Robot Tour
Trial 2023
Div C

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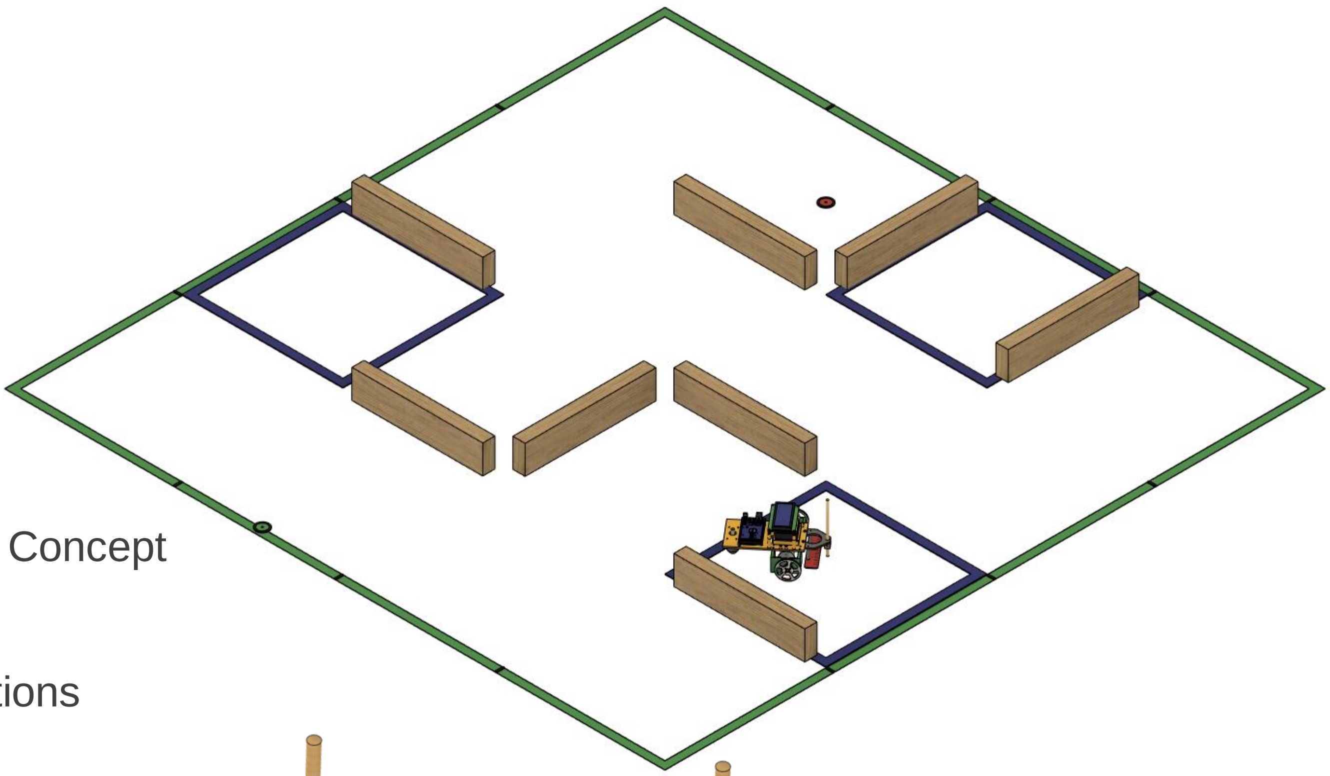
SO Event Coach
State Event Supervisor
National Event Supervisor
Tech Committee Member

Agenda

- Goals of Event
- Event Description
- Event Rules
  - Build
  - Track Area
  - Competition
- Location Tracking Concept
- Robot Design
- Kit Recommendations

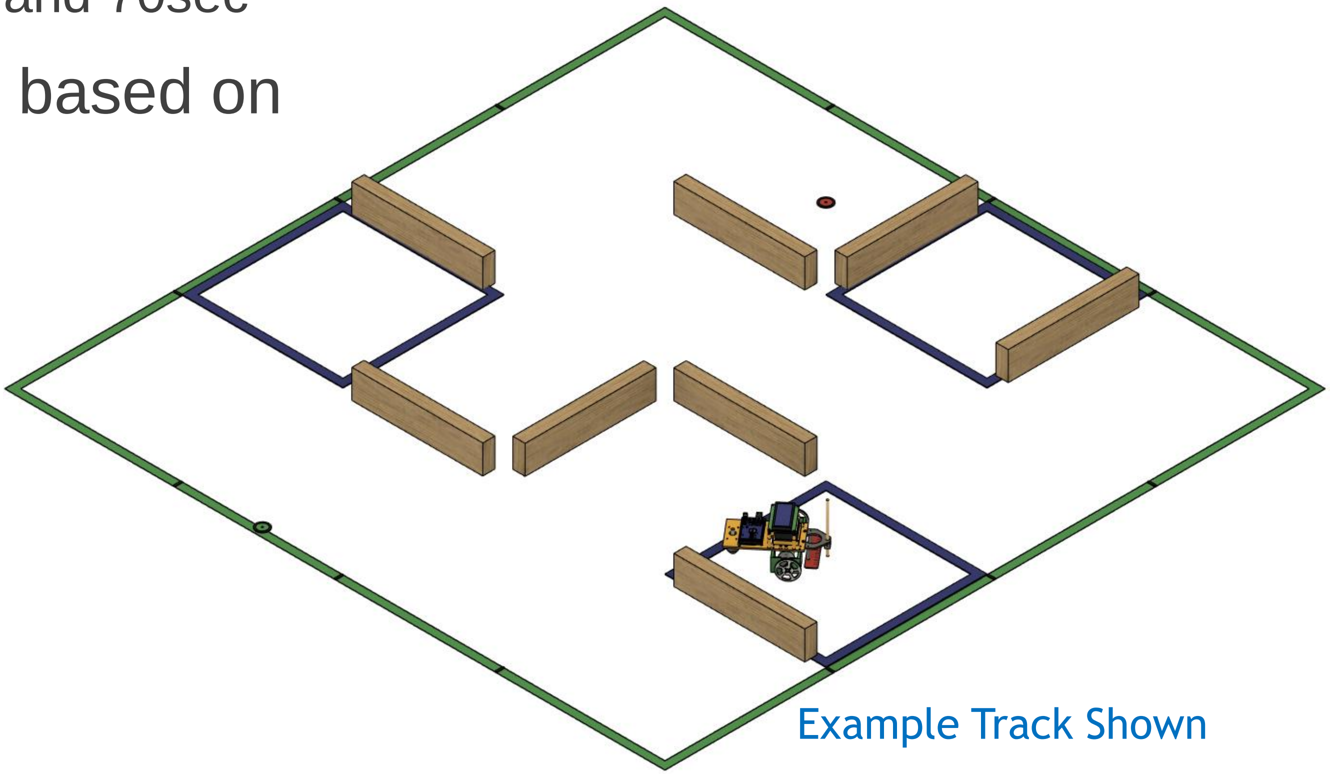


Goals for Robot Tour

- Create a True Robot Event
  - Autonomous Operation
  - NOT Remote Controlled
- Low Cost Robot Kits (<$60) are Competitive
  - Large Availability of Robot Kits
  - Higher Cost Kits do NOT have Major Advantage
- Programming During Event Time
  - Competitors must make some programming changes after impound
- Not Complex for Event Supervisor

