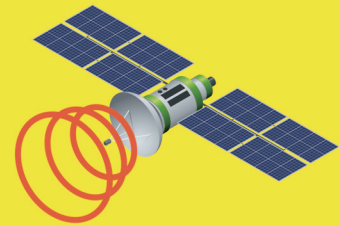


Driverless Vehicles and Future Transportation



Era of Driverless Vehicles
Find the Shortest Route!
Make Your Own Driverless
Vehicle



How to Use
This Program

Software is changing the world. The programs installed in computers and apps that make it more convenient to use smartphones are all software. Software is in every part of our lives, so it is difficult to find areas where we are not affected by software.

The state-of-the-art science and technology that we see in the news is also helped by software. In turn, progress in math, science and technology advances software further. As such, math, science and technology are closely related with and cannot be separated from software.

These module series were created through collaboration between experts in related fields and software education, and its suitability for classrooms has been verified. As students follow teachers' direction through each module, they will be able to better understand the world that has been changed by software.

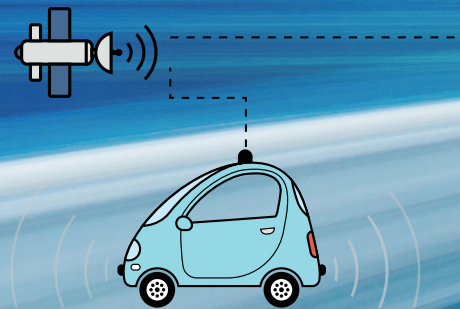


software

education module

CONTENTS

Intro	Smart Self-Driving Vehicles	02
PART1	Era of Driverless Vehicles	08
Activity1	Be a Pathfinder	12
PART2	Find the Shortest Route!	18
Activity2	Help Hanbi Find the Shortest Route	22
PART3	Make Your Own Driverless Vehicle!	24
Activity3	Turn Hamster Robot into an SDV	26
Career Exploration	Automobile engineering expert	38
Maker Activity	SDV contest	40

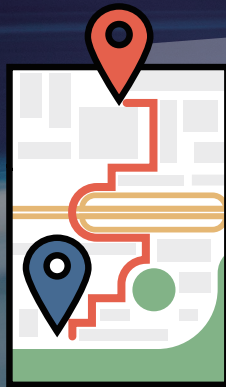


Smart Self-Driving Vehicles

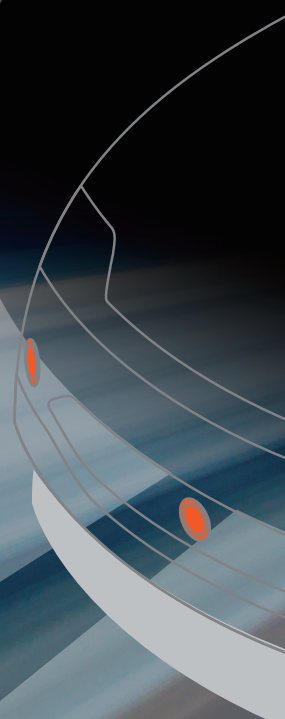
Cars are cruising down the highway. Wait! Something doesn't feel right! Some drivers are lying on their backs asleep, while others have turned their seats around in the opposite direction to talk with passengers in the back. What's going on?

It may seem bewildering, but this is the new future being ushered in by driverless vehicles.

How can a vehicle drive itself? Let's find out together.



Radar





LIDAR

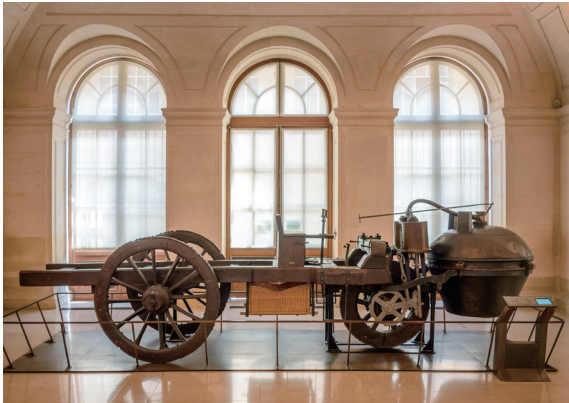
GPS

Camera

Computer

Wheel
Encoder

SAFER FOR CARS TO DRIVE THEMSELVES?



