Summer 2024

Solar Car Radio Control Car Curriculum (9-10 grade)

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RACING AGAINST THE SUN- CREATING A SOLAR PANEL RC CAR

ADVANCED ENGINEERING: 9th & 10th GRADE

LYLE CIEE ENGINEERING CAMP SUMMER 2024

Divya Baranwal, PDF, Caruth Institute of Engineering Education, Lyle School of Engineering, SMU	Developed Pre and Post Test for the grade Co-wrote the curriculum, Contributed in Curriculum designing, and finalized designing activities, lead the curriculum.
Ashish Gandhi, PDF, Department of Mechanical Engineering, Lyle School of Engineering, SMU	Contributed to IoT components and technical guidance and supervision, fabrication in prototyping, assisted in testing & debugging in coding & programming, and physics concepts.

Science/Physics = Speed, Distance, Time, Acceleration, Deacceleration, Gravity, Friction, Inertia, Inclination, Potential Energy, Kinetic Energy, Solar Energy, Electrical Energy
Mathematical Calculation = Average Speed, Av. Distance, Av. Time, graph of av. Speed and Distance, Height, weight, battery charging time, voltage measure, Budget chart
Electrical Engg = Wiring, Soldering, Basic introduction of electrical components and uses
Computer Science = Python, programming, coding
Mechanical Engg = Chassis design, gear wheels, building prototyping, balance btw weight & strength,
Civil Engg = Planning, Design, and Implementation of infrastructure for solar power car
Environmental Engg = Emissions, Climate change local/neighbor problems,
Robotic = Microcontrollers, ultrasonic sensors
Engineering Practices: EDP

GOALS:

- Introduce campers to the concepts of solar energy and its applications.
- Introduce basic electronics, circuitry principles, and electric components like microcontrollers, resistors, sensors, and LEDs.
- Provide basic programming hands-on experience to write code for microcontrollers and programming functionalities like controlling the car's movement, sensor data, and transmitting data over the internet.
- Learn how solar panels convert sunlight into electricity.
- Explore the conversion of potential energy to kinetic energy on various inclined ramps, delving into scientific principles such as distance, time, and speed.
- Engaging in building low/high-fidelity prototyping to understand the materials and build their own solar-powered cars.
- Foster a collaborative environment where campers can learn from each other and share their experiences.
- Organize a showcase where campers can demonstrate their solar car and IoT system to peers, counselors, and parents.

Monday (Day 1) – Brainstorming/Sketching/ Prototyping

Specific Actions:

- Introduce the concept of renewable energy and how solar power can be harnessed to propel vehicles.
- Introduce basic engineering principles and design, and construct a simple car using cardboard as a building material, focusing on concepts like stability and structure.
- Encourage creativity and problem-solving as campers explore different designs, sketching, and prototyping of cars.
- Introduce campers to the concepts through an activity, such as a handout drawing, and how they apply to mechanical drawing, emphasizing the importance of accurate representation in top, side, and front views.
- Emphasize the need for clear annotations and labels on their drawings, including dimensions, part names, and other relevant information to enhance understanding.
- Encourage campers to practice drawing straight lines, curves, and other shapes neatly and accurately, as these skills are fundamental to mechanical drawing.
- Guide students through an iterative design process, where they sketch, receive feedback, and revise their drawings to improve accuracy and detail.
- Promote collaboration among campers by encouraging them to work together on designing and sketching their solar car components, fostering effective communication and teamwork skills.
- Introduce fundamental concepts of vehicle construction, such as chassis design and wheel assembly.
- Introduce the concept of Potential energy as stored energy due to an object's position.
- Explain kinetic energy as the energy of motion possessed by an object.
- Demonstrate how potential energy is converted into kinetic energy as the car moves down to an inclined ramp.
- Explain how the different heights of ramps affect the potential energy of the car and its subsequent motion.
- Introduce camper methods of accurately measuring the distance traveled by the cardboard car along the inclined ramp using measure tape or marked distances.
- Introduce accurately measuring the time it takes for the car to travel down the ramp using a stopwatch.
- Explain the concepts of speed (distance traveled per unit of time) and acceleration (rate of change of speed).
- Guide campers to calculate the average speed of the cardboard car during its descent down the ramp.
- Encourage campers to experiment by adding weight and testing the cardboard car on ramps of various heights.
- Prompt them to record observations, including taken time, distance traveled, speed, and any noticeable changes in acceleration.
- Facilitate discussion on the relationship between ramp height, potential energy, distance traveled, time taken, speed, and acceleration, and encourage campers to reflect on what they've learned.
- Campers will gain a deeper understanding of energy conversion, motion, and the fundamental principles of physics, engaging in hands-on experimentation with the cardboard car on inclined ramps.

Ice Breaker: (9:00 AM; 25min) Speed Meetings:

IB is a fun activity to help people get to know and warm-up sessions. Campers will ask at least four campers questions about themselves, such as names, favorite colors, or food, in 4 min. This is a great way to learn more about the people in your group and find common ground. Once the speed meeting is done, campers will tell the whole group. Speed meeting starts with

- Handshake
- Tell them who you are
- Tell one small thing about yourself (what are your skills, hobbies, sports, town, best subject?)
- Campers will write their name on the first page clearly and one thing about themselves in the Notebook/Journal.
- They will have plenty of chances to decorate their notebooks/journals later.

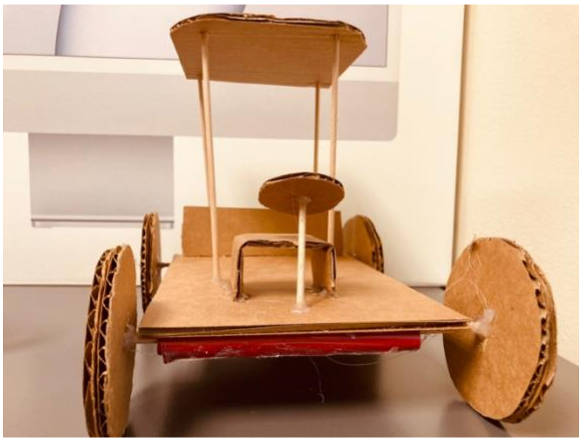
Instant Challenge: Build Your Golf/Dune Buggy Car (45min)

Purpose: to energize the campers, have campers introduce each other while getting them to think about the essential elements and basic engineering design of a car.
Engineering Practice: Communicate Effectively

This activity integrates science learning, engineering design, mechanics, and problem-solving to construct a vehicle, hands-on learning, and developing critical thinking.
Think Pair and Share

Counselors: Ask campers first to sketch a picture of a golf/dune buggy car in pairs; they can be as creative as possible – think creatively and think outside the box. Ask them to share their sketches with other pairs and counselors.
Materials:

- Copy paper
- pen/pencil
- Notebooks/journals
- Cardboard
- Cardboard
- Plastic Straws
- Skewers
- Popsicle sticks
- Aluminum Foil Sheets
- Scotch tape
- Compass
- Ruler
- Hot / Glue
- Scissors
- wire cutters



Campers: Use your imagination to build your golf/dune buggy car. Build their car based on the materials given below. Each pair will build their Golf/Dune Buggy Car using the materials: Building Body/ Chassis, Axle Sleeves, Wheels, and putting the Axles in place.
NOTE for Counselors: They will ask some guided brainstorming questions about what they observe and notice., i.e.,

- Has anyone ridden/driven any vehicle, i.e., Dune Buggy/ Golf/ smart car?
- Why might cardboard be better for the chassis than paper or card stock?

- What if we put weight on the car?
- What if we add more wheels?
- What if we make three-wheel cars?
- What challenges did you encounter during the construction process?
- How would you iterate on your design if you had more time or resources?

Research Survey-Pre-Test (10 mins)

Administering by Divya: Pre-Test is administered before the treatment based on what campers know or don't know. This can help to build a foundation for future learning.

Racing Against the Sun: Creating a Solar Car Project Introduction (30 min)

Purpose: to introduce the solar car design project and engineering design process.
Engineering Practices: Consider problems in context; Envision multiple solutions
Counselors: create an environment to understand and reflect on Texas state's contextual/local/neighbor problem, particularly 'transportation' that leads to other channeling problems.

Background and Problem:

- A wicked problem that has impacted the United States, mainly in highly populated areas, is climate change and emissions.
- Like in many other parts of the United States, transportation in Texas faces several challenges, including Traffic Congestion, Infrastructure Maintenance, Urban Sprawl, Public Transit Challenges, Energy, and Environmental Impact. Addressing these transportation challenges requires comprehensive planning, investment in infrastructure, adoption of new technologies, and coordination among government agencies, private sector stakeholders, and the community.
- Therefore, Solar panel transportation would be an intelligent solution. Understanding the importance of using solar panels and solar-powered vehicles has become increasingly popular as we work to understand and reduce the effects of air pollution and lower greenhouse gas emissions.

Counselors: make your own guided PowerPoint presentation (PPT) with one or two slides of the above hyperlinks to reach the exact page and highlight the points, including images. (See References page of hyperlinks for more details).

- How to Make a Car - Mini Solar Powered Car - Easy to Build - YouTube

Materials:

- Pen/Pencil
- Sketch/Markers
- Notebook/Journal
- Big Sticky notes

Reflection:

Counselors will pose problem questions, ask, discuss, and reflect. will provide space for brainstorming on Solar Panel Cars, their Dimensions, Constraints, Cost-effectiveness, time, and sustainability.