Event Description

- Track Location
- Start & Target Points announced after Impound
- Target Time
  - Between 40 and 70sec
- Bonus Points based on Path Taken



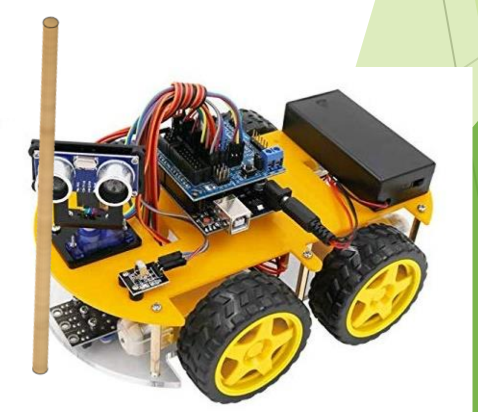
AGV

Auto **G**uided **V**ehicle

This Event is Based on Current Real World Tech!!!

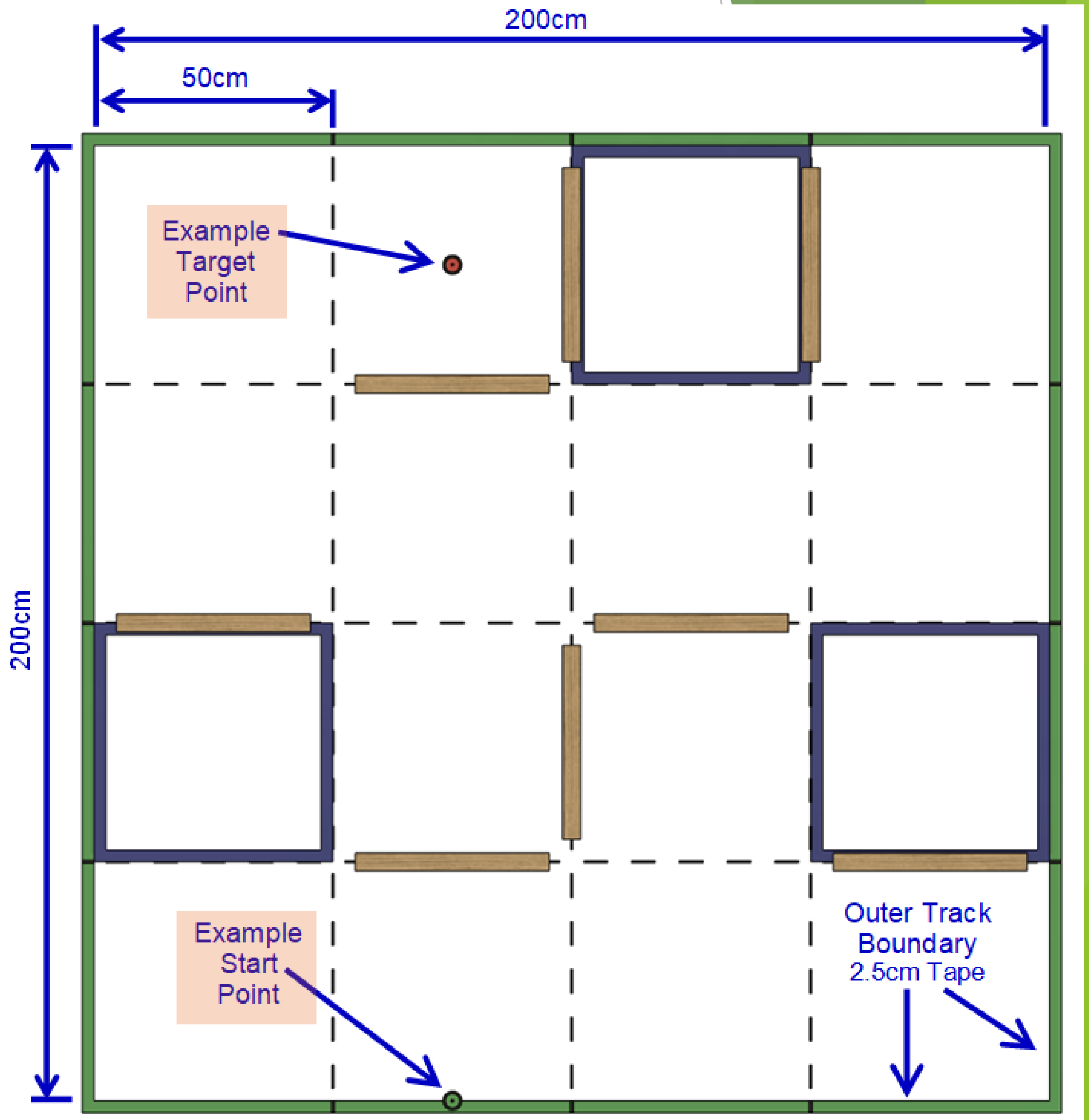
Event Rules - Build

- Autonomous robotic vehicle to track location on track
  - Not Remote Controlled
- Powered by up to 8 AA batteries
- Must completely fit in a 30cm by 30cm space of any height
- ¼” Dowel Round mounted to front for measurements. At least 10cm height.