Steam car created by Nicolas Joseph Cugnot in 1769

In 1769, French engineer Nicolas Joseph Cugnot built the world's first steam car. People at that time must have been very suspicious of his new invention.

“How can it move on its own without horses? Is it even safe?”

Almost three centuries have passed, and a world without cars is unimaginable. In short, cars have become indispensable.

Computers do not get distracted

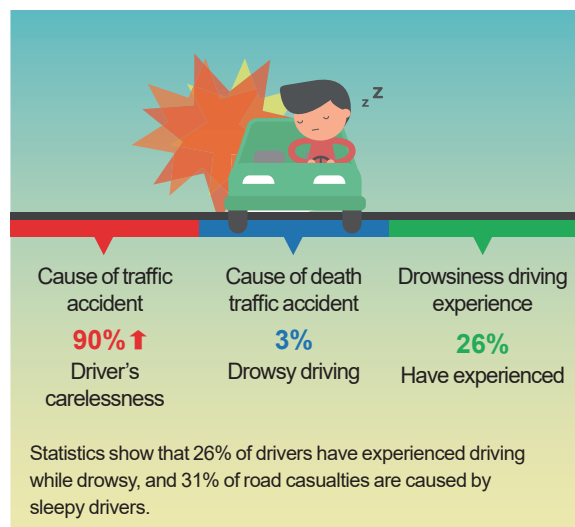
Driverless vehicles are to people today what steam vehicles were to people in 1769. Back then, steam vehicles were the object of both marvel and concern, just as driverless vehicles are today. In the near future, it will be difficult to imagine a world without self-driving vehicles, or SDVs for short.

Admittedly, we still feel a little uneasy and ap-

prehensive about fully handing over the wheel to a computer. However, human driving is a lot less reliable than we would like to believe. In fact, over 90% of traffic accidents are the result of careless driving, not vehicle defects. In other words, the majority of accidents are caused by drivers who fail to operate their cars safely.

People sometimes drive while drowsy, especially overworked truck and bus drivers. Some drivers even use their mobile phones and run red lights. These situations may not always lead to accidents, but they definitely increase the risk.

Computers never doze. They don't run red lights or take their eyes off the road. As they are emotionless, they can also remain composed and follow preset guidelines during emergencies.





Cars made smart by smart computers!

A driver must process a large amount of information while on the road. They have to check and scan the shape of the road, lanes, safe distances to other cars, traffic lights, pedestrians and obstacles. After collecting all this visual information, drivers must identify and assess the overall surrounding conditions and make continuous decisions accordingly to remain safe on the road.

This makes a driver sound like a person of great capacity, but we all undergo this same process on a daily basis when we walk. Although we are unaware of it due to repeatedly carrying out the task, it is a daunting challenge to reach a destination safely on foot as well as by car.

As such, the computers mounted on SDVs are taught extensively how to drive. Computers view and perceive the world differently than we do. They are similar to a blind person who suddenly obtains a sight. Various objects are seen but not recognized. Therefore, computers have to learn and study.

SDVs are taught how to drive using software. Computers, recognizing nothing at first, learn to make out other cars, people, centerlines, lanes, traffic lights and crosswalks. In other words, they learn to “perceive”.

Once they have learned to perceive, they begin to ceaselessly examine their surroundings - whether they are at a safe distance from other cars and whether the road ahead is clear of obstacles. Computers are now even able to make judgments. Based on what has been perceived and judged, they operate the vehicles. This is the stage of “control”. Thus, SDVs can drive on the road through the process of “perceiving, making judgments, and controlling”.