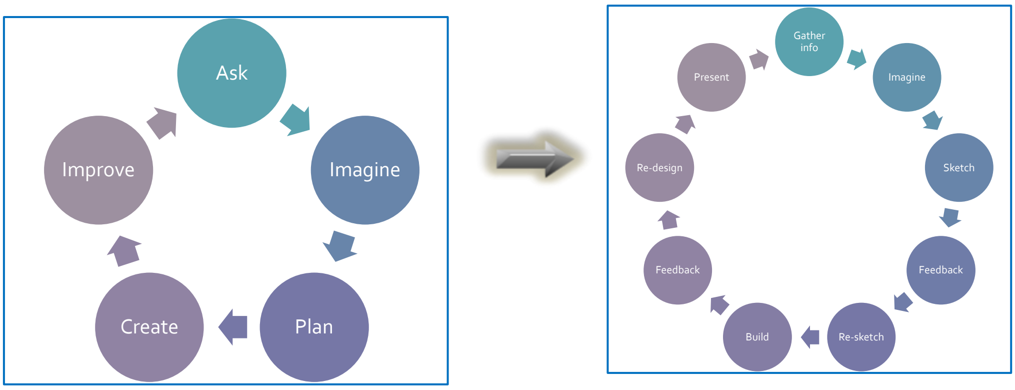
Add a campus map with different locations to reflect on the different surfaces (https://www.smu.edu/aboutsmu/maps), extend to the major highways, and include Pegasus Park as part of the route (https://www.smu.edu/research/pegasus-park)

Campers will record or note what they observe in articles and videos and reflect on it.
Ask campers to share their experiences traveling in a car or bus. Here are some guided questions:

- What do Campers observe or notice after watching this YouTube video on Solar cars?
- How does it work in the morning and at night time?
- How does it work in rain or windy weather?
- Discuss the advantages and disadvantages of solar cars.
- Do you think so, should we promote the adoption of sustainable transportation modes such as electric vehicles, bicycles, and public transit to reduce greenhouse gas emissions and combat climate change?
- Should we encourage using eco-friendly transportation like electric cars, bikes, and public transit to help fight climate change by reducing greenhouse gas emissions?
- What problems or challenges do civil and transportation engineers face when developing a solar-powered car?

- Wrap up the context of the project by asking campers how they can design and build a solar panel car that can travel at least 20 ft.

Introduce the Engineering Design Process (EDP) (15 min)
Using your own guided PPT with one slide, introduce EDP steps, significance, and applications for this one-week camp: Identify, Imagine/Plan, Create Prototyping (sketching/low/high fidelity), Test/Analyze, Feedback/Revise, and Final Model.



Materials:

- Pen/Pencil
- Sketch/Markers
- Notebook/Journal
- Big Sticky notes

Research and Secondary Data Collection (30 min)
Engineering Practices: Consider problems in the context; Make evidence-based decisions; Communicate effectively;
Think Pair and Share
Counselors will give 2-3 questions to each pair to do R&D.
Under the supervision of counselors, pair campers will visit the computer lab to research, collect general information on solar panel cars, understand solar power and other factors they would like to consider when building a vehicle, and note them down in notebooks, i.e.,

- Equipment and materials for building a solar car
- Measurement and dimensions of the solar panel car's various parts

- What will be the total cost to build a solar panel car?
- Does the sun affect solar panels?
- Where is the best place to put a solar panel to get the most sunlight?
- What is a solar panel made of?
- Why do we need rechargeable batteries for solar cars?
- Does the physical design and the weight of a car affect its speed?
- What happens if solar cars run on smooth/ rough ramps?
- Can we accelerate or deaccelerate solar-powered cars? Explain.

Paired campers will share their research and secondary data collection with other pair campers and counselors to get feedback. They will record this information in big sticky notes.
Counselors: will show the video links.

- YouTube: Could solar-powered cars be the future of electric vehicles? - YouTube
- Article: North Texas Students build solar-powered car they'll drive to California – NBC 5 Dallas-Fort Worth (nbcdfw.com)

Materials:

- computer lab
- Pen/Pencil
- Sketch/Markers
- Notebook/Journal
- Big Sticky notes

Campers will respond: *I observe, I notice, and I find* and write in a notebook/journal.

Sketching Prototype- Individually (20 min)

Engineering Practices: Consider problems in context; Communicate effectively; Persist through and learn from failure
Counselors: Inform the sketching prototyping, which is the next step in EDP. Before creating the low/high-fidelity prototype, discuss the significance of sketching, labeling, keywords, illustrations, and descriptions that will help to identify the parts necessary, and visualizing how they come together is crucial. Counselors add 2-3 guided questions here.
Materials:

- Pen/Pencil
- Sketch & Markers
- Notebook/Journal
- Ruler
- Compass

Campers: Campers will have the opportunity to design and create their own ideas for solar-powered cars individually.
Campers will hypothesize and develop sketches based on their research and interpretation of solar panel cars.
Mechanical sketching: to present a free-hand drawing and sketching technique to represent three-dimensional objects (image for reference fig 3). Campers will sketch the front, top, and side views, label the different parts, and brainstorm with other tablemates. Discussion and feedback can use stem like I'm really interested in using ideas on my own prototyping.

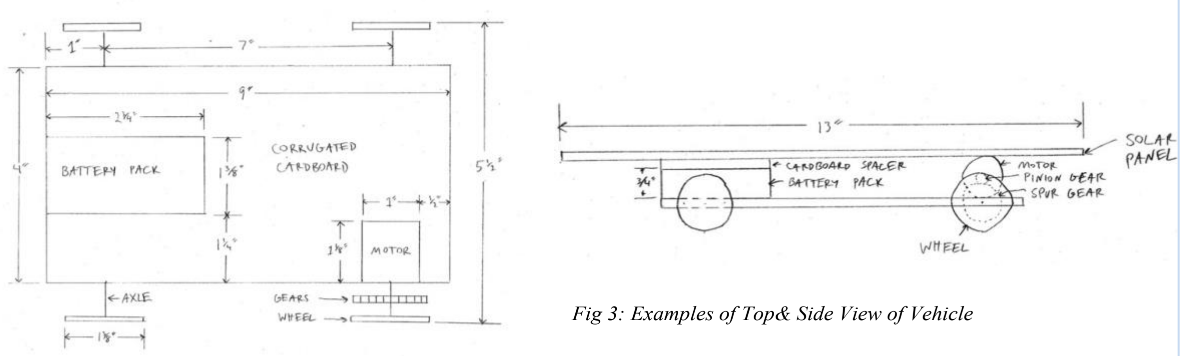


Fig 3: Examples of Top& Side View of Vehicle

Lunch (12:00-1:00 PM)

Journal Writing and Decorating (30 min)

Purpose: to provide campers with background information about the purpose of the notebooks/journals throughout the camp period and to share progress and receive constructive feedback from peers and counselors
Engineering Practices: Communicate effectively

Counselors ensure each camper writes in a journal daily, including activity names, sketches, illustrations, keywords, written descriptions, labeling, math, science, and engineering concepts with dates and timing, and self-reflection.

- Every day, they must mention that campers must have captured pictures (via cellphone or personal camera) of various activities and insert them in their online portfolios.
- Give feedback on graphs, using keywords, etc.
- Ask campers to label, scale, draw arrows, etc.

Campers will write their name on the notebook.

- Campers ensure that their name are clearly on the front of the notebook.
- Use the first page of your notebook to draw and tell us your interests, hobbies, family, etc., in colors, pictures, and words.
- Campers will write what they have done all day, including sketches, descriptions, labeling, math, and engineering concepts.
- Campers will share their progress and give/receive feedback on progress.
- The campers will have a gallery walk to the other prototypes and give and receive feedback:
  - Who (if anyone) helped you today?
  - What activity did you enjoy most today? (other than lunch 😊)
  - What was the most challenging activity?

Low-Fidelity Prototype (LFP) (60 min): Build a Car using prompts and a Ramp
Purpose: to introduce the essential components of the engineering design process and prototyping and to recall and understand the scientific principles. To help campers test materials before beginning their final project prototype.

Engineering Practices: Work effectively in teams; consider problems in contexts; Apply Science and math knowledge to problem-solving; Use System Thinking; Persist through and learn from failure

LFP: Basic Design model & Experiment 1 (with/without weight) – Showcase & Reflection – Dialogue Circle & feedback – Graph and mathematic calculation in notebook/ journal

Counselors: Inform about LFP and its significance. Create a guided handy PPT using 1 or 2 slides to provide scientific principles (gravity, math, acceleration, friction, inclination potential & kinetic energy), engineering concepts, and learning.



(images for reference)

Materials:

- Cardboard (3mm)
- Corrugated Plastic Coroplast Sheet Board (4mm; 18" x 24" size)
- Wood skewers for Axles
- Iron rod for Axles
- Straws
- Paper cutters
- Cardboard Scissors
- Wire cutters
- Hot glue gun
- Hot Glue sticks
- Ruler/ Measurement tape
- Craft materials
- Ramp (can use a simple cardboard/ Corrugated Plastic Coroplast Sheet Board)

- Describe the essential elements /materials of prototypes.
- Basic Car Model & Experiment 1: Groups will build a basic car without a solar panel and ramp. Campers will get 30 minutes to build a Car for LFP.
- Guided a car building and assisted the campers when they needed to.
- Discuss & measure its speed with and without weight and angle/height changes in ramps.
- They build their own ramps from a long roll of corrugated cardboard. It is interesting to see them experimenting differently, but the cars often slid off the edge.
- Try multiple iterations of their cars to find the best combination to get theirs to go faster or travel further.
- Variables are Height and Weight. Look at Table 1 for more details:

Table 1

Height	H1 (14.3 cm)	H2 (22.6 cm)
Weight	W1 (0= car weight)	W2 (6 wooden blocks= 120gm)

  - What will happen if we put extra weight, i.e., 20/30/40 grams?
  - Are there any changes in the speed of the car?
  - What will happen if the car runs in a downward direction on the ramp?
  - Are there any changes in time for distance cover?
  - What will happen if we change the ramp's angle, i.e., 30°/40°/60°

- What if we increase the height?
- What if we increase the weight?
- Are there any changes in the speed of the car?
- Are there any changes in time for distance cover?
- What is potential energy and kinetic energy here?
- Ask campers to calculate the average speed using different variables (see Table A, B, C, D) and draw a graph (graph 1) in their notebook/journal **, including sketches, illustrations, keywords, written descriptions, and labeling.

