Lawrence Technological University

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LAWRENCE TECHNOLOGICAL UNIVERSITY ROBOFEST

VCC 2026

Robo-Driver: Traffic Sign Challenge

V 3.4.1 – Initial Version for 2026 Season

This file can be found on the **VCC** page on the Robofest website

Coaches are responsible for communicating rules updates to participants

www.robofest.net **robofest@ltu.edu** 248-204-3568

Room J233 Taubman Complex, LTU 21000 West 10 Mile Road, Southfield, MI 48075, USA

1. Vcc Overview

Learning Objectives

- Video image processing
- Machine learning and classification
- Object, shape, text identification recognition, and detection
- VLM (Vision Language Model)
- Practical Real-World Applications using AI models

- An Open Category competition, which will take place at the World Robofest Championship
- A unique STEM (Science, Technology, Engineering, and Mathematics) competition using vision-based systems to compete

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2. Age Divisions and Team Size

- Age Divisions:
  - Senior Division (Grades 9-12)
  - Winning teams receive renewable LTU scholarship - 1st Place: a $20,000 annual LTU Scholarship (total of $80,000)
  - Team Size: Maximum five (5) members. *Two members are recommended*
- Team Registration Fee: $100 at the World Championship (local events may have an additional fee)
- Teams must review and abide by: Robofest 2026 General Rules
- Each team member must bring the signed Robofest Consent and Release Form on the day of the event, if not completed online

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3. Introduction

- Challenge focused on autonomous robot vision systems to recognize traffic signs in the USA
- Robots must "pass the driver's test" on traffic signs through image-based shape, symbol, and text recognition
- Importance for autonomous driving safety and traffic rule compliance

4. Game Synopsis

- Simulates the traffic sign portion of driver's exam for autonomous agents
- Robots identify, interpret, and understand signs in realistic scenarios mimicking the human test environment
- Challenges robot vision accuracy and traffic rule comprehension

5: Challenge Description

- Recognize and interpret traffic signs of varying difficulties.
  - Level 1: Traffic sign images (Slideshow of 15 images, each image displayed for minimum 6 seconds on the screen)
  - Level 2: Traffic sign real-world images acquired during day (Slideshow of 15 images, each image displayed for minimum 6 seconds on the screen)
  - Level 3: Traffic sign real-world images acquired during night (Slideshow of 15 images, each image displayed for minimum 6 seconds on the screen)
- **Level 2 and Level 3 images will only correspond to the images in the complete set of Level 1 images**
- During competition, signs will be presented using a slideshow of images on a display monitor
- Size of images displayed will vary (See slide #12)

Level 1 (Image and Expected Output Displayed)

Complete Set
(24 images)

Pedestrian Crossing

Right Curve Ahead

Right Turn Only

No Right Turn

One Way Left

Left Turn Only

Level 1 (Image and Expected Output Displayed)

Complete Set

No Parking No Arrow

Straight or Left Turn Only

Speed Limit 25mph

Left Turn Yield on Green

School Crossing

Yield

Level 1 (Image and Expected Output Displayed)

Complete Set

WhenFlashing

No Left Turn

One Way Right

Do Not Enter

No Turn on Red

Stop

Level 1 (Image and Expected Output Displayed)

Complete Set

No Parking Double Arrow

Be Prepared to Stop

Straight or Right Turn Only

No Parking Left Arrow

Left Curve Ahead

No U Turn

How to Access Twenty Four (24) Level 1 Images

- 24 image type files: https://drive.google.com/drive/folders/1qEBgGZcgtI4F8DtqgeduWxpVxMLjwalc?usp=drive_link
- L1_24classes.pptx file with the 24 images is on the Vcc web page
- Note: The image files show image types (classes). For example, variation of stop signs are possible. The following are all valid Level 1 Stop signs

...