Event Rules - Track

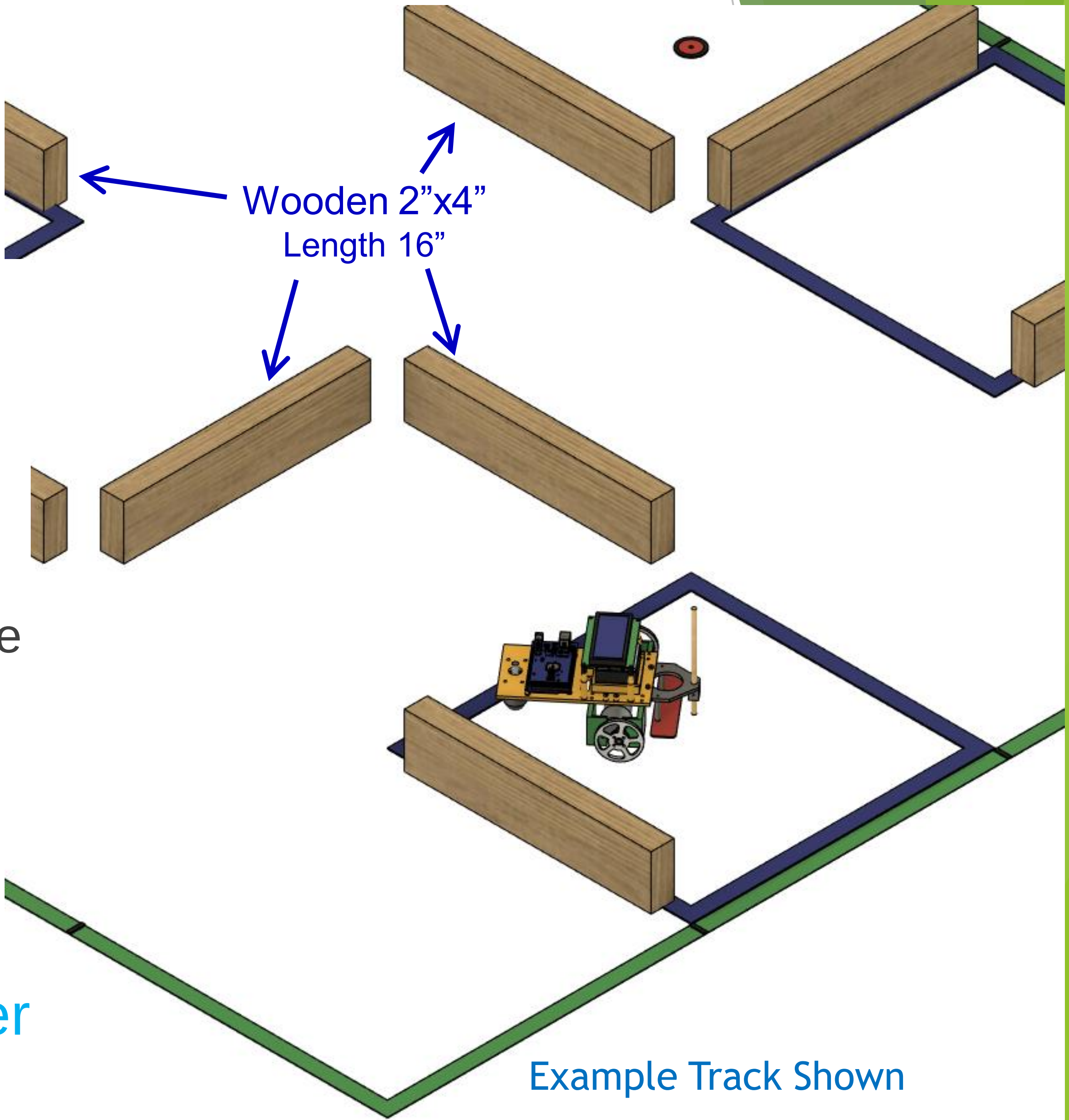
- Track Area 2m x 2m
- Start Point
  - 16 Possible Locations
  - Placed at Track Perimeter in Center of Grids
  - Chosen by Event Supervisor
- Target Point
  - 16 Possible Locations
  - Placed in Center of Any Grid
  - Chosen by Event Supervisor



Example Track Shown

Event Rules - Track

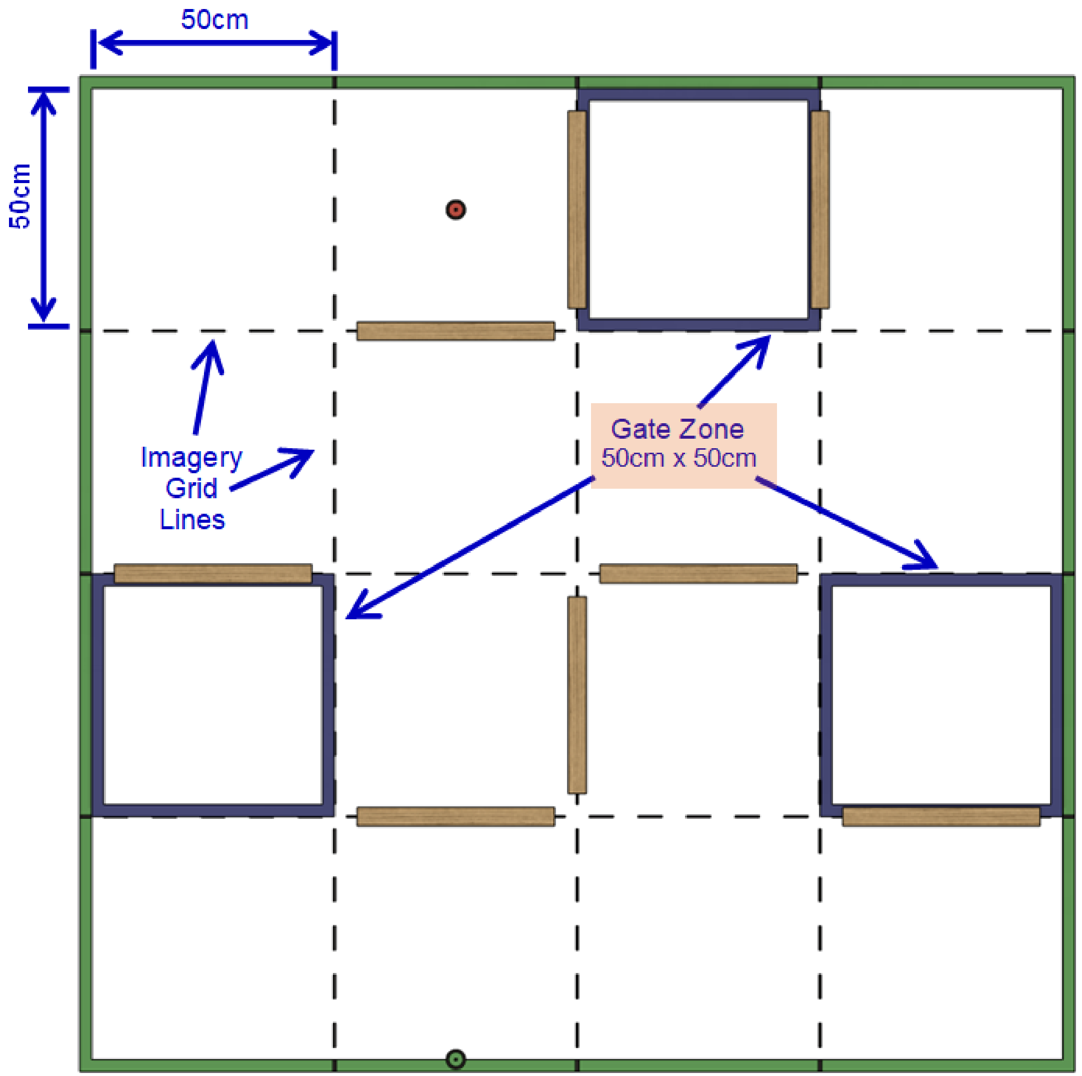
- Wooden 2” x 4” Obstacles
  - Up to Eight (8) 2x4s
  - Randomly Placed by Event Supervisor on Imagery Line
  - Competition Violation for touching any of the 2x4s
  - Actual Size of 2x4s
    - 1.5” x 3.5” x 16”
- Obstacles can be removed for a smaller penalty than touch



Example Track Shown

Event Rules - Track

- Bonus Gate Zones
  - Bonus Awarded for Entering Gate Zone
  - Number of Gates Zones
    - 3 at Regionals
    - 4 at States
    - 6 at National
  - Size 50cm by 50cm
  - Marked by 2.5cm Tape