The first vehicle to be operated this way was created by Japans University of Tsukuba in 1977. Using a camera, the vehicle simply recognized white dots marked on the road and followed them at the speed of 20 kilometers per hour. However, the SDVs

An SDV made by Google, which attained a driver's license for the first time in the industry on May 8, 2012, in Nevada. © google



CARS THAT THINK LIKE HUMANS!

created 35 years later have succeeded in earning a driver's license in the US. Talk about evolution!

How incredible that a car can see, think and get a driver's license just like a person! This was made possible through cutting-edge cameras, radar and the computer's ability to infer based on Big Data. Let's find out more about the technologies used in SDVs.

Cars that think like humans

People can infer a lot from visual information, and computers still lag behind us in this sense. Thus, SDVs are equipped with two devices that serve as their eyes. One is a camera that collects visual information and the other is radar that identifies the location and size of objects.

The camera identifies lanes, signs and other ob-

jects by shape and color. It also checks other cars, pedestrians and obstacles. However, it has one defect. It cannot readily sense the speed and location change of objects.

Therefore, radar is also needed. The radar system emits radio waves, which then reflect against surrounding objects and return. By analyzing the time lag, reflection angle and shape of the reflected waves, the movements of objects are identified promptly and accurately. This is how bats navigate in darkness without hitting obstacles. Radar cannot make out the exact color or shape of an object, but it can accurately identify its movements in real-time. The SDV developed by Google in 2012 emits radio waves 1.6 million times per second and reads out the movements of objects 200 meters away.

The combination of the camera and radar enables the car to fully perceive its surroundings, but there is still a long way to go. What if it snows heavily? What if snow covers all the lanes or interferes with radio waves and the camera and radar end up with incorrect information? Then, the SDV will not be able to make the right judgments and may cause an accident. To avoid this risk, it is designed to "infer".

Through inference, previously input sets of information are assembled into a new set of information. This is the beauty of artificial intelligence. Computers used to output results only for input information, but now they can create new information. At this stage, Big Data technology is necessary.

SDVs perceive their surroundings using cameras and radars. If information collected is insufficient, artificial intelligence make conjectures.





Let us go back to the road blanketed under snow. Fortunately, computers can recall the positions of the lanes based on vast Big Data collected from previous trips. Although the lanes are invisible, this previously attained information combined with the surrounding landscape and road shape allows them to infer the likely positions of lanes and drive safely. Just like a human driver would!

A car that has become a friend?

In order for technology to win in the marketplace, it must be friendly as well as convenient. As such, future SDVs will be designed to not only drive themselves but also respond to the driver's health conditions and mood changes.

Pepper, a robot created by Japan's SoftBank, is able to read human emotions. Based on Big Data, Pepper analyzes tone of voice and facial muscular changes to identify emotions. Honda, a Japanese automobile maker, recently announced its plan to develop a car installed with Pepper's ability to read emotions. This car will be able to strike up a conversation or select music accordingly.

The Electronics and Telecommunications Research Institute is currently developing technology to check the driver's condition.

An infrared camera analyzes facial changes, eye-blinking frequency, the direction of eyes and the head tilt to determine whether the driver is drowsy, while at the same time, short-distance radar continually checks health conditions based on heartbeat patterns. If the car senses the possibility of drowsy driving or abnormal health conditions, it activates the self-driving function and pulls itself over at a safe spot.



PART 1

Recommended target

Elementary creative experience activities

Relevant subjects

Practical course, elementary school

Era of Driverless Vehicles

In the early 2000s, those who had trouble parking were thrilled at the news that a self-parking car was released. At the time, it caused a sensation around the world. After 10 years or so, this feature is now standard on most vehicles.

Today, there is good news for those who lack the skills for or are afraid of driving. Vehicles that can take their passengers to their desired destinations autonomously are being developed.

They are called driverless vehicles because they do not require human drivers. More accurately, computers perform driving tasks and control each component so that human drivers don't have to. Thus, they should be called self-driving vehicles. One study has revealed that one out of every four vehicles will be driverless by 2035. SDVs are about to become a major means of transportation - how informed are you about them?