- Campers will get 30 minutes for calculation, dialogue circle, and feedback.
- Ensure campers take pictures of each activity in their notebook/journal to import into an online portfolio.
- Wrap up the experiment by informing what happens if we add solar panels to this car.

Table A when H = H1 (14.3 cm), W = W1

Iteration	Distance (Inch)	Time (Sec.)
1	58.1”	2.56
2	57.61”	2.53
3	56.9”	2.36
Total	172.6/3	7.45/3
Average	57.5 (1.46 meter)	2.4
=Speed1 (D/T) 1.46/2.4 = 0.61 meter/sec.		

Table B when H = H1 (14.3 cm), W = W2

Iteration	Distance (Inch)	Time (Sec.)
1	57.2”	2.20
2	57.2”	2.20
3	58.8”	2.11
Total	173.2/3	6.51/3
Average	57.7 (1.46 meter)	2.17
=Speed2 (D/T) 57.7/2.17 = 26.6In/sec = 0.68 meter/sec.		

Table C when H = H2 (22.6 cm), W = W1

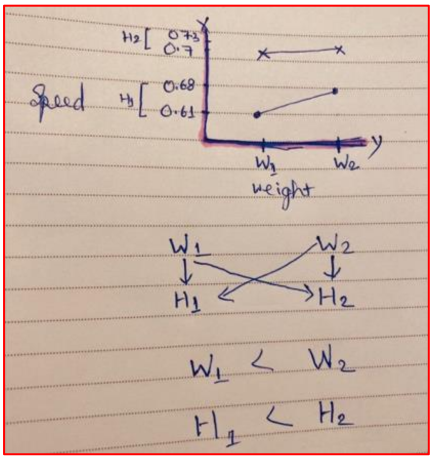
Iteration	Distance (Inch)	Time (Sec.)
1	79”	2.91
2	76”	2.81
3	81”	2.83
Total	236/3	8.55/3
Average	78.7 (2.0 meter)	2.85
=Speed3 (D/T) 78.7/2.85 = 27.6 In/sec = 0.7 meter/sec.		

Table D when H = H2 (22.6 cm), W = W2

Iteration	Distance (Inch)	Time (Sec.)
1	80”	2.86
2	81.5”	2.81

3	81.5”	2.63
Total	243/3	8.55/3
Average	81	2.8
=Speed4 (D/T) 81/2.8 = 28.9 In/sec = 0.73 meter/sec.		

Graph 1



Counselors: Connect prototyping to the project with guided questions. Counselors will help campers understand scientific principles in brief, i.e., gravity force, potential and kinetic energy, acceleration, deceleration, incline, and friction. Introduce the multimeter to measure current and voltage. Counselors can ask guided questions, i.e.,

- What forces are involved in making your car move?
- How does friction affect the movement of your car's wheels?
- Besides the force from the motor, what other forces act on your car while it's moving?
- Can you explain how momentum changes when your car accelerates, decelerates, or changes direction
- What role do inclined planes play in the design of your car?
- What strategies did you use to overcome the challenge of driving your car uphill?
- How do your car's chassis and suspension design help maintain stability when driving on uneven terrain?
- How is your car's potential energy converted into kinetic energy when it moves?
- Can you describe how your car's motor converts electrical energy into mechanical energy to drive the wheels?

Campers would reflect on their team’s low-fidelity digital prototype and the scientific principles, math, and engineering concepts. Receive feedback from other groups and counselors in the dialogue circle. Counselors will answer questions and provide advice to improve their model to understand modeling design.

Campers will do mathematical calculations, measure the average speed, distance, and time, and graph design in their notebooks/journals and pencils.

Online Portfolio: Introduction to Wix.com/Google Sites/Prezi (30min)

Purpose: to encourage campers to collaborate and understand the necessity of online artifacts /portfolios

Engineering Practices: Communicate effectively

Counselors: will advise students during this portion of the project. Online portfolios from previous campers will be shown during this time to provide current campers with an idea of the details of their portfolio. Ensure that each group has done an online portfolio including the description, inserting captured pictures, sketching, measurements, labeling, dimensions, if any, etc., day-wise, including *I see, I notice, and I like it*.

Materials:

- Laptop/computer

Campers: Each group of 4-5 campers will work on developing their wix.com, Google Sites, and Prezi Online portfolio. Capture pictures and write captions to include in their website throughout the day to include in their online portfolio.

- Free Website Builder | Create a Free Website | Wix.com
- Presentations and videos with engaging visuals for hybrid teams | Prezi
- https://sites.google.com
- Camper Teams and Counselors Clean-Up.

Note for Counselors: Collect Journals

- All counselors should collect camper journals on Tuesdays/Thursdays of each week. Counselors should use post-its/sticky notes to ask campers questions in the notebooks.
- Counselors should provide specific feedback in journals/notebooks to campers**
  - Give feedback on graphs, using keywords, etc.
  - Ask campers to label, scale, draw arrows, etc.

Camper Teams and Counselors Clean-up & Transportation/Bus/Parent Pick-up for Campers

Tuesday - Day 2 – 3D Digital Modeling/Prototyping/Physical Design

Specific Actions:

- Emphasize the need for clear annotations and labels on their drawings, including dimensions, part names, and other relevant information to enhance understanding.
- Encourage campers to practice drawing straight lines, curves, and other shapes neatly and accurately, as these skills are fundamental to mechanical drawing.
- Guide students through an iterative design process, where they sketch, receive feedback, and revise their drawings to improve accuracy and detail.
- Tailored to progress from an instant challenge vehicle, a cardboard car, to a low-fidelity prototype car and a solar-powered car.
- Facilitate discussion on the relationship between ramp height, potential energy, distance traveled, time taken, speed, and acceleration, and encourage campers to reflect on what they've learned.
- Campers will gain a deeper understanding of energy conversion, motion, and the fundamental principles of physics, engaging in hands-on experimentation with the cardboard car on inclined ramps.
- Guide campers through the assembly process using various components, such as small motors, solar panels, and solar battery gear wheels, demonstrating how to integrate solar panels to power the car's motor.
- Introduce campers to renewable energy sources, specifically solar energy, and how solar panels convert sunlight into electricity.

- Introduce campers to grasp fundamental programming concepts such as variables, loops, conditionals, and functions.
- Foster problem-solving abilities through coding challenges.

Ice Breaker: Think Creatively! (9:00 AM; 15min)
Purpose: to get campers to start thinking creatively

- Campers will sit in a circle and take turns saying creative uses for a standard water bottle (or another familiar object).
- It could be made competitive by having a time limit and an elimination-style circle. If someone doesn't say a creative use within 6 seconds, they're out, and the next person tries until there is one winner. Multiple rounds with different objects.

Instant Challenge: Think Out of the Box! (15 min)
Purpose: to get campers to think about the 2D and 3D aspects of the project

Engineering Practices: Communicate effectively
Think Pair and Share
Build a box: Use materials to build a box. The box can be used to hold flat objects. Questions to engage campers: Think of your box as if you were modeling the outside frame of your solar car. Here are some guided questions:

  - What was challenging about this activity?
  - How does this relate to working with your team members?
  - How does the size of the box relate to the size of the objects it will hold?
  - How does building this box help you understand the transition from 2D to 3D structures?
  - Imagine your box is the frame of your solar car. How might your box's dimensions and structure relate to your car's design?
  - How important is it for the frame of the solar car to be sturdy and well-built? How does this relate to the sturdiness of your box?

Materials:

  - Card stock
  - Cardboard
  - Scissors
  - Hot glue gun or tape
  - paper
  - pen/pencil

Collaborative and Sketching Prototype- Group (30 min)
Engineering Practices: Persist through and learn from failure; Consider problems in the context; Communicate effectively; Work effectively in teams; Construct, and use models and prototypes
Counselors: will help to make a group of 4-5 campers and work as a team to sketch vehicles they want to build. Ensure labeling, keywords, illustrations, and descriptions are mentioned in their sketching. Counselors must provide suggestions and feedback during the activity to each group.

Materials:

  - Pen/Pencil
  - Sketch

- 5M large Post-its (poster)
- Markers
- Ruler
- Compass
- Notebook/Journal

Campers: will discuss their individual sketches and decide as a team how they will collaborate and incorporate specific design features from each person's sketch. Campers will debrief and explain why they incorporated the various designs into the team sketch. Remind them to think through the design features thoroughly.

Discuss each group sketching and reflection of groups.

Campers will sketch the [front, top, and side views](), label the different parts, keywords, illustrations, and descriptions, and brainstorm with teammates. Each team will sketch the proposed model, including labeling, keywords, measurements and dimensions, illustrations, and brief descriptions.

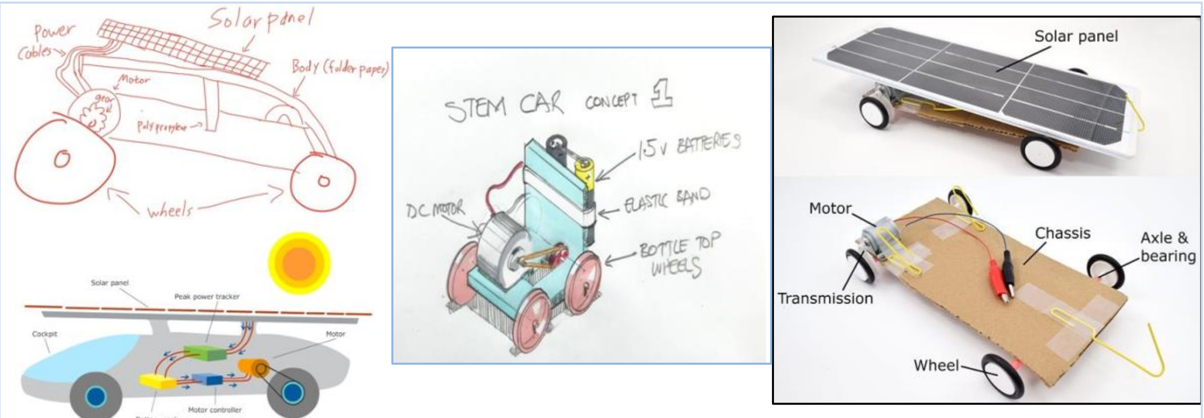


Fig 2: Examples of Front/Side/top View of Vehicle

Digital Prototype: Introduction to Tinker CAD (30 min)

Purpose: to introduce TinkerCAD.com and its use in 3D modeling to design a car.