Example Track Shown

Event Rules - Competition

- Impound Requirements
  - Robot and Spare Parts
  - Robot Program (USB Drive and <u>Not</u> Laptop)
    - Competitors MUST ONLY use Impounded Program
- Setup Time: 10 Minutes
  - Initial robot setup
  - <u>No Testing Allowed</u>
- Track Time: 8 Minutes
  - Includes programming changes
  - Include all runs
  - Not included is Event Supervisor measurement time
  - Track Time used is recorded for use as a tie breaker

Event Rules - Competition

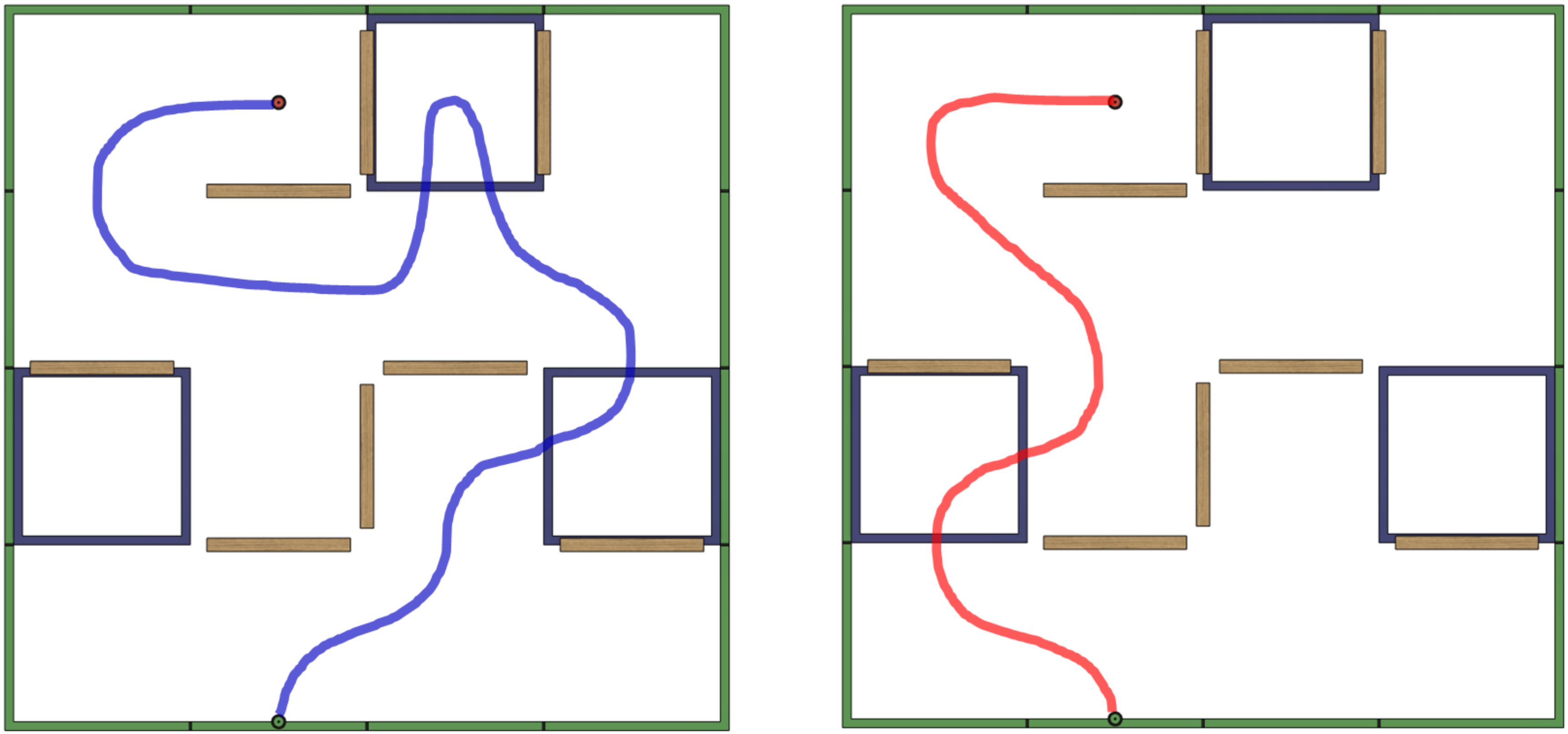
- Track Time ends at:
  - 2 Successful Runs **OR**
  - 3 Failed Runs **OR**
  - 8 Minute Track Time Limit Reached
    - Current Run allowed to Finish
- Failed Run is
  - Run Time reaches twice the Target Time
  - Robot exits the Track Area
    - Determined by robot outside of track boundary lines
  - Competitors ask current run to be marked as a Failed Run

Event Rules - Competition

- Run Time (Compared to Target Time)
  - Starts when robot begins to move
  - Ends when Robot Stops or is a Failed Run
    - Robot is stopped if does not move for 3 seconds; the 3 seconds is not included in run time
    - Not recorded for a Failed Run
- Gate Bonus
  - Dowel MUST enter Gate Zone first
  - Gate Zones can be entered in any order and direction.
  - Each Gate Zone may only be counted once

Robot Path is Not Defined

- Competitors choose their best path



Example Tracks Shown

Practice Log & Design Log

- Practice Log & Design Log must be impounded with the Robot
- Practice Log must contain at least 10 runs with the following information
  - Target Time
  - Run Time
  - Distance from Target Point
  - Gate Zones (if used)
  - At least one Robot parameter
    Path taken, gates, motor speed, …
- Design Log must contain descriptions of robot hardware and all sensors that provide data used by the robot to track location

Run #	Target Time	Run Time	Distance from Target Point	Gate Zones	Example Robot Parameter
1	55	46.23	12.4	2	Motor Speed 70%
2	55	59.49	8.6	2	Motor Speed 50%
3	48	56.71	15.8	1	Motor Speed 50%
…	…	…	…	…	…
10	65	72.14	5.2	3	Motor Speed 60%

Scoring (Non-Failed Run)

- Run Score =

  Time Score +

  Distance Score +

  Gate Bonus +

  Penalties
- Final Score is <u>lowest</u> Run Score
- Team with the <u>lowest</u> Final Score

Scoring (Failed Run)

