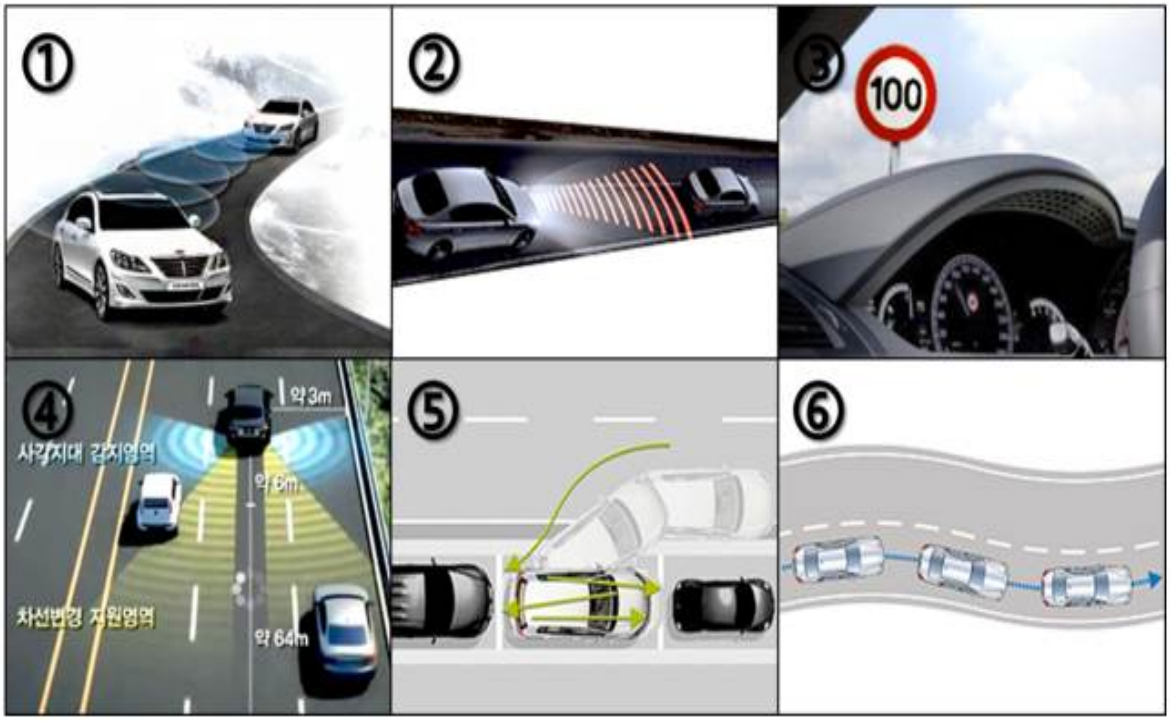
High School Division Final Round Assignment: Hands-on Activity	Building Autonomous Cars That Detect and Avoid Obstacles

1. Background

We see many car accidents captured by car black boxes nowadays. The footages show us that many of the accidents are caused by not keeping a safe distance, failing to see another vehicle hidden from view, and dozing off and getting into a wrong lane. To prevent these accidents, automakers have developed or are developing various cutting-edge systems that employ the technological advancements of the Fourth Industrial Revolution.



출처: 현대모비스 홈페이지

A. Smart Cruise Control (SCC): SCC uses a radar to detect vehicles in front and accelerates/deaccelerates the vehicle for the driver.

B. Autonomous Emergency Braking (AEB): This safety system uses a radar and a camera to predict and avoid collision with vehicles or pedestrians.

C. Traffic Sign Recognition (TSR): A TSR system has a front camera that recognizes speed limit signs and other related signs to provide the driver with the speed limit of

the current road.

D. Blind Spot Detection (BSD): This system ensures safe driving by detecting obstacles in the side and rear blind spots and alerting the driver.

E. Smart Parking Assist System (SPAS): This system helps drivers park their cars with more ease and convenience. A sensor mounted in the vehicle searches for a parking space, and the system calculates the optimal route for parking the car in the identified space. Then, it controls the steering wheel to park the car along the optimal route.

F. Lane Keeping Assist System (LKAS): When a driver unintentionally departs (or is about to depart) from a lane because of drowsiness, etc., this system controls the steering wheel to help the driver stay on the lane.

In particular, the collision-evading safety system in B is the core technology and basic component for commercializing autonomous cars in smart cities in the future.

If these technologies are standardized and implemented, autonomous cars will usher in the era of smart cities that provide a safe driving environment.