Augmentation of Level 1 Images

Level 1 images can be augmented for example:

rotated

scaled

Artificial noise

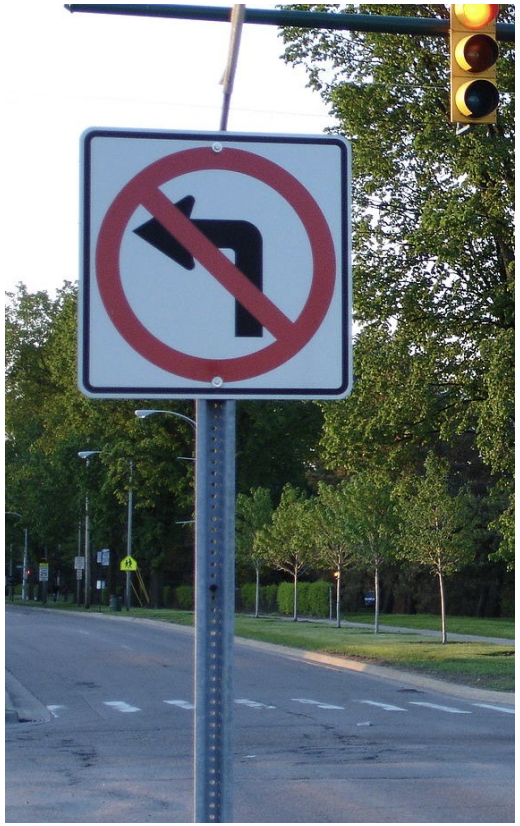
...

Aspect Ratio Change

Level 2 and Level 3 Samples: Real-world variants of the images in the Level 1 dataset. An image type may be repeated with variations in the slideshow

Sample images

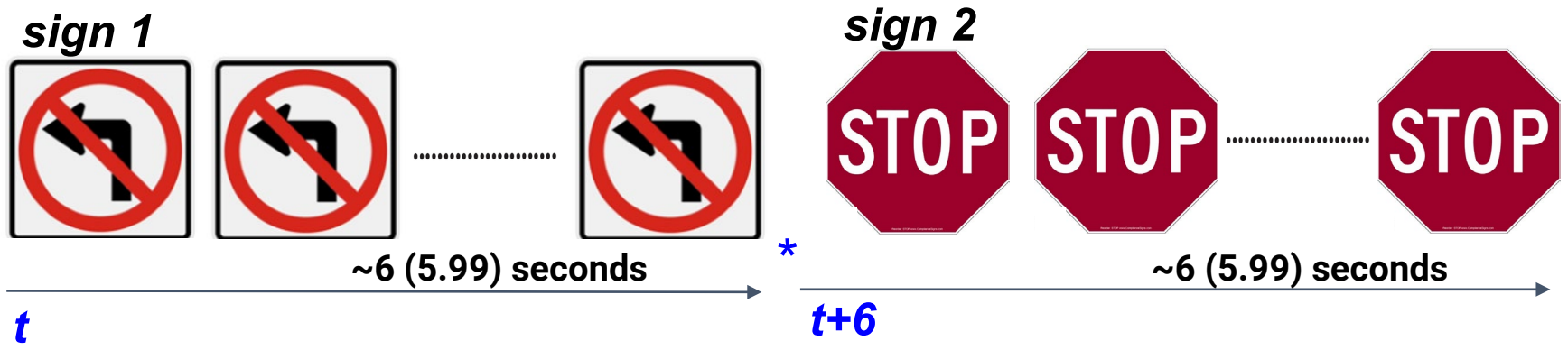
No U Turn



No Left Turn

Stop sign at night

Slideshow of traffic sign images and Required Outputs



(*) PowerPoint's transition duration is 0.01 seconds

Expected Outputs

Please watch YouTube video
Interval was 4 sec, not 6

Between *t:t+5.99* : No Left Turn (Print) and "No Left Turn" (Spoken)

Between *t+6:t+11.99* : Stop (Print) and "Stop" (Spoken)