- Run Score =

  750 points +

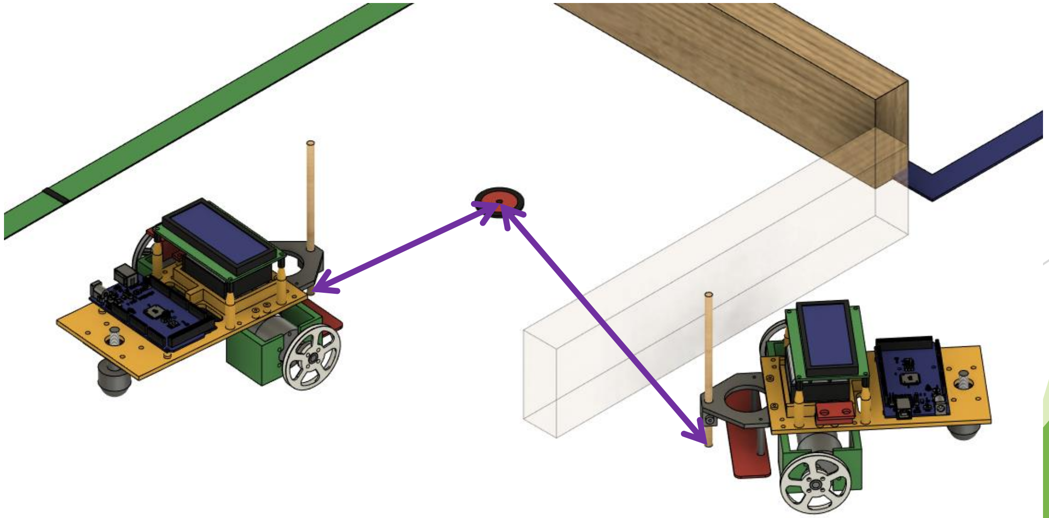
  Penalties
- Final Score is <u>lowest</u> Run Score
- Team with the <u>lowest</u> Final Score

Scoring – Time Score

- Run Time < Target Time
  - Time Score = (Target Time – Run Time) x 2
- Run Time >= Target Time
  - Time Score = (Run Time – Target Time)
- Larger Penalty for being under Target Time

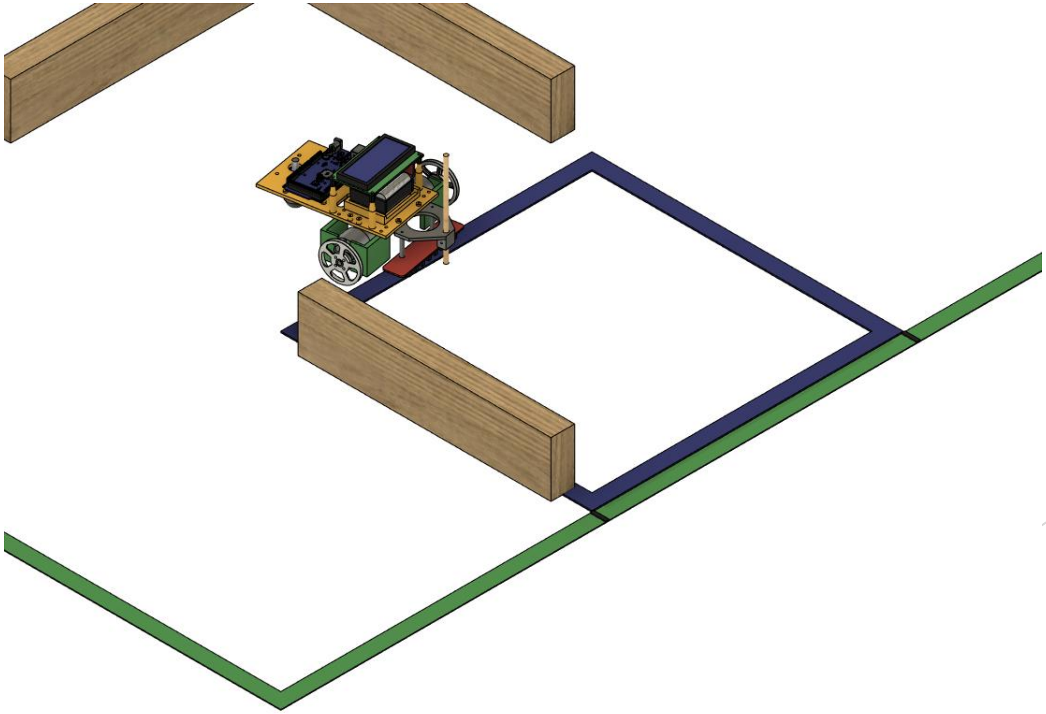
Scoring – Distance Score

- Robot Distance
  - Point to Point Measurement from the Target Point to Robot's Dowel
    - Front Edge of Dowel is Measurement Point
  - Measured to nearest 0.1cm
  - 2x4s can be removed temporarily to perform measurements if required
- Distance Score = Robot Distance * 1 point/cm



Scoring – Gate Zone Bonus

- Gate Zone Bonus
  - -15 Points for Each Zone Gate entered in any order
    - Entering Gate Zones lowers Run Score
  - A Gate Zone may only be counted once



Scoring – Run Penalties

- 50 points added for contacting 1 or more 2x4 Obstacles during a run
- 35 points added to all Run Scores when a team chooses to run with 2x4 Obstacles
- Competition Violation
  - 150 points added to each Run Score with 1 or more competition violations.
- Construction Violation
  - 300 points added to each Run Score with 1 or more construction violations

Scoring – Final Score Penalties

- Log Penalty
  - 25 Points for Incomplete Practice Log
  - 25 Points for Incomplete Design Log
  - 150 Points for Not Impounded Practice Log
  - 150 Points for Not Impounded Design Log
- 200 points added to the Final Score for robot movements tested during Setup Time
- Robot Not Impounded
  - 5000 points added to each Run Score

Scoring - Example

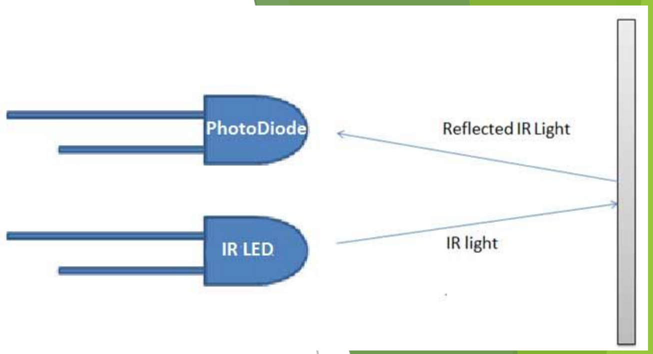
Target Time	= 43s.
Robot Distance	= 21.7 cm
Run Time	= 58.53 sec.
Gate Zones Entered	= 2
Practices Log	= Both Valid & Impounded

Time Score	= 58.53 – 43	=	15.53
Distance Score	= 21.7 x 1 pt/cm	=	21.7
Gate Zone Bonus	= 2 x -15	=	-30.00
Log Penalty	= 0	=	0.00
Run Score		**=**	**7.23**