Engineering Practices: Communicate effectively

Think Pair and Share

Counselors: will show a path to navigate the Tinkercad.

TinkerCAD Tutorials: https://www.tinkercad.com/learn/project-gallery;collectionId=OPC41AJJKIKDWDV

Guide campers in connecting the 2D sketches to their respective 3D shapes. Discuss how the sketches connect to the 3D digital model. Create some 3D shapes and design their Car model on TinkerCAD.

Materials:

- Laptop/computer

Campers: Campers will independently work on their prototypes to improve them based on the feedback received from peers and counselors.

Campers will go through the tutorials on TinkerCAD.com to familiarize themselves with the program and go through 3D. (https://www.tinkercad.com/learn/circuits?collectionId=O0K87SQL1W5N4P2)
Place it, View it, Move it, Rotate it, Size it up, Group it, Copy it, Duplicate it.
Campers will share their progress with the whole group.

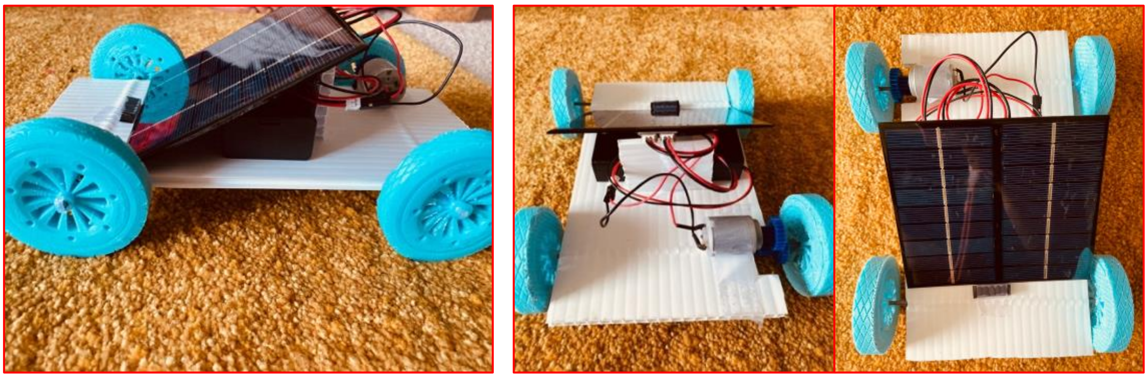
Continuing Low-Fidelity Prototype (LFP) (45 min): Build a Car using solar as prompts
Purpose: to introduce the essential components of the engineering design process and prototyping and to recall and understand the scientific principles. To help campers test materials before beginning their final project prototype.

Engineering Practices: Work effectively in teams; consider problems in contexts; Apply Science and math knowledge to problem-solving; Use System Thinking; Persist through and learn from failure

LFP: Basic Design model + Solar panel & Experiment 2 – Showcase & Reflection – Dialogue Circle & feedback – Graph and mathematic calculation in notebook/ journal

Materials:

- Solar panel 6V
- Motor
- Solar battery (1)
- Battery holder (1)
- CN3065 Mini Solar Lipo Charger Board Battery Charge and wire
- Gear wheels
- Silicone Tubing
- LED light
- Wires
- Soldering Gun
- Soldering wax
- Soldering metal wire
- Scotch electrical tape
- Wire cutters
- Hot glue gun
- Hot Glue sticks
- Ruler/ Measurement tape
- Pencil or Pen
- Notebook/journals
- Weights (e.g., wooden blocks)
- Mobile Stopwatch
- Multimeter



(images for reference)

- Solar Car Model and Experiment 2: Add solar panels as prompts.
- Test the LED light: Attach the LED light to test the solar panel.
- For Camp Counselors' reference: https://www.youtube.com/watch?v=Io05Tq7QZgA&ab_channel=CreativeChannel
- Discuss & measure its speed with and without weight and angle changes in ramps.
- Variables are Angles and Weight

Height	H1 (14.3 cm)	H2 (22.6 cm)
Weight	W1 (0= car weight)	W2 (6 wooden blocks= 120gm)

- What will happen if the car runs in an uphill direction on the ramp?
- How acceleration and deacceleration is associated here?
- How does friction affect the movement of your car's wheels?
- Can you explain how momentum changes when your car accelerates and decelerates?
- How do your car's chassis and suspension design help maintain stability when driving on uneven terrain?
- How long will it take for the solar panel to charge the battery?
- Ask campers to do mathematical calculations and draw a graph in their notebook/journal ** including sketches, keywords, labeling, and written descriptions.
- Ensure campers take pictures of each activity in their notebook/journal to import into an online portfolio.
- Ensure the time limit for each activity and be flexible in rolling in other activities.

Counselors: Introduce the multimeter to measure current and voltage. Counselors can ask guided questions, i.e.,

- How long will it take for the solar panel to charge the battery?
- What will be solar power if I want to charge the same battery and battery volt in 5 hours?

Charge Time =	Battery Capacity in Watt hours (Wh) ÷ Solar panel power in watt (W) Conversion formulas: • Watt hours (battery) = Amp hours (battery) × Volts (battery) • Milliamp hours = Amp hours × 1000 • i.e. 9.9*3.7/2= 18.31 hours • 9.9*3.7/X=5 hours?

Campers: will be able to work as a group of 4-5 campers to try out different materials for LFP and would reflect on their team's LFP, the scientific principles, math, and engineering concepts. Counselors will answer questions and provide advice to improve their model to understand modeling design.

Campers will do mathematical calculations, measure the average speed, distance, and time, and graph design and battery charging time in their notebooks/journals and pencils.

Speaker (45 min)

- SMU TRiO Program
    - Leah Granados, Program Manager, Educational Talent Search, Launch, Lift

Lunch (12:00-1:00 PM)

Journal Writing and Reflection (30 min)

Purpose: to provide campers with background information about the purpose of the notebooks/journals throughout the camp period, share progress, and receive constructive feedback from peers and counselors.

Engineering Practice: Communicate effectively

Counselors ensure each camper writes whatever they have done today in their journal daily, including activities, sketches, descriptions, labeling, math, science, and engineering with dates and timing.

- Every day, they must mention that campers must have captured pictures (via cellphone or personal camera) of various activities and insert them in their online portfolios.
- Counselors should use post-its/sticky notes to ask campers questions in the notebooks.
- Counselors should provide specific feedback in journals/notebooks to campers**
- Give feedback on graphs, using keywords, etc.
- Ask campers to label, scale, draw arrows, etc.

Campers will write what they have done all day, including sketches, descriptions, labeling, math, and engineering concepts.

- The campers will have a gallery walk to the other prototypes and give and receive feedback:
    - Who (if anyone) helped you today?
    - What activity did you enjoy most today? (other than lunch 😊)
    - What was the most challenging activity?

Introduction of Hands-on Experience with Python (60 min)

Purpose: offers engaging learning opportunities, fosters problem-solving skills, computational thinking, and creativity, and prepares them for future careers in technology and beyond.

Engineering Practice: Identify as Engineers

Think Pair and Share

Counselors should introduce campers to Python.

- Briefly explain what Python is and what its significance is in today's world.
- Use the projector or PPT to display slides or examples explaining basic programming concepts such as variables, data types, and loops. Below is an example; however, counselors have a free hand to provide other examples.
- Variables: can assign a value to a variable using the assignment operator "="; can consist of letters, numbers, and underscores but cannot start with a number
    - # Assigning values to variables

- x = 5
- y = "Hello"

- Data types define the nature of the data variables that can be held in Python.
- Common data types in Python include:
  - Numeric: Integers (int), floating-point numbers (float), and complex numbers (complex).
  - String: Sequence of characters enclosed in single (' ') or double (" ") quotes.
  - Boolean: True or False.
  - List: Ordered collection of items.
  - Tuple: Immutable ordered collection of items.
  - Dictionary: Unordered collection of key-value pairs.
  - Set: Unordered collection of unique items.

```
# Different data types
age = 18                # Integer
height = 5.9            # Float
name = "John"           # String
is_student = True       # Boolean
fruits = ['apple', 'banana', 'orange']  # List
```

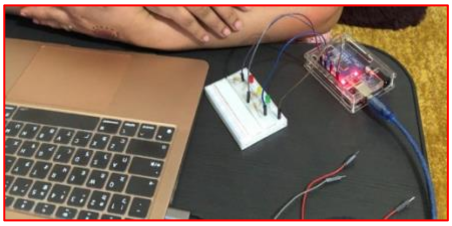
- Loops in Python allow you to execute a block of code repeatedly.
  - Two main types of loops in Python are:
  - For Loop: Executes a code block for each item in an iterable object (like a list, tuple, or string).
  - While Loop: Executes a block of code as long as a specified condition is actual.
  - Loop control statements like "break" and "continue" can alter the loops' flow.
  - Example of a for loop:

```
# Example of a for loop
fruits = ["apple", "banana", "orange"]
for fruit in fruits:
    print(fruit)
# Example of a while loop
num = 1
while num <= 5:
    print(num)
    num += 1
```

- Assign a simple coding task, such as printing "Hello, World!"
- Encourage campers to continue exploring Python programming on their own.
- Campers will actively work through Python modules with writing and code programming.
- The Python Code is in the Box folder
- https://forum.arduino.cc/t/traffic-light-code-beginner-level-coding/53399

Materials:

- Laptop
- Arduino Breadboard
- Uno R3 + USB Cable
- LED Light RYG
- Register
- Jumper Wires



Continue to Online Portfolio: Wix.com/Google Sites/Prezi (30min)

Purpose: to encourage campers to collaborate, understand the necessity of online artifacts/portfolios, and practice and gain hands-on experience in digital prototyping.

