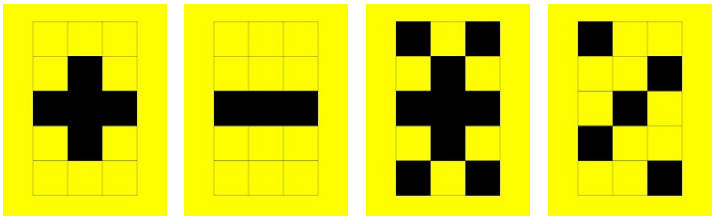
- Michigan Championship at LTU in Michigan
  - Saturday, May 13, 2017, 8:00am ~ 4:30pm
  - Practice field will be setup on May 12, 2017, afternoon. Exact time: TBD
- Other locations/dates: To be announced at www.robofest.net
- World Championship in St. Pete Beach, FL
  - Saturday, June 3, 2017, 8:00am ~ 4:30pm
  - Practice field will be setup on June 2, 2017

9. Questions regarding rules, registration, or L2Bot lease: Contact Prof. Chung at cchung@LTU.edu

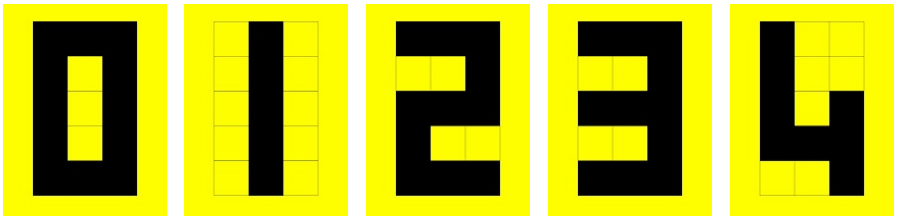
10. Misc. Info

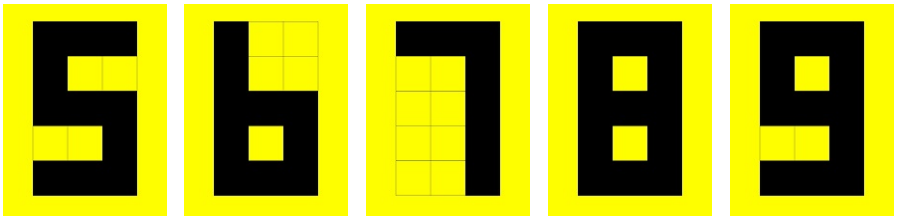
- Go to www.robofest.net/index.php/current-competitions/vision-centric-challenge for more info and possible rule updates
- The event is open to the public. Admission is free. Parking is free

Appendix A – Binary Operators (+, -, *, %)

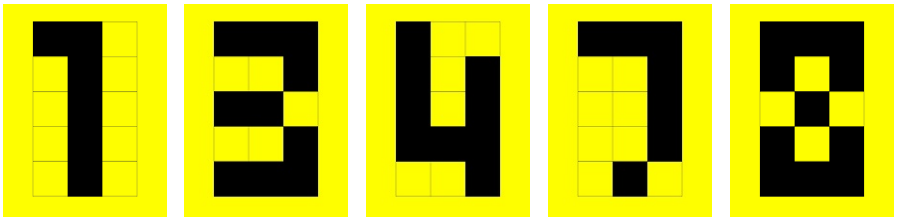


Appendix B – Digits (0~9)





Appendix C – Some examples of possible variations (1, 3, 4, 7, 8) – There will be NO variations for 6, 9, and the 4 binary operators.



Pattern Files in PDF

- Operator Patters: No color background and Yellow color as background
- Digit Patters**:** No color background and Yellow color as background

FAQs

Q1. Can teams decide orientation of the robot when it starts? Yes.
Q2. Can robot expand its dimension larger than the specified max values? No
Q3. What is the maximum number of nodes? Unknown
Q4. What is the maximum field (mat) size? Unknown
Q5. Does the robot need to follow the dashed lines (branches)? Since the height of the robot is 2 feet, cameras cannot be mounted up high. Due to the camera's limited field of vision, you will need to follow the dashed lines.
Q6. In High School Challenge, can a robot return to the root node directly without following lines and visiting nodes? Yes, you may. However, it is not an easy task to identify the root node.
Q7. In High School Challenge, must a robot visit all the nodes? No, you do not need to. Especially after finding the goal node, the robot needs to return back to the root node without visiting unnecessary branches. Judges may count number of nodes visited as anther tie breaker. The smaller, the better.
Q8. Can the root node also be the goal node? No (added on Jan 23)