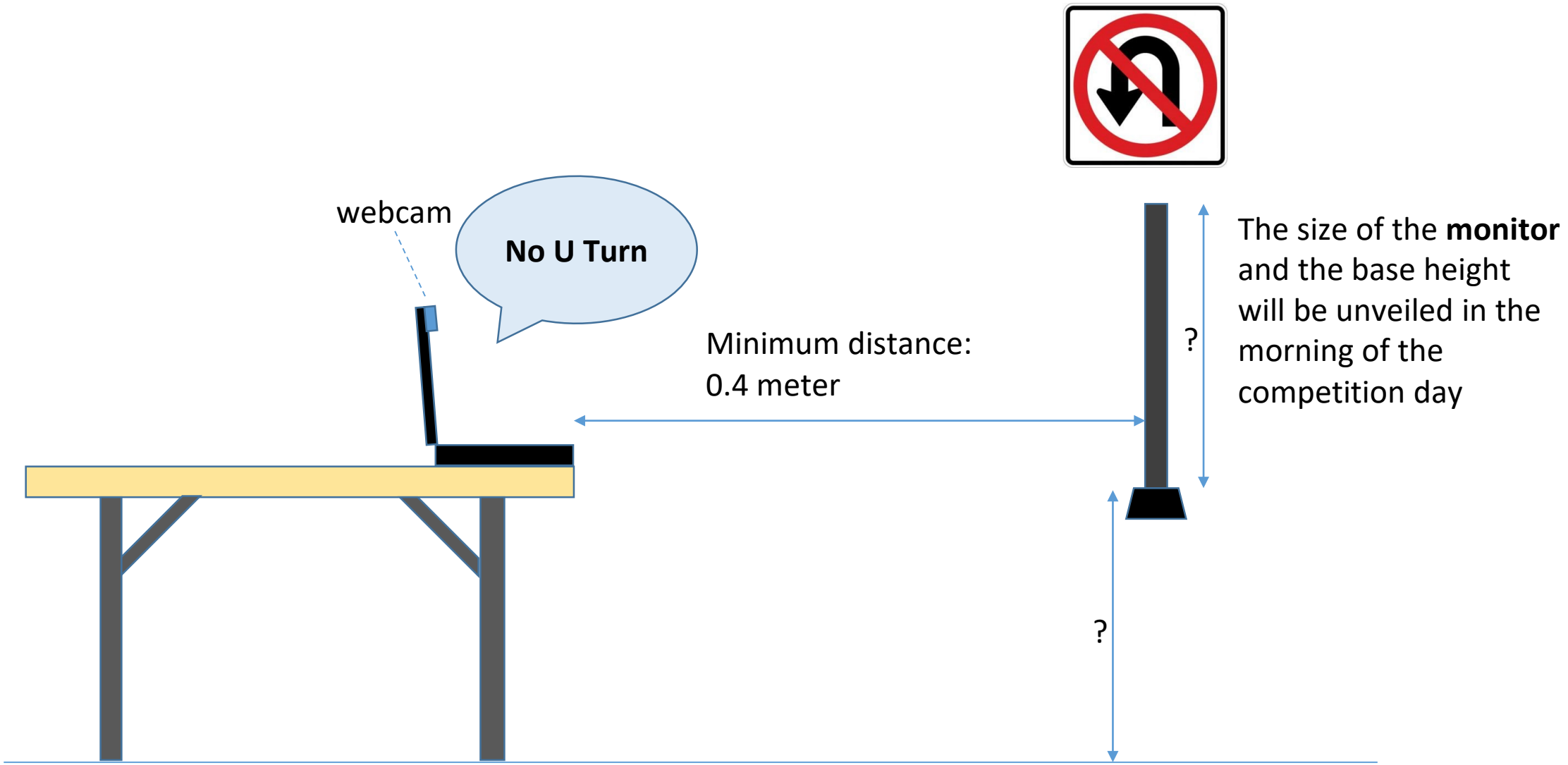
Specific rules:
if a traffic sign's answer is printed more than once before the next one: 50% deduction
if a traffic sign's answer is spoken more than once before the next one: 50% deduction

Also note that the sequence of words is not important. For example, "Left turn No" gets full points too.
As long as required words are presents, full points are given. For example, "No Left turn **sign**" is also OK.