Engineering Practice: Communicate effectively

Counselors: Ensure that each group has done an online portfolio including the description, inserting captured pictures, sketching, measurements, labeling, dimensions, if any, etc., day-wise, including *I see, I notice, and I like it.*

Campers: Each group of 4-5 campers will work on developing their wix.com, Google Sites, and Prezi Online portfolio. Capture pictures and write captions to include in their website throughout the day to include in their online portfolio.

- Free Website Builder | Create a Free Website | Wix.com
- Presentations and videos with engaging visuals for hybrid teams | Prezi
- https://sites.google.com

Camper Teams and Counselors Clean-up & Transportation/Bus/Parent Pick-up for Campers

WEDNESDAY - DAY 3 –FINAL MODEL/HIGH-FIDELITY PROTOTYPING

Specific Actions:

- Introduce campers to IoT components like microcontrollers and Arduino and explain how they can be applied to enhance the functionality of their solar-powered cars.
- Guide campers through the process of integrating IoT components in High-fidelity prototyping.
- Guide campers in programming the microcontrollers to collect from ultra-sensors and make decisions based on that data.
- Encourage campers to showcase their IoT-based solar-powered cars and demonstrate the added functionalities, such as how obstacle avoidance detectors decide to turn in the direction at the showcase event.
- Encourage campers to test their solar car in different conditions, i.e., different surfaces or inclined ramps.
- Emphasize the importance of iteration and improvement in engineering projects.
- Encourage creativity and problem-solving skills while learning about solar energy, IoT, and engineering.
- Foster a collaborative and supportive environment where campers can learn about each other's challenges and successes.

Ice Breaker: Pictionary! (9:00 AM; 15min)
Purpose: to get campers to start thinking creatively

Instant Challenge: Introducing Vectr.com or Inkscape.org to Create a chassis (15 min)
Purpose: To develop basic skills in vector graphic design and design a foundational vehicle or mechanical device chassis. This activity fosters creativity, problem-solving, and spatial visualization while promoting digital literacy through accessible software like Inkscape.

This challenge aims to enhance their understanding of design concepts like shape, symmetry, and proportion while familiarizing them with digital design software. Additionally, campers will practice effective communication and collaboration skills as they work together to bring their ideas to life.
Counselors: Based on what campers learned on Tuesday regarding creating a net using Inkscape or Vectr, create a Chassis via Inkscape. A web diagram is helpful when fabricating because it allows the sketch to be used as a file that can be transferred to a laser cutter or 3D printing.
Think Pair and Share
Campers: will create a web sketch using vectr.com or Inkscape. Each camper will sketch their own chassis and share it with other team members and counselors to get feedback.
Materials:

- Laptop/computer
- Vector or Inkscape
- Vectr - Free Online Vector Graphics Editor
- Draw Freely | Inkscape

Build the Digital Version of High-Fidelity Prototype (HFP) (30 mins)
Purpose: To progress from prototyping to digital modeling
Engineering Practices: Envision multiple solutions; Use system thinking; Innovate to design solutions

Counselors: will be answering questions and providing advice.

Campers: will design their model using TinkerCAD (https://www.tinkercad.com/learn/circuits?collectionId=O0K87SQL1W5N4P2): Place it, View it, Move it, Rotate it, Size it up, Group it, Copy it, Duplicate it.

- Campers will use the TinkerCAD Circuits page to practice *wiring components, adding components, and using digital-analog input.*
- Campers will share their progress within the group to share progress and receive constructive feedback from peers and counselors.
- Ensure campers have captured pictures (via cellphone or personal camera) of various activities and insert them in their online portfolios.

Begin building the High-Fidelity Prototype (HFP) (90 mins)

Purpose: To design and build a solar panel vehicle and to introduce the essential components of the engineering design process and prototyping, the principles of renewable energy, and hands-on problem-solving. Campers will engage in STEM learning that cultivates critical thinking, computational thinking, teamwork, and innovations.

Engineering Practices: Use a systematic, problem-solving process; Explore properties and uses of materials; Balance tradeoffs between criteria and constraints; Innovate to Design Solutions; Apply science and math knowledge to problem-solving; Make evidence-based decisions; Use System Thinking; Work effectively in teams

Counselors: will introduce the different materials to the campers for building a solar panel vehicle. Build a chassis, add wheels and axles, and make space for other electrical devices. Counselors will assist campers whenever they need any help. HFP will be done in Deason Innovation Gym (DIG), where campers will explore 3D printers, Vinyl cutters, Laser cutters, and other apparatus under the supervision and guidance of Camp counselors and DIG staff.

Materials:

- 9V Solar panel (2W) converting sunlight into energy
- L298N Dual H-Bridge Motor Driver (1) can handle 2DC motors
- Servo motor (1)
- 18650 Li-ion batteries (2)
- 18650 Li-ion battery holder/ storage case with switch (1)
- HC- SR04 Ultrasonic Sensor (1)
- Microcontroller/UNO Board R3
- Breadboard
- Wheels with DC motor (4)
- Jumper wires – Male to Male
- Jumper wires – Female to Male
- Jumper wires – Male to Female
- Corrugated Plastic Coroplast Sheet Board (4mm; 18" x 24" size)
- Paper cutters
- Wire cutters
- Cardboard Scissors
- Computer/Laptop
- Soldering Gun
- Soldering wax
- Soldering metal wire
- Scotch electrical tape
- Hot glue gun
- Hot Glue sticks
- Ruler/ Measurement tape

- Pencil or Pen
- Notebook/journals
- Mobile Stopwatch
- Multimeter

Campers: have the opportunity to think differently and design and build the vehicle. Groups containing 4-5 campers are advised to review the materials thoroughly, and based on Sketching prototyping and LFP, the groups will build a high-fidelity prototype.

Need all of the sketch dimensions and the measurements of the low-fidelity. Campers begin building the initial design model, and the use of the materials should also be related to a budget. They should propose an approx. budget cost for designing their model in their journals. Campers will work on designing and building chassis, adding wheels, servo motor, Uno board, breadboard, wiring, and coding.

Note: Remind them to write every single detail in their notebooks/ journals and use them on the final presentation and demonstration day. Campers should consider:

- How is your new design innovative/unique?
- How did you use your previous learning to inform your last design?
- Why is this your high-fidelity prototype?

Lunch (12:00-1:00 PM)

Journal Writing and Reflection (30 min)

Purpose: to provide campers with background information about the purpose of the notebooks/journals throughout the camp period, share progress, and receive constructive feedback from peers and counselors.
Engineering Practice: Communicate effectively
Counselors ensure each camper writes whatever they have done today in their journal daily, including activities, sketches, descriptions, labeling, math, science, and engineering with dates and timing.

- Every day, they must mention that campers must have captured pictures (via cellphone or personal camera) of various activities and insert them in their online portfolios.
- Counselors should use post-its/sticky notes to ask campers questions in the notebooks.
- Counselors should provide specific feedback in journals/notebooks to campers**
- Give feedback on graphs, using keywords, etc.
- Ask campers to label, scale, draw arrows, etc.

Campers will write what they have done all day, including sketches, descriptions, labeling, math, and engineering concepts.

- The campers will have a gallery walk to the other prototypes and give and receive feedback:
  - Who (if anyone) helped you today?
  - What activity did you enjoy most today? (other than lunch 😊)
  - What was the most challenging activity?

Continue to High-Fidelity Prototype (wiring) (60 min)

Purpose: To cultivate critical thinking, computational thinking, teamwork, and innovations.

Engineering Practices: Use a systematic, problem-solving process; Explore properties and uses of materials; Balance tradeoffs between criteria and constraints; Innovate to Design Solutions; Apply science and math knowledge to problem-solving; Make evidence-based decisions; Use System Thinking; Work effectively in teams

Counselors will provide advice and help them build and wire the R3 microcontroller, breadboard, and other wiring stuff for the car.

Campers: each group will continue to work on completing and testing the car building in HFP. Each group will work to solve the problems they identify. Each group will share with counselors to get feedback.

Continue to Online Portfolio: Wix.com/Google Sites/Prezi (30min)
Purpose: to encourage campers to collaborate, understand the necessity of online artifacts/portfolios, and practice and gain hands-on experience in digital prototyping.
Engineering Practice: Communicate effectively
Counselors: Ensure that each group has done an online portfolio including the description, inserting captured pictures, sketching, measurements, labeling, dimensions, if any, etc., day-wise, including *I see, I notice, and I like it.*

Campers: Each group of 4-5 campers will work on developing their wix.com, Google Sites, and Prezi Online portfolio. Capture pictures and write captions to include in their website throughout the day to include in their online portfolio.

- Free Website Builder | Create a Free Website | Wix.com
- Presentations and videos with engaging visuals for hybrid teams | Prezi
- https://sites.google.com

Camper Teams and Counselors Clean-up & Transportation/Bus/Parent Pick Up for Campers

THURSDAY (DAY 4) – HIGH-FIDELITY PROTOTYPING / CODING/TESTING

Specific Actions:

- Introduce the basic Machine Learning (ML) concept, hands-on experiences focusing on image, pose, and voice recognition using a Teachable Machine.
- Provide students with a basic understanding of how ML algorithms can be trained to recognize patterns in data, leading to applications such as image, pose, and voice recognition.
- Campers will learn about the principles of engineering, renewable energy, and IoT and gain hands-on experience in designing, building, and testing their own vehicles.
- Encourage campers to identify any issues or bugs encountered during testing and brainstorm, troubleshoot, and address challenges in their solar car.
- Promote teamwork, collaboration, and healthy competitions for a mini-race.