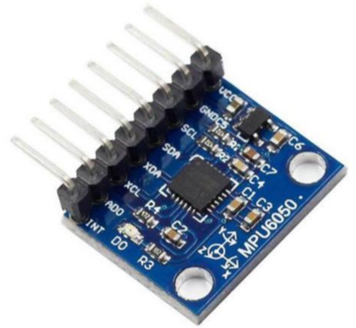
Building a Robot

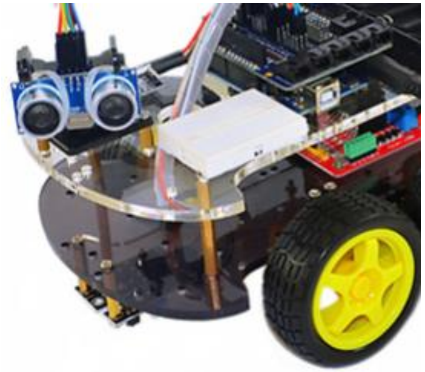
TIPS & SUGGESTIONS

Building a Robot

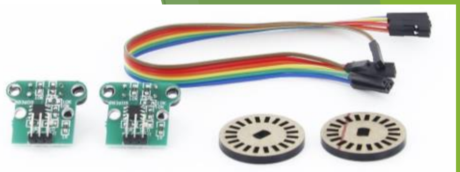


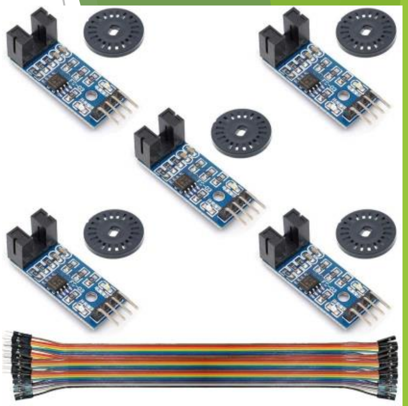
- Event is Location Tracking and Navigation as the Robot travels from Start Point to Target Point
- Information about Location is EVERYTHING
- Sensors attached to the Robot can provide Data to track the Robot's Location





Motor/Wheel Encoders



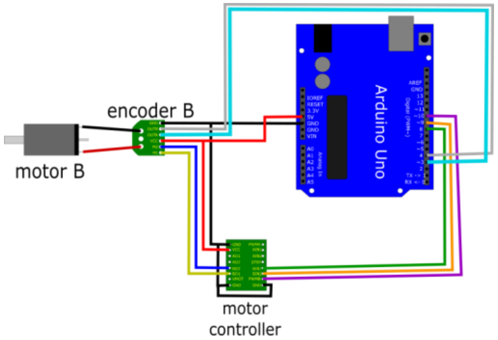


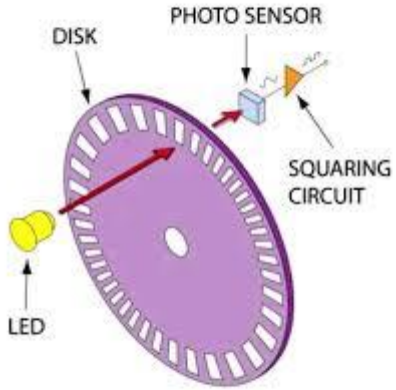
- Purpose
  - Measure Linear Distance Traveled
- Complexity

- Technology
  - Pulses from a photo sensor measure motor/wheel rotations used to calculate linear distance traveled

- Costs

$$$$$ to $$$$$





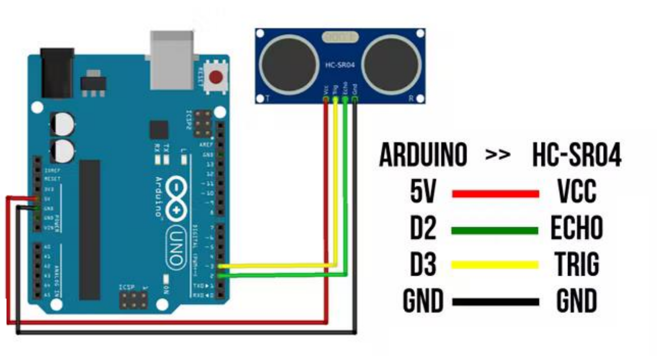
HC-SR04 Distance Transducer

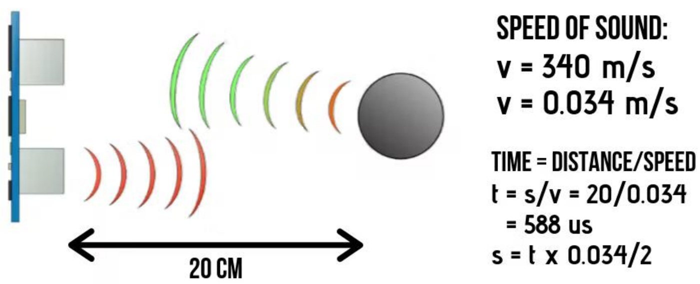
- Purpose
  - Measure Distance to Object
- Complexity

- Technology
  - Uses ultrasonic sound waves to measure distance to objects
  - Simple to program
- Costs

$$$$$

HC-SR04





Accelerometer/Gyroscope

- Purpose
  - Compass for Robot
- Complexity

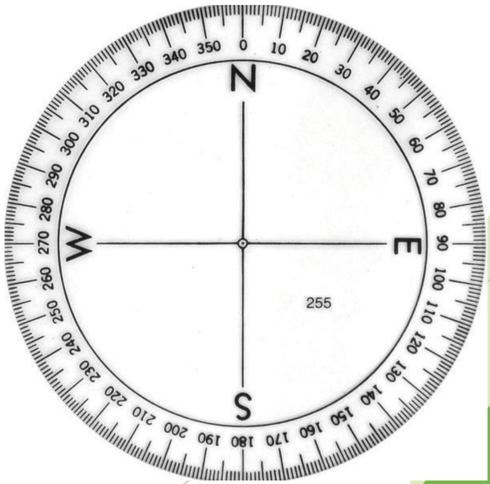
- Technology
  - MPU-6050 combine a 3-axis gyroscope and a 3-axis accelerometer
  - Using software libraries to determine robot's heading
- Costs

  $$$$$ to $$$$$

Note: - Mounting orientation for the MPU-6050 is very important.

- Make sure you select the best library for your needs.

MPU-6050
Accelerometer
Gyroscope



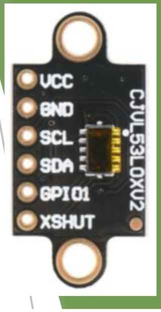
Time of Flight Sensor

- Purpose
  - Measure Distance to Object
- Complexity

- Technology
  - Laser distance measurement sensor
  - The sensor can detect the "time of flight", or how long the laser light has taken to bounce back to the sensor
- Costs

$$$$$ to $$$$$

Opinion: More expensive sensors may not give better results for this event. Whereas using several low-cost sensors could give an advantage if used correctly.