2. Hands-on Activities

Perform the following with the given materials:

A. Design and build an autonomous car.

B. The autonomous car should be able to move along the designated lines, avoid collision with vehicles and pedestrians (obstacles), and reach the destination accurately, safely, and fast.

C. Provide the details of the ideas, designs, and a standardization plan for the vehicle in the portfolio.

3. Rules

A. The vehicle must be based on ideas derived through an idea meeting among team members.

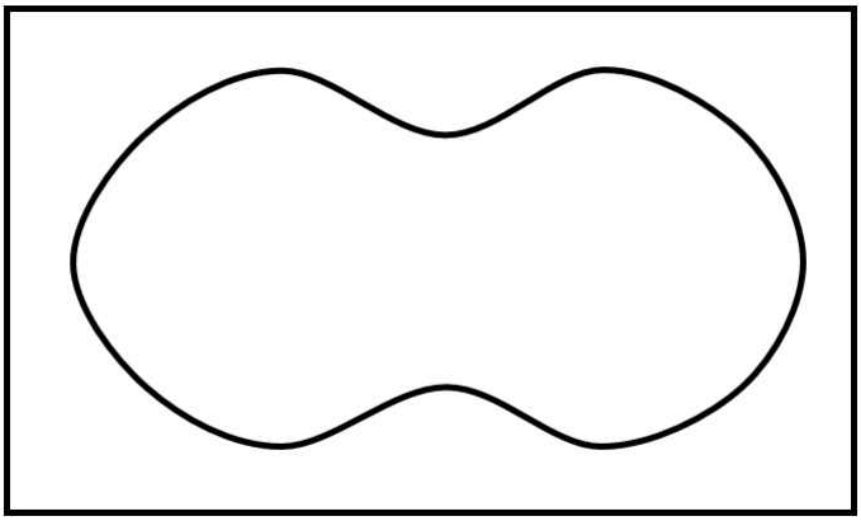
B. The shape, size, and detection/avoidance capabilities should be designed and implemented based on ideas selected by the team. (No restriction on the size of the autonomous vehicle)

4. Limitations

A. You are not allowed to use any materials and tools other than those provided to you.

B. You are not allowed to discuss ideas with people other than your team members.

C. The lines will be placed on a 1,200 mm × 2,000 mm space and are around 30 mm wide.



D. Two obstacles will be placed at random spots on the lines. Use the standard obstacles provided to you.

5. Materials and Tools

Category	Name	Specification	Quantity	Note
Materials	Woodrock	600 mm × 900 mm × 5 mm	3 sheets	
	DC motors	-	2	
	Breadboard	400 holes	1	
	Arduino board	Uno	1	
	Arduino USB cable	-	1	
	Motor driver shield	L298P	1	
	Infrared sensor for obstacle detection	-	2	
	Ultrasonic sensor	-	1	
	LED	Red, green, etc.	5 each	
	Battery holder	AA 1.5 V	1	
	Battery connector	9 V	1	
	Batteries	AA	4	
	Battery	9 V	1	
	Line tracer modules	-	2	
	Jumper cables	-	1 set	
	Insulation tape	Black	1	
	Scotch tape	12 mm × 15 M	1	
Tools	Glue gun, glue stick	For gluing	1 set	

	Driver	(-)	1	
	Rulers	Plastic, 30 cm	3	
	Scissors	All-purpose	3	
	Knives	All-purpose	3	
	Pencil, marker	Pencil: HB, Marker: Black	1 each	

● **Additional infrared sensors, ultrasonic sensors, and LEDs are provided upon request.**

6. Submissions

A. Submission 1: Autonomous car

B. Submission 2: Standardization plan for obstacle detection/avoidance

7. Evaluation Criteria

A. prototype Evaluation

1) Science and technology (function)

2) Creativity (originality)

3) Economic Efficiency

B. Portfolio Evaluation

1) Understanding of standards and Logic

2) Realization of standardization

3) Logic of operation principles

8. Evaluation Sheet

A. Evaluation of students' work

Category		Criteria		Pts
Item	Grade	Note	Score	
Science and Technology (Function) (30)	A	The robot moves along the designated lines, avoids collision with obstacles, and reaches the destination accurately, safely, and fast.	30	30
	B	The robot moves along the designated lines, avoids collision with obstacles, and reaches the destination.	25	
	C	The robot moves along the designated lines, but cannot avoid collision with obstacles.	20	
	D	The robot departs from the designated lines and cannot avoid collision with obstacles.	15	
	E	The car is not finished or does not move.	10	
Creativity (Originality) (20)	A	Each team member proposed various ideas, and the team chose the best original idea to complete the assignment.	20	20
	B	Each team member proposed various ideas, and the team chose the best idea to complete the assignment. However, the chosen idea lacks originality.	16	
	C	Each team member proposed various ideas, and the team chose the best idea to complete the assignment. However, the chosen idea lacks originality, and the finished work does not match the idea.	12	
	D	The team proposed only a single idea to complete the assignment.	8	
	E	The team failed to complete the assignment.	4	