6: Tools, Data, Models, and Environment

- Machine learning approaches are allowed, including pre-existing VLM and pre-trained models
- Teams may pre-train systems using any combination of provided or publicly available image/video datasets
- Training data can be images reflecting real USA traffic scenarios in English
- The use of public computer vision libraries are allowed
- Any programming languages are allowed
- System must operate reliably under varied lighting conditions: Brightness and contrast of the monitor can be changed

7. Competition Set Up



8. Competition Rule Details

- Autonomous operation; no human control once testing begins
- Handle occlusion and lighting changes
- Real-time recognition capability is required; systems must respond promptly to images shown on the display
- Recognition accuracy, speed, and robustness will be closely evaluated
- Teams are to use their own training data if needed, but the evaluation will be based on the unknown test images competition organizer provides

9. Competition Procedures

1) Official monitor for slideshow will be unveiled in the morning
2) Each team will have a max. 3 min chance to practice
3) All the robots will be impounded
4) Level 1 test begins:
    a) Team's setup time should be less than 1 minute. No program change is allowed
    b) Judges will start the program
    c) Teams are required to sign the score sheet to verify scores after each run
    d) A same slideshow file will be used for every team
5) Teams will have max. 5 min to adjust their robot and code
6) Re-impound
7) Level 2 test begins
8) Level 3 test begins

Note: computers will be impounded during any scheduled break in the agenda

10. Scoring

Level 1: 1 point for correct print + 1 point for correct speech
Level 2: 2 points for correct print + 2 points for correct speech
Level 3: 3 points for correct print + 3 points for correct speech

For an individual image displayed for at least 4 seconds	**Correct Printout/Speech for the 6 second window**		**None OR Incorrect Printout/Speech for the 6 second window**	
	Single printout / speech	Multiple printouts/speech **(All instances correct)** 50% deduction	Single printout/speech	Multiple printouts/speech **(Even 1 instance is incorrect)**
Level 1	1 point	0.5 point	0	0
Level 2	2 points	1 point	0	0
Level 3	3 points	1.5 points	0	0

11. How to decide winners

- Total Score = Level 1 + Level 2 + Level 3
- For example for Team A (see the Level 1 scoresheet on slide #21):

Team A	Number of correct answers	Score	Max Score
Level 1	15	15x2= 30	15x2 = 30
Level 2	12	12x4= 48	15x4 = 60
Level 3	10	10x6= 60	15x6 = 90
	Total Score (Max.)	**138**	**180**

- Tie breaker
  1. Level 3 score
  2. Level 2 score
  3. Rerun Level 3 slideshow with (1) longer distance (2) different brightness of the monitor, (3) faster transition time, and/or (4) introducing occlusion

12. Level 1 Judging Score Sheet for a Team (Sample)

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Team: Name: ~~team A~~ Team ID: 1234-1

Level (circle one) : 1 2 3

Points for each level: 1 2 3

Max Points (Circle one): 30 60 90

Seq No.	Correct Sign	Sign Displayed	Sign Spoken	Points	Notes
1	*stop*	1	1	2	
2	*yield*	1	1	2	
3	*no left turn*	1	1	2	
4	*right turn only*	1	1	2	
5	*no right turn*	1	1	2	
6	*left turn only*	1	1	2	
7	*No parking no arrow*	1	1	2	
8	*speed limit 25mph*	0	0	0	*25 mph missing*
9	*When flashing*	1	1	2	
10	*One way right*	1	1	2	
11	*no turn on red*	1	1	2	
12	*do not enter*	1	1	2	
13	*No U turn*	1	1	2	
14	*No parking Double Arrow*	1	1	2	
15	*No parking left arrow*	0	0	0	*left arrow missing*
			Total Points	26	

Judge Signature: _____

Team Verfication Signature: _____

ScoreSheet.xlsx file is on the Vcc page

13. Robot Specifications

- Must be completely autonomous
- Any platform with only 1 cameras is allowed. Must be USB, single lens camera. Any lens is acceptable
- Using built-in laptop cam is OK
- Any programming language may be used
- No WIFI allowed (e.g. Google Colab, P5.js not allowed)
- Weight: no limit
- Additional lighting can be provided by the robot
- Camera angle and lens: no restriction (Robots can use motors)

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14. Sample Resources

- Level 1 Slideshow file in MS PowerPoint on the Vcc page
  - File name: L1_3classes.pptx
  - Background color of slides is white
  - When a slide with no sign is present, the program may say “none”
  - The same sign type will never appear twice in a row. In other words, Adjacent signs in the slideshow sequence will always be different sign types.
  - Duration 6 sec, transition: 0.01 sec
- Level 1 Test Video on YouTube Using the PowerPoint file on the web: https://youtu.be/JbvWN4sV-Zs (4 sec duration was used, instead of official duration 6 seconds)