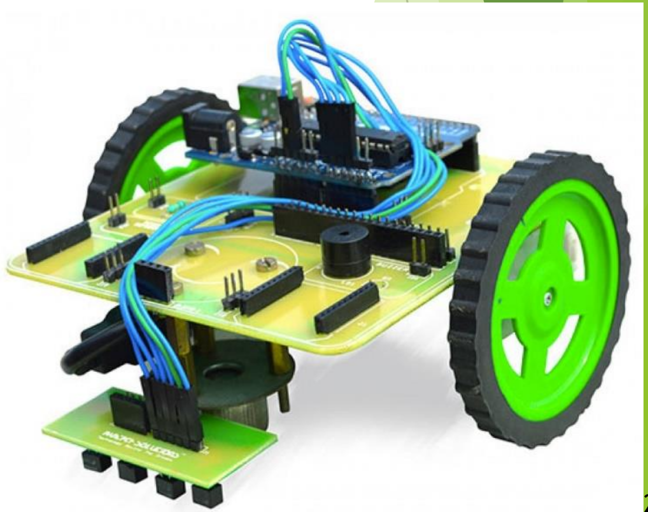


VL53L0X Laser Distance Sensor

Garmin LIDAR-Lite Optical Distance Sensor

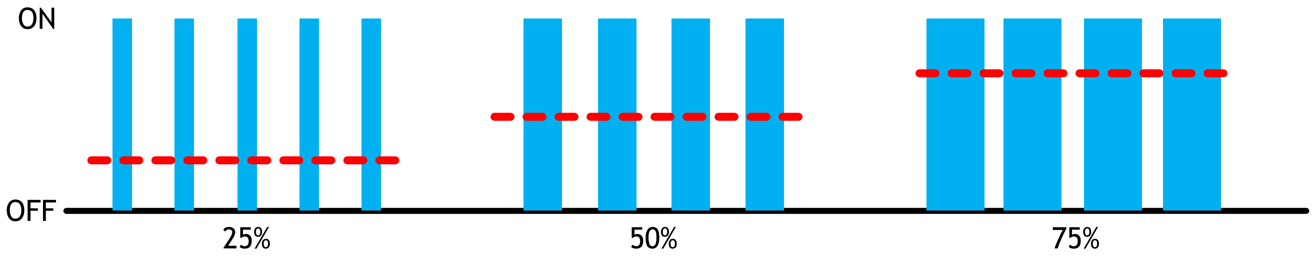
Building - Motion

- 4 wheel vs 2 wheel???
  - 2 Wheels = Less costs and easier steering
- Moving fast is not as important
- Slower robots are easier to steer
- Most basic robot kits move fast!!



Building - Motors

- Recommend DC motors with speed control
  - Most microcontrollers use PWM outputs
    - PWM is Pulse Width Modulation



  - The higher the PWM percentage then the faster the motor will rotate
  - Typically DC motors need 50% or higher to start rotating

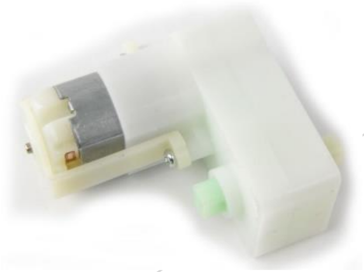
Building – Motor Gearing

- Many DC motors w/o gearing rotate at 1000 to 8000 RPMs or higher
- A Gearbox is recommended to reduce the speed to a useable level
- Higher gear reductions given better speed and steering control but at a loss of overall movement speed
- Motors shown range from $2 to $8 each

48:1

120:1 w/ Encoder

224:1



143:1

Robot - Brains

- The robot needs to have its program modified during the event
- Recommend using a micro controller that is easy and quick to modify
- Determine: Does the school or competitors have access to a laptop for use during the event?
  - If no, more expensive robots may be required
- Common Micro processors / computers

Arduino	Teensy	ESP32
Raspberry Pi	PIC	ESP8266
Lego	and many more….	

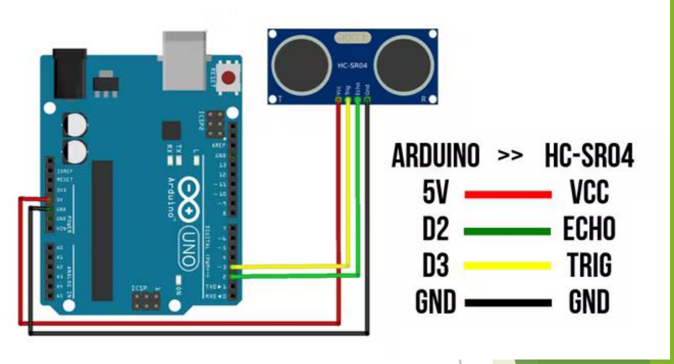
Robot – Brains - Arduino

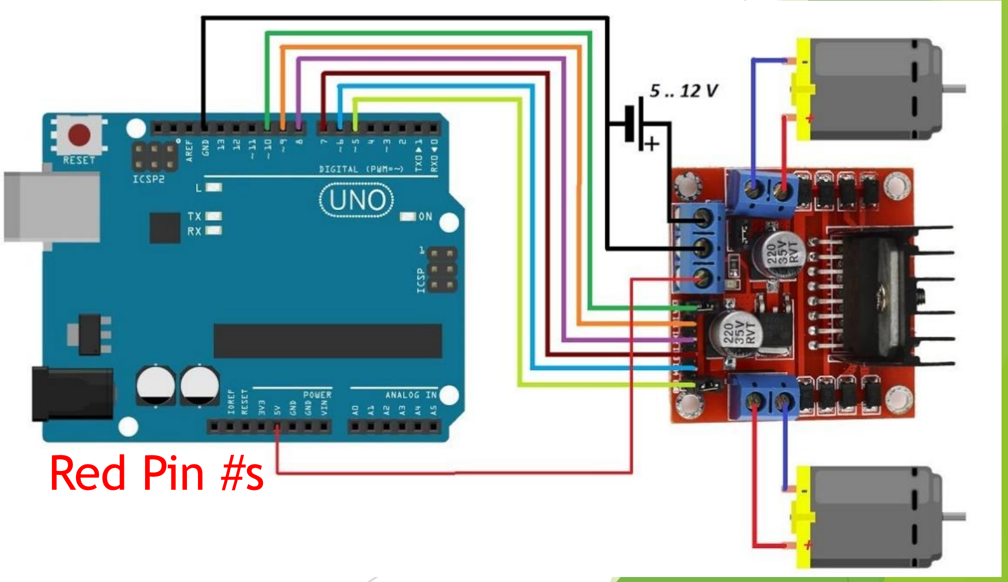
- Arduino is an excellent option
  - Windows / Mac / Linux
- Most robot basic kits include an Arduino
- Add-on kits available for
  - Display screens
  - Modules for easier wiring
  - And more ….
- Caution: A limited number of sensors and motors that can be connected
    - Next Slide shows Example
    - Several options exist to expand this number, but that is beyond this presentation

Ardunio UNO – Example

Pin #	Function
0	RXD (Not Available)
1	TXD (Not Available)
2	Distance Echo Input
3	Distance Trigger Output
4	
5	Motor A Speed (PWM)
6	Motor A Direction 1
7	Motor A Direction 2
8	Motor B Direction 1
9	Motor B Direction 2
10	Motor B Speed (PWM)
11	Motor A Encoder
12	Motor B Encoder
13	LED

Green Pin #s





Red Pin #s

Note: Diagrams are example wirings and should not be used. Consult purchased hardware's instructions for actual wiring.