Ice Breaker: Trading Cards (9:00 am; 15min)
Purpose: a fun activity to get to know each other
Campers: are given a notecard or sticky notes to write within this activity. Each camper will draw a personal card about themselves. It should include a) Name, b) Hobbies/ Interests (drawn), c) Goals, d) Skills/Fun Facts (probably written), and e) whatever else they want to share.
Counselors: collect the cards and redistribute them randomly to the campers so nobody has their own card. Each camper should read their card and ask the owner questions. The moderator facilitates discussion as well.
Materials:

- Notecards or Sticky Notes
- Pen/ Pencils/ Markers/Sketches

Introduction of Machine Learning: Using Teachable Machine– Image/Pose/Voice Recognition (60 min)
Purpose: To introduce the basics of machine learning in a hands-on and accessible way and help them with the rudimentary knowledge of comprehending AI technology and how algorithms learn data to make predictions. To engage in the design process, problem-solving, and ethical considerations, i.e., training data, privacy concerns, and societal impact.
Engineering Practices: Identify as engineers
Think Pair and Share
Counselors will introduce a brief introduction to machine learning by asking the campers questions (https://youtu.be/T2qQGqZxkD0?si=sdcq5zFz7vkIkaLx).
Need to login the page and explore it. Ensure campers are involved in exploring and enjoying the image/ pose/ voice recognition activity. Counselors must prepare one or two slides on machine learning: a) data collection, b) feature extraction, c) training the model, d) testing validation, e) prediction, and f) feedback loop with guided questions for brainstorming, i.e.,

- What do you think machine learning is, and how do you think it works?
- Can you give examples of how machine learning is used in everyday life?
- Can we train a computer to recognize different gestures or sounds?
- What examples do you think we should use to teach the computer?

Materials:

- Notebook/journals
- Pen/Pencil/Markers
- Laptops

- https://teachablemachine.withgoogle.com/train
- https://teachablemachine.withgoogle.com/train/image
- https://teachablemachine.withgoogle.com/train/pose
- https://teachablemachine.withgoogle.com/train/audio

Campers will explore the Google Experiment Teachable Machine, starting with image recognition and pose/voice recognition. Campers can use any prompt (bottle, soft toys, etc.) or their faces for face recognition and can create background noise. Campers will reflect on the activity in their journals.

Reflection & Discussion (15 min)

Counselors will ask some reflection questions, i.e.,

- What are some ethical considerations we need to keep in mind when using a Teachable Machine?
- How can we ensure fairness and avoid biases in the data we use to train the computer model?
- How could learning about machine learning be helpful in the future?
- What did you learn from using a Teachable Machine?

Campers will share and discuss with counselors to get feedback. Campers will reflect using *I see, I notice, and I like it* in their notebooks/journals.

Continue with HFP's wiring & Coding (90 min)

Purpose: Hands-on learning experiences with Arduino and wiring allow them to gain exposure to fundamental principles and practices of electrical engineering, computer science, mechanical engineering embedded systems, and robotics. (see pg. 31).

Engineering Practices: Identify as engineers

Counselors will guide and assist campers with Arduino (https://www.arduino.cc/), microcontrollers, and other wiring projects, answering questions and providing advice.

Campers: Explore ways to incorporate various functions of an Arduino microcontroller into the final prototype. Campers will have the opportunity to work independently to explore the Arduino platform further.

Wiring: Connect the wires from the servos and joystick as shown.

Coding:

Lunch (12:00-1:00 PM)

Journal Writing and Reflecting (30 min)

Purpose: to provide campers with background information about the purpose of the notebooks/journals throughout the camp period, share progress, and receive constructive feedback from peers and counselors.

Counselors ensure each camper writes in a journal daily, including activities, sketches, descriptions, labeling, math, science, and engineering concepts with dates and timing.

- Every day, they must mention that campers must have captured pictures (via cellphone or personal camera) of various activities and insert them in their online portfolios.
- Counselors should use post-its/sticky notes to ask campers questions in the notebooks.
- Counselors should provide specific feedback in journals/notebooks to campers**
- Give feedback on graphs, using keywords, etc.
- Ask campers to label, scale, draw arrows, etc.

Campers will write what they have done all day, including sketches, descriptions, labeling, math, and engineering concepts.

- The campers will have a gallery walk to the other prototypes and give and receive feedback:
  - Who (if anyone) helped you today?
  - What activity did you enjoy most today? (other than lunch 😊)
  - What was the most challenging activity?

Testing, Bugging, Racing, and calculation (60 min)

Counselors: Campers will enjoy the solar car racing and learn whose car is quickly moving forward, backward, or in another direction.

Materials:

- Notebook/journals
- Pen/Pencil/Markers
- Measuring Tape
- Stopwatch

Testing:

Each group will test their solar car. Fix a place as a testing station. Instruct campers to test their solar cars and record observations about their performance under different conditions. Guide them if campers need any assistance.

It's time to test/race the car in

- Surface: rough terrain, wooden or smooth pavement
- Programming: how to change the speed
- Obstacles design: Create a path including obstacles, i.e., books, cardboard, toys, boxes, etc. Challenge them to navigate the robot through the course using the obstacle avoidance algorithm they've implemented.
- Fine-Tuning Sensors: Task campers with experimenting to optimize the performance of the ultrasonic sensor. They can adjust parameters such as the detection range and angle to improve obstacle detection accuracy.
- Real-World Applications: Discuss real-world applications of robotics and challenge kids to brainstorm and develop solutions to specific problems in their community or environment using their robot.

Bug Identification: Discuss any issues or "bugs" students encountered during testing. Allow them a few minutes to make any adjustments or improvements to their cars based on the testing data and bug identification.

Calculation:

- How long will it take for the solar panel to charge the battery?

Charge Time =	Battery Capacity in Watt hours (Wh) ÷ Solar panel power in watt (W) Conversion formulas: • Watt hours (battery) = Amp hours (battery) × Volts (battery) • Milliamp hours = Amp hours × 1000 • i.e. 9.9*3.7+3.7/2= hours

Counselors: Introduce the multimeter to measure current and voltage.

Solar Car Race (10 minutes):

- Line up the solar cars at the starting line.
- Start the race and have students cheer on their cars as they race to the finish line.
- Record the time it takes for each car to complete the race.

Wrap up & Reflection, Dialogue Circle & feedback (15min)

- First, congratulations to campers for completing the testing, bug identification, and racing activities.
- Lead a brief discussion on their learning from the testing and racing process.
- Please encourage students to think about how they can apply what they learned to improve their solar car designs in the future.

Counselors will ask guided questions, for example:

- How's your teamwork coordination?
- What were the challenges you faced? How did you overcome it?
- Did you enjoy the solar car activity?
- What if you made a chassis out of cardboard?
- Why did you choose a Corrugated Plastic Coroplast Sheet Board for chassis?
- What is the most important thing to consider when designing a car/ vehicle?
- What were the challenges during wiring the breadboard, R3, and other electrical parts? How did you overcome it?
- What were the challenges you faced during the coding? How did you overcome it?
- What if sunlight is not here, and it's rainy and cloudy?
- What is a Radio Control (RC) car?
- How is solar energy converted into electrical energy?
- What's your takeaway or lesson learned from the solar car activity?

Continue to Online Portfolio: Wix.com/Google Sites/Prezi (20min)

Purpose: to encourage campers to collaborate, understand the necessity of online artifacts/portfolios, practice and gain hands-on experience in digital prototyping, and share progress.
Counselors: Ensure each group has done an online portfolio including the description, inserting captured pictures of low/high/digital prototyping, sketching, measurements, labeling, dimensions, if any, etc., day-wise, including *I see, I notice, and I like it*.
Online portfolios from previous campers will be shown during this time to give current campers an idea of the details of their portfolios. Encourage campers to upload pictures of servo Arduino and Tinker CAD. Be sure to upload pictures/videos of HFP to an online portfolio.
Campers: Each group of 4-5 campers will work on developing their wix.com, Google Sites, and Prezi Online portfolio. Capture pictures and write captions to include in their website throughout the day to include in their online portfolio.

- Free Website Builder | Create a Free Website | Wix.com
- Presentations and videos with engaging visuals for hybrid teams | Prezi
- https://sites.google.com

Camper Teams and Counselors Clean-up & Transportation/Bus/Parent Pick-up for Campers

FRIDAY (DAY 5) – PRESENTATION DAY

Specific Actions:

- Provide an environment to enhance campers' presentation abilities and communication.
- Encourage campers to present their IoT-based robotic solar-powered cars confidently.
- Do highlights integrating functionalities of IoT components into their solar car projects.
- Have campers present their projects to their peers or parents. Encourage them to explain how their car works, the challenges they face, and the solutions they implement. This helps improve their communication and presentation skills.
- Create a platform where campers can feel proud of their achievements and share their excitement with peers, counselors, and parents.

Ice Breaker: Two Truths and a Lie! (9:00 am; 15min)
Purpose: a fun activity to get to know each other
**There will not be a formal instant challenge; campers are encouraged to finish their presentations.

Finish Portfolios and Practice Presentations: (60 min)
Campers will have the opportunity to finish online portfolios and practice for group presentations.

Journal Writing and Reflection (30 min)

Purpose: to provide campers with background information about the purpose of the notebooks/journals throughout the camp period, share progress, and receive constructive feedback from peers and counselors.
Counselors ensure each camper writes in a journal daily, including activities, sketches, descriptions, labeling, math, science, and engineering concepts with dates and timing.