Economic Efficiency (10)	A	The team used the provided materials efficiently, and the robot suffered no damage during operation.	10	10
	B	The team used the provided materials efficiently. The robot suffered damage on a single spot during operation.	8	
	C	The team used the provided materials efficiently. The robot suffered damage on more than one spot during operation.	6	
	D	The team used the provided materials efficiently, and the robot suffered damage during operation and requires replacement (repair).	4	
	E	The team failed to complete the assignment.	2	
Total				**60**

B. Evaluation of Portfolio

Category		Criteria		Pts
Item	Grade	Note	Score	
Understanding of Standards and Logic (20)	A	The team has a good understanding of the related standards, and applied highly logical standardization principles to the assignment.	20	20
	B	The team has a good understanding of the related standards, and applied logical standardization principles to the assignment.	18	
	C	The team somewhat needs improvement for understanding of the related standards or standardization principles applied to the assignment.	16	
	D	The team somewhat needs improvement for understanding of the related standards and standardization principles applied to the assignment.	14	
	E	The team failed to complete the relevant part of the portfolio.	12	
Realization of Standardization (10)	A	The team selected the parts (components or materials) of the prototype that are available for standardization and provided logical reasons for their selection.	10	10
	B	The team selected the parts (components or materials) of the prototype that are available for standardization. However, the reasons provided by the team need improvement.	8	
	C	The team selected the parts (components or materials) of the prototype that are available for standardization. However, the team failed to provide a reason for their selection.	6	

	D	The team failed to select the parts (components or materials) of the prototype that are available for standardization or provide any reason for it.	4	
	E	The team failed to complete the relevant part of the portfolio.	2	
Logic of Operating Principles (10)	A	The operating principles are explained in a reasonable and comprehensible manner.	10	**10**
	B	The operating principles are recorded, but the explanation needs improvement.	8	
	C	The operating principles are explained, but the explanation is difficult to understand in some parts.	6	
	D	The team failed to provide a complete explanation of the operating principles.	4	
	E	The team failed to complete the relevant part of the portfolio.	2	
Total				**40**

[Submission 2]

Standardization Plan for Obstacle Detection/Avoidance

※ **Standardize the obstacle detection/avoidance functions of your autonomous car by filling up the following forms**:

1. System Concept

1-1. Draw an overall concept for your idea for an autonomous car system.

System Concept

1-2. Based on the overall concept drawn in 1-1, provide the operating principles of each part.

No.	**Features and Principles**	Others
1		
2		
3		
4		
5		

1-3. What are the basic principles of the autonomous car?

1-4. What are the basic principles of obstacle detection/avoidance?

1-5. List various methods (ideas) to make the car detect and avoid obstacles faster.

No.	**Rough Ideas**
1	
2	
3	
4	
5	

1-6. Compare the pros and cons of each method (idea) to make the car detect and avoid obstacles faster, and choose the best idea.

No.	**Pros and Cons**	Others
1		
2		
3		
4		
5		

1-7. Why do you think the selected idea is the best?

2. Draw a sketch of the autonomous car.

2-1. (Before building the car) Draw a detailed sketch of your autonomous car design.

※The drawing must indicate the dimensions (mm). However, do not indicate the unit.

Provide the names of each part as needed. (You can change them later.)

2-2. (After building the car) Draw a detailed sketch of the autonomous car that you built.

※The drawing must indicate the dimensions (mm). However, do not indicate the unit.

Provide the names of each part as needed. (You can change them later.)

2-3. How is the finished prototype different from the idea and why?

Differences
Reasons

3. Provide a standardization plan for the obstacle detection/avoidance functions of your autonomous car.

3-1. Specify the parts where standardization was applied and the principles behind them.

Standardization Principles	Applied Parts and Principles
Unity	
Simplicity	

Compatibility	

3-2. Select one or more parts (components or materials) of your obstacle detection/avoidance technology that need to be standardized, and provide a reason for your selection.

Parts Requiring Standardization (Components or Materials)	
Reason:	

3-3. Write the program (source) for the main functions and standards of the finished prototype.