Programming Tip

- Teams have a limited number of minutes to program and run their robot.
- Program should be developed to execute a list of commands that are easily modified

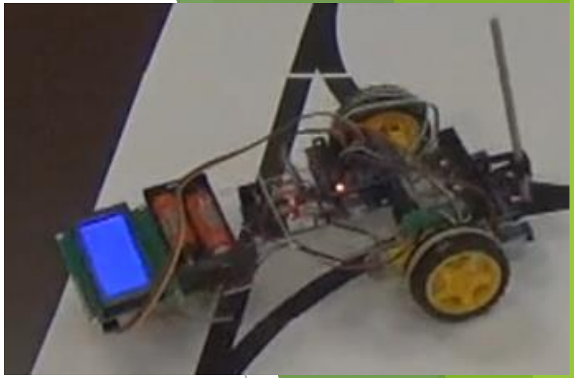
1. Forward 50cm
2. Left 90 Degrees
3. Forward 120cm
4. Right 90 Degrees
5. Forward 60cm
6. Left 90 Degrees
7. Forward 40cm
8. Right 180 Degrees
9. Forward 120cm
10. Right 90 Degrees
11. Forward 70cm
12. Stop

Robot Ideas

- The following robots are examples only.
- No promises on performance.
- Use at your own risk.
- Modifications should be made to improve performance and costs.

Robot #1

Approximate Cost $64 ($52)



OSOYOO 2WD
Robot Car Kit
$35.99

6 AA Battery Holder
(2) $7.39

- Excellent low cost starting point.
- Difficult to control at low speeds

DAOKI Tacho
Sensor (5)
$6.79

SunFounder I2C
20x4 Display
$12.99

Optional
Can slow reaction time

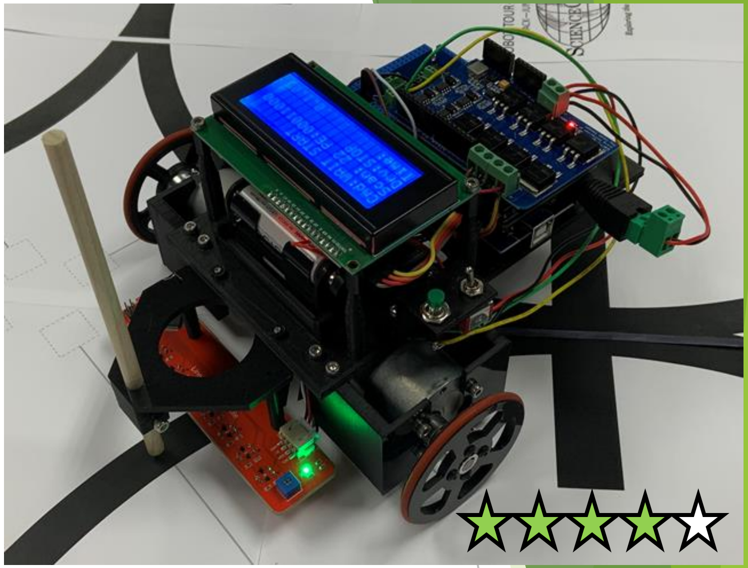
Robot #2
Approximate Cost $60

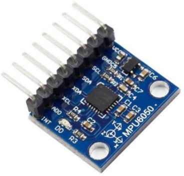
ELEGOO UNO Project
Smart Robot Car Kit
$54.99

4WD requires more motors and needs a higher level of programming skills to follow a curved path

Robot #3
Approximate Cost $130

Very good but expensive

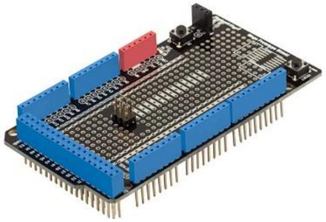




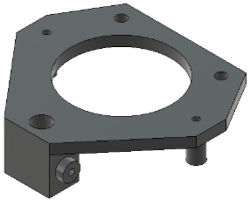
MPU-6050 Accelerometer Gyroscope $5.99

6 AA Battery Holder (2) $7.39

DPDT Mini Power Switch $2.70



RobotDyn Mega Prototype Shield $8.20

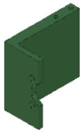


3D Printed PE & Dowel Mount $0.35

12V, 58RPM 60:1 Gear Motor w/ Encoder (2) $18.50/ea

Elecrow Dual H-Bridge DC Motor Controller $17.80

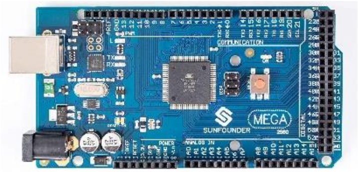
SunFounder I2C 20x4 Display $12.99



3D Printed Motor Mount (4) $0.25/ea

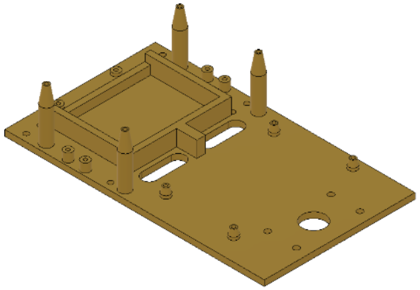
Lynxmotion HUB-02 Universal Hub - 6mm (pair) $7.65

Caster Wheel 25mm Diameter $4.90



SunFounder Arduino Mega $13.99

3D Printed Wheel (2) $0.10/ea

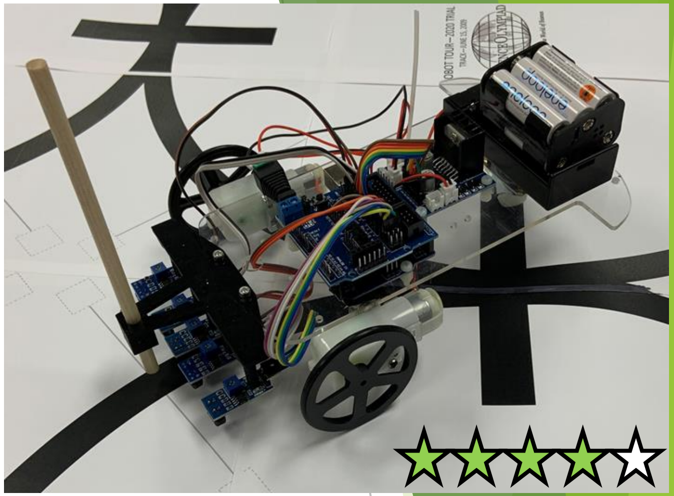


3D Printed Base $1.50

12 SPST Pushbuttons $7.99

Robot #4

Approximate Cost $60



OSOYOO 2WD
Robot Car Kit
$35.99

6 AA Battery Holder
(2) $7.39

DAOKI Tacho
Sensor (5)
$6.79

MPU-6050
Accelerometer
Gyroscope
$5.99

HC-SR04 Distance
Transducer Sensor
$2.54

Upgrades to Robot #1

GM9 Gear Motor
200:1 (2) $5.75/ea

3D Printed Wheel (2)
$0.10/ea

Very good speed control for
a low cost robot

Questions???

???