15. FAQs

Q1. Expected label of the right sign is: “No Parking Double Arrow”. How do we score if the output is **“No Parking <u>Any Time</u> Double Arrow”**? Ans: Full Points

No Parking Double Arrow

Q2. Expected label of the right sign is: “No right turn”. How do we score if the output is **“No Left Turn”**? Ans: Zero Points

No Right Turn

Q3. Expected label of the right sign is: “Speed Limit 25 mph”. How do we score if the output is **“Speed Limit 52mph”**? Ans: Zero Points

Speed Limit 25mph

16. 2025-2026 Committee

Member	Short Bio
Dr. Vijay John, Chairperson; Main creator of the 2026 game	Associate Professor at Lawrence Technological University specializing in multimodal learning for robotics and autonomous driving. He has developed innovative frameworks integrating audio, visual, thermal, and other sensing modalities for human-robot interaction and intelligent mobility. Previously, he served as a Research Scientist at RIKEN's Guardian Robot Project and as a faculty member at the Toyota Technological Institute in Japan.
Devson Butani, Vice Chair	Graduated with a BS in Mechanical Engineering 2019 and a MS in Computer Science from LTU in 2025. Now Robotics Research Lab Manager at LTU. Background in AI, autonomous systems, 3D Printing, and electro-mechanical and software architecture design. Robofest judge and volunteer since 2016; participating in robotics competitions since 2012.
Dr. CJ Chung	Professor of Computer Science. Founder of Robofest. Director of Robofest 1999-2020. Director of LTU's CAR (CS AI Robotics) Lab. Launched Vision-based Mini Urban Challenge using L2Bots in 2007. The category name changed to Vcc in 2009. Designed Vcc challenge rules 2007-2020.
Dr. Mohammad Hassanzadeh	Assistant Professor at Lawrence Technological University, specializing in artificial intelligence, machine learning, and computer vision. His research focuses on developing advanced AI and machine learning methods for intelligent agents, medical imaging, bioinformatics, image and signal processing, computer vision, autonomous vehicles and robotics. He has published extensively and secured multiple research grants in these fields.
Dr. Tao Liu	Assistant Professor at Lawrence Technological University, specializing in computer vision and intelligent visual computing systems. His research focuses on developing efficient, robust, and secure deep vision models for autonomous perception, medical imaging, and edge AI. He has contributed to advances in vision-oriented compression, adversarial defense, and hardware-aware learning, with publications in top computer vision and AI venues such as CVPR, NeurIPS, MICCAI, and DAC, cited over 1,000 times.

17. Tentative In-person Workshop Schedule (at LTU)

- Early Feb on a Sat (3 hours)
- During days for field trips, if there are requests (Half day)
- Workshop materials will be posted on the Robofest website

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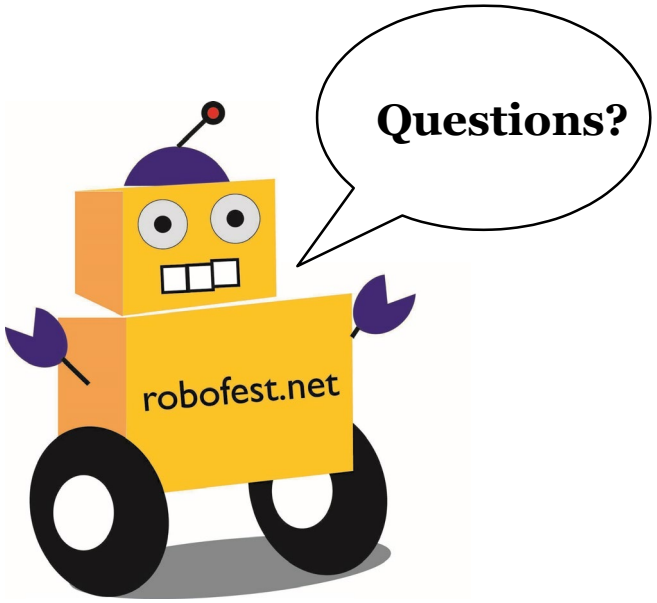
Little Robots, Big Missions



Send emails at vjohn@ltu.edu
Dr. Vijay John, Vcc 2026 Chair

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