- They must mention that campers must have captured pictures (via cellphone or personal camera) of various activities and insert them in their online portfolios.
- This is the last chance to write and reflect in a journal.
- Counselors should use post-its/sticky notes to ask campers questions in the notebooks.
- Counselors should provide specific feedback in journals/notebooks to campers**
- Give feedback on graphs, using keywords, etc.
- Ask campers to label, scale, draw arrows, etc.

Campers will write what they have done all day, including sketches, descriptions, labeling, math, and engineering concepts. The campers will have a gallery walk to the other prototypes and give and receive feedback:

  - Who (if anyone) helped you today?
  - What activity did you enjoy most today? (other than lunch 😊)
  - What was the most challenging activity?

Counselors Collect Journals (15 mins)

- All counselors must collect camper journals from all campers on Friday.
- Counselors should collect name badges/lanyards from campers as well.
- Log out of all computers.
- Reorganize the crate with necessary materials and have campers help if required.
- Clean classroom (sweep floor, wipe off tables, etc.)

Research Survey-Post-Test (20 mins)

Administering by Divya (work in progress): A post-test is administered after the treatment to measure what experiences and first-hand knowledge campers have gained during a week-long summer camp. This can help to build a foundation for future learning.

Camp Photos/Post Activation Lab Survey (30 mins)

Campers: who have signed both Parent Consent and Youth Assent Forms will take the Activation Lab Survey in the computer lab.

Counselors: The Camp Coordinator will take group photos of counselors and campers. All counselors/campers are requested to wear SMU t-shirts.

Lunch (12:00 PM – 1:00 PM)

Counselors ensure all campers clean/clear tables before leaving lunch.

Final Presentations and Showcase Hour

Purpose: Hands-on learning experiences with Arduino and wiring allow them to gain exposure to fundamental principles and practices of electrical engineering, computer science, mechanical engineering embedded systems, and robotics.

Engineering Practices: Identify as engineers; Balance tradeoffs between criteria and constraints; Innovate to Design Solutions; Make evidence-based decisions

9th/10th graders (1:00-2:00 PM):

11th/12th graders (2:00 PM - 3:00 PM):

- Presentations: Each team/ group will present their digital portfolio and low/high prototype to peers, community members, Lyle faculty/staff, and parents (Zoom link provided)
- Parents will stay logged into Zoom to hear the presentations from the recruiting office following the camper presentations.

Transportation/Pick-Up (3:30 PM – 4:00 PM)

References:

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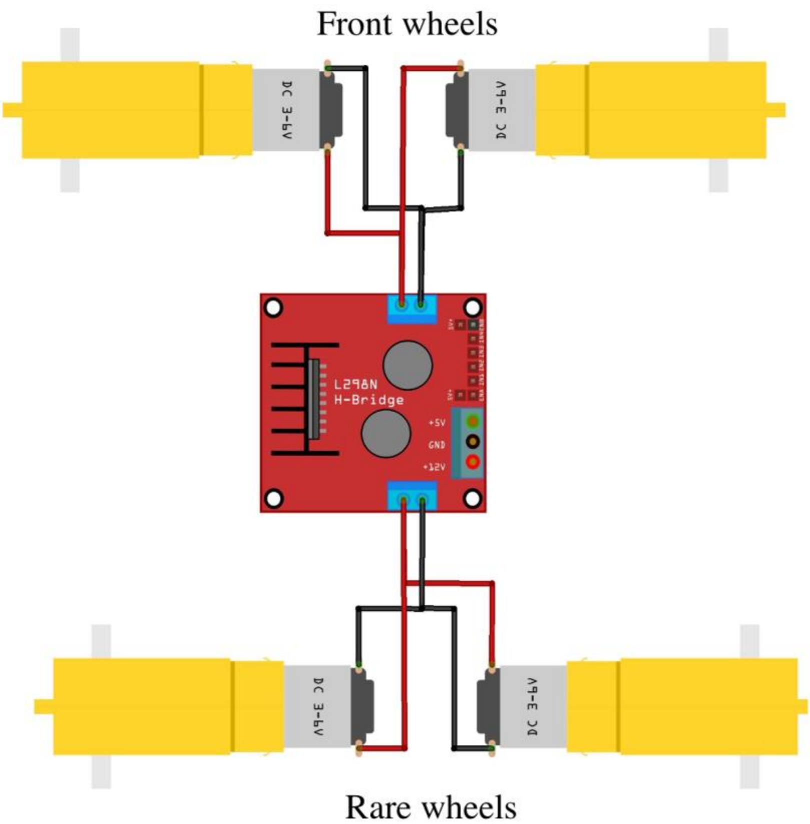
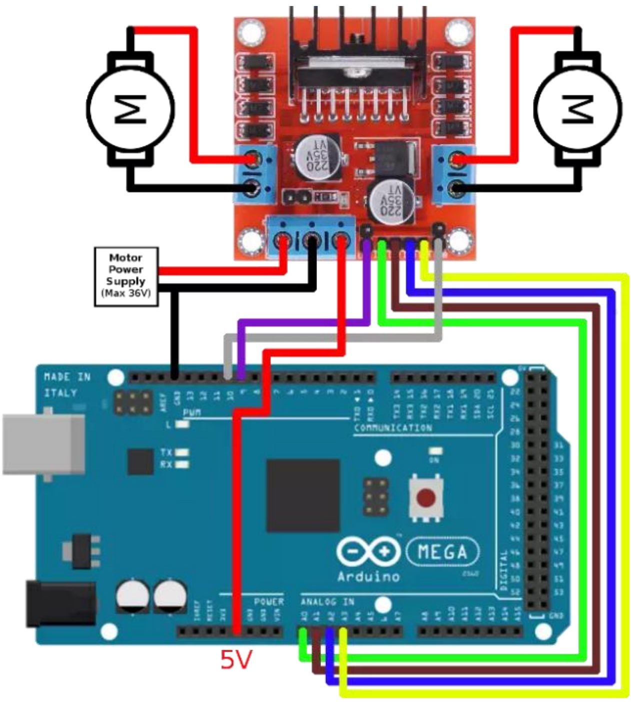
STEPS: Coding-wiring-programming-Solar Car

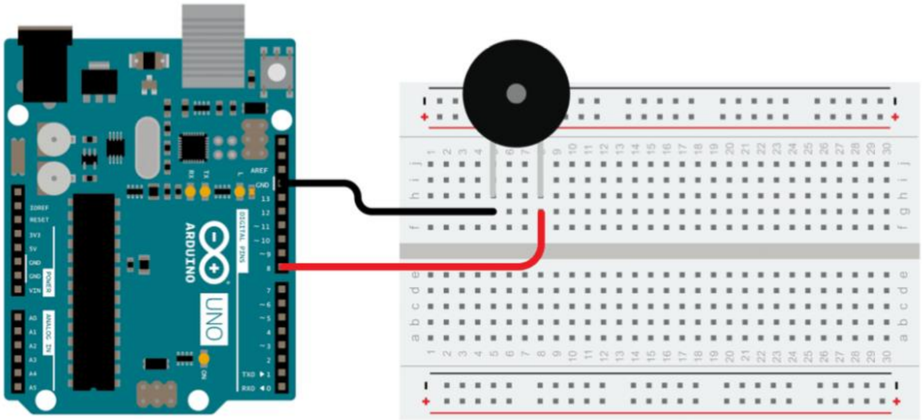
Step1: 4 DC motors to the L298N connections



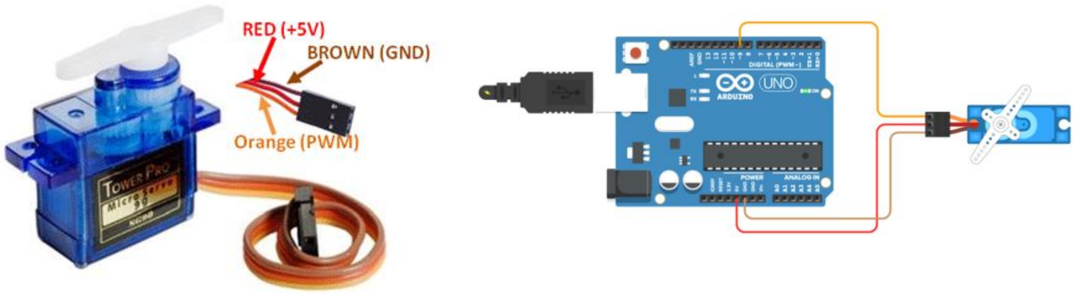
Step 2: L298N to Uno connections



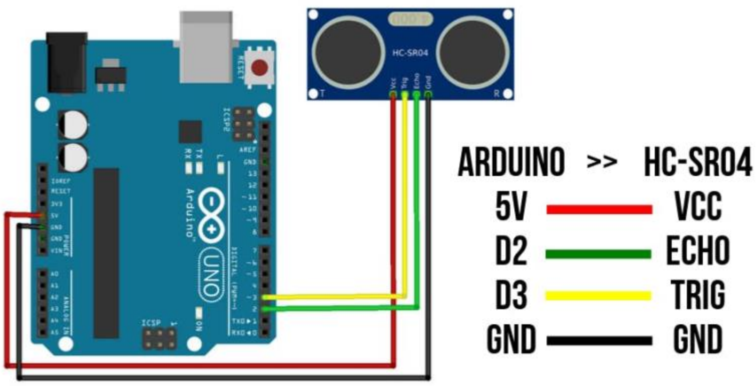
Step 3: Buzzer to Uno connection:



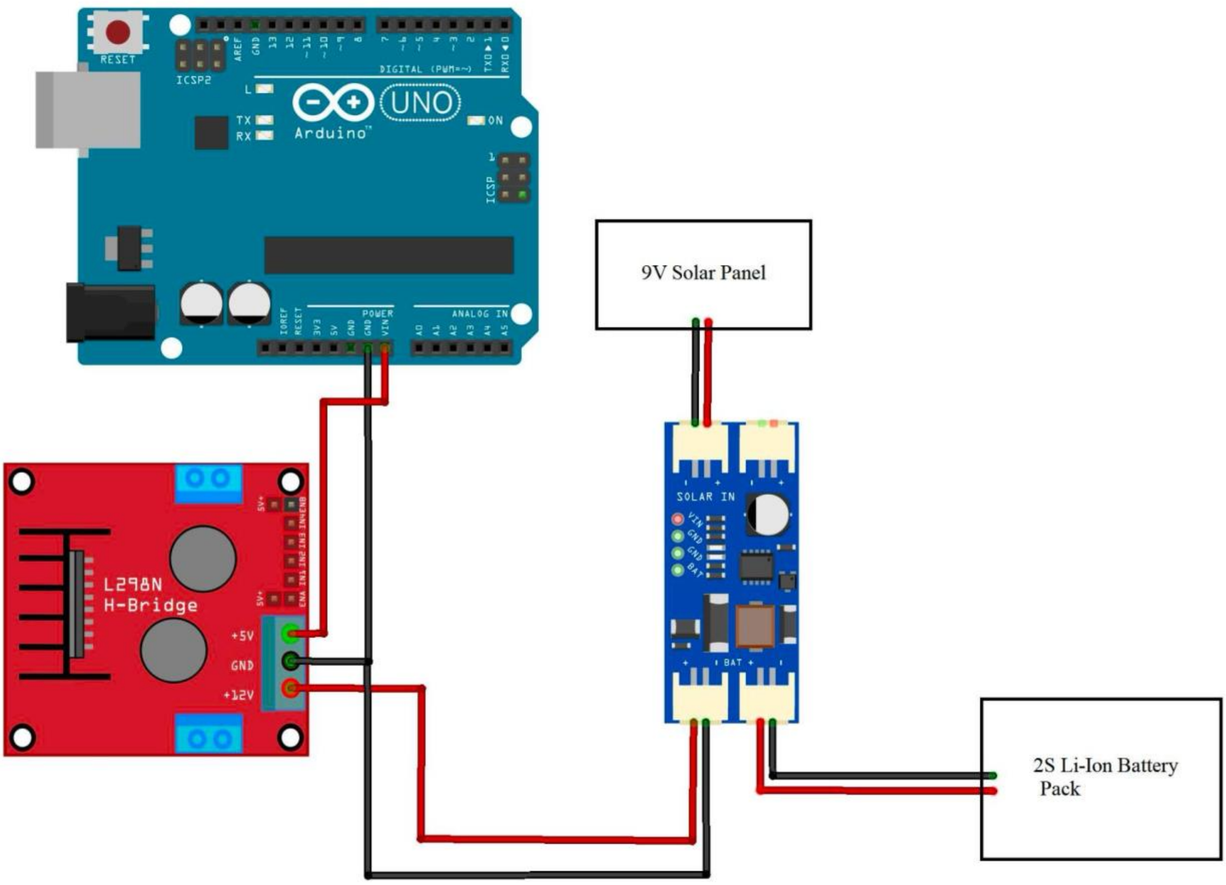
Step: 4 Servo motor to Uno connection



Step 5: Ultrasonic sensor connects:



Step 6: Solar panel, CN-3791 controller, Li-ion battery, and UNO power connection:



Steps to set the ultrasonic sensor facing forward:

1. Fix the ultrasonic sensor on the servo motor.
2. Connect the servo motor to Arduino Uno (e.g. pin 2)
3. Run bellow code:

```
#include <Servo.h> // Download the library

Servo head;

#define SERVO_PIN 2 //set the control pin of Arduino, which connects to the signal pin of the servo motor. e.g.,
pin 2


void setup() {

  // put your setup code here, to run once:

head.attach(SERVO_PIN);

head.write(60);

delay(1000);

head.write(120);

delay(1000);

head.write(90);

}
```

```
void loop() {
  // put your main code here, to run repeatedly:

}
```

4. Switch off the power and see if the ultrasonic sensor faces exactly forward.
5. If not, switch off the power and refix the ultrasonic sensor (facing forward) to the servo motor.
6. Run the code and see if the ultrasonic sensor faces forward; if not, then repeat steps 4 and 5.

Code for solar powered autonomous RC Car

```
#include <Servo.h> //including libraries of Servo motor
#include <NewPing.h> //including libraries of Ultrasonic sensor

#define MAX_DISTANCE 200

int ENA = 9; //pin of controlling speed---- ENA of motor driver board
int IN1 = 11; //pin of controlling turning---- IN1 of motor driver board
int IN2 = 6; //pin of controlling turning---- IN2 of motor driver board
int ENB = 10; //pin of controlling speed---- ENB of motor driver board
int IN3 = 5; //pin of controlling turning---- IN3 of motor driver board
int IN4 = 3; //pin of controlling turning---- IN4 of motor driver board

int trigPin = 7; // ultrasonic triger pin connect to 7
int echoPin = 8; // ultrasonic echo pin connect to 8
int buzzer = 4; // Buzzer pin connect to 4
volatile unsigned int distance = 0;

NewPing sonar(trigPin, echoPin, MAX_DISTANCE); //pin 7; pin 8
Servo myservo;

void setup()
{
pinMode(ENA, OUTPUT); //pin 9
pinMode(IN1, OUTPUT); //pin 11
pinMode(IN2, OUTPUT); //pin 6
pinMode(ENB, OUTPUT); //pin 10
```

```
pinMode(IN3, OUTPUT); //pin 5
pinMode(IN4, OUTPUT); //pin 3
pinMode(buzzer, OUTPUT); //pin 4

myservo.attach(2); //pin 2

Serial.begin(9600);
}

void loop() {
delay(10);
unsigned int uS = sonar.ping();
unsigned int distance = uS / US_ROUNDTRIP_CM;
Serial.print("Distance: ");
Serial.print(distance); //
Serial.println(" cm"); //

if (distance >= 1 && distance <= 20)
{
  digitalWrite(ENA, LOW); //
  digitalWrite(ENB, LOW);
  beepBuzzer(); //
  delay(1000);
  randomTurn();
  delay(500);
}
else
{
  digitalWrite(ENA, HIGH);
  digitalWrite(IN1, HIGH);
  digitalWrite(IN2, LOW);
  digitalWrite(ENB, HIGH);
  digitalWrite(IN3, HIGH);
  digitalWrite(IN4, LOW);
  rotateServo();
}
}

void rotateServo()
{
```

```
  static int pos = 60;
  static int dir = 1;
  myservo.write(pos);
  pos += dir;
  if (pos >= 120) dir = -1;
  else if (pos <= 60) dir = 1;
}

void randomTurn()
{
int direction = random(2);
if (direction == 0)
{
  digitalWrite(IN1, LOW);
  digitalWrite(IN2, HIGH);
  analogWrite(ENA, 0);
  digitalWrite(IN3, HIGH);
  digitalWrite(IN4, LOW);
  analogWrite(ENB, 0);
}
else {
  digitalWrite(IN1, HIGH);
  digitalWrite(IN2, LOW);
  analogWrite(ENA, 0);
  digitalWrite(IN3, LOW);
  digitalWrite(IN4, HIGH);
  analogWrite(ENB, 0);
}
delay(1000);
}

void beepBuzzer()
{
for (long i = 0; i < 1000 * 1000L; i += 1000)
{
  digitalWrite(buzzer, HIGH);
  delayMicroseconds(500);
  digitalWrite(buzzer, LOW);
  delayMicroseconds(500);
}
```

```
  digitalWrite(buzzer, LOW);
}
```

[Traffic light code (beginner level coding)](https://forum.arduino.cc/t/traffic-light-code-beginner-level-coding/53399)

(https://forum.arduino.cc/t/traffic-light-code-beginner-level-coding/53399)

```
// Traffic light code designed by Marquez Santos! (on facebook)
// Connect green LED to pin 13
// Connect yellow LED to pin 12
// Connect red LED to pin 11

void setup()  {
  // declare pin 11,12,13 to be outputs:
  pinMode(11, OUTPUT);
  pinMode(12, OUTPUT);
  pinMode(13, OUTPUT);
}

void loop(){{
   digitalWrite(13, HIGH); // Turns LED on pin 13 on
delay(2500); // LED on pin 13 remains on for 5 seconds
   digitalWrite(13, LOW); //  Turns LED on pin 13 off
delay(0);}
   digitalWrite(12, HIGH); // Turns LED on pin 12 on
delay(2500); // LED on pin 12 remains on for 5 seconds
   digitalWrite(12, LOW); //  Turns LED on pin 12 off
delay(0);
   digitalWrite(11, HIGH); // Turns LED on pin 11 on
delay(2500); // LED on pin 11 remains on for 5 seconds
   digitalWrite(11, LOW); //  Turns LED on pin 11 off
delay(0);
}
```

```
int rl =10; // initialize digital pin 10.

int yl =7; // initialize digital pin 7.

int gl =4; // initialize digital pin 4.

void setup()

{

pinMode(rl, OUTPUT);// set the pin with red LED as "output"

pinMode(yl, OUTPUT); // set the pin with yellow LED as "output"

pinMode(gl, OUTPUT); // set the pin with blue LED as "output"

}

void loop()

{
```

```
digitalWrite(gl, HIGH);//// turn on blue LED
delay(3000);// wait 2 seconds
digitalWrite(gl, LOW); // turn off blue LED
for(int i=0;i<10;i++)// blinks for 3 times
{
delay(500);// wait 0.5 second
digitalWrite(gl, HIGH);// turn on blue LED
delay(500);// wait 0.5 second
digitalWrite(gl, LOW);// turn off blue LED
}
digitalWrite(yl, HIGH);//// turn on blue LED
delay(3000);// wait 3 seconds
digitalWrite(yl, LOW); // turn off blue LED
digitalWrite(rl, HIGH);// turn on red LED
delay(3000);// wait 3 second
digitalWrite(rl, LOW);// turn off red LED
}
```