Different levels of autonomy

The National Highway Traffic Safety Administration describes the automated driving system with five levels, from Level 0 (non-autonomous) to Level 4 (completely self-driving). The SDVs currently being marketed are classified as

Levels 2 and 3, and Level 4 testing is underway. Level 4 vehicles are designed to control every aspect of driving and therefore don't have steering wheels or brake pedals. With Level 3 vehicles, human drivers



SELF-DRIVING CAR

can take back control if necessary. Thus, they still have steering wheels and brake pedals.



A completely self-driving vehicle comes without steering wheel and brake pedal as the vehicle takes full control. The front seats can be turned around to face the rear seats.

Pros of SDVs

Once commercialized, driverless vehicles will eliminate all need for human for driving. What are the benefits when they become a common sight?

① Fewer auto accidents

Most auto accidents are caused by the humans behind the wheel, especially by those using their smartphones or watching videos on DMB devices. Human drivers can become drowsy and their visibility can be restricted. It also takes time for them to react to roadway incidents that may occur. In short, humans have insurmountable limitations. However, driverless vehicles have no such limitations and are much less likely to cause accidents.

② More time on our hands

While on the move in a driverless vehicle, passengers are free to engage in any activities they want. They can take their minds off driving and spend their time freely. Furthermore, driverless vehicles sort out



SDVs do not pose the risks of driving while drowsy or looking away from the road. They are therefore expected to reduce traffic accidents.

the optimal route by analyzing driving environments, saving time spent on the road. They park themselves upon arrival, saving even more time. In short, they will give passengers more free time.

③ Less traffic congestion and higher energy efficiency

Driverless vehicles can reduce energy consumption. They can drive more economically by minimizing vehicle-to-vehicle distance in a safe manner and help improve traffic conditions by avoiding quick starts and quick braking. Efficient performance leads to reduced energy consumption and reduced carbon dioxide emissions, thus conserving the environment.

④ No pressure for driving

Those who are too young to drive or who have physical challenges typically have to rely on licensed drivers for their mobility. However, driverless vehicles ensure full independence in mobility for those who are unable or reluctant to drive.



The above are only some of the advantages of driverless vehicles. Come up with your own ideas on how widespread driverless vehicles will alter our world and lifestyle and write them down below.

Cons of SDVs

Technically speaking, driverless vehicles may have reached the final stage of completion. However, this does not mean they can hit the road right away. Countless situations that may arise when they are actually used by consumers must be thoroughly reviewed in advance. The following are the problems that have yet to be resolved for us to safely take off into the era of driverless vehicles.

① Legal issues

Whom should be held liable for collisions involving driverless vehicles? Should it be the manufacturer or the owner? It has yet to be legally defined whom should be held responsible.

② Telecommunications and security hitches

Driverless vehicles continuously exchange information on their position, speed, etc., with a server* while on the move. What if a telecommunications problem occurs? What if the server is hacked? Wouldn't misinformed vehicles end up interfering with traffic flow and possibly even cause traffic fatalities?

* server

A server is a device connected with multiple computers, or clients, to which it provides multiple services (data and resource sharing and computing).

③ Driverless vehicle dilemma

Let's say a driverless vehicle comes across an obstacle on the road while driving and has to change direction instantly. On one side are pedestrians and on the other is a steep cliff. What choice would you make and why? Articulate below.



Activity ①

Be a Pathfinder

Driverless vehicles depend on information collected using their sensors to move around. Humans piece together information using all our sensory organs to recognize our surroundings. However, these vehicles only have the information detected and collected by sensors to rely on to identify their surroundings. Let's imagine you have become a driverless vehicle. Try to pass through a maze to grasp an understanding of their process of collecting information.

What to prepare Activity Materials 1—① through 1—②, scissors, transparent film, transparent tape, a marking pen, a stopwatch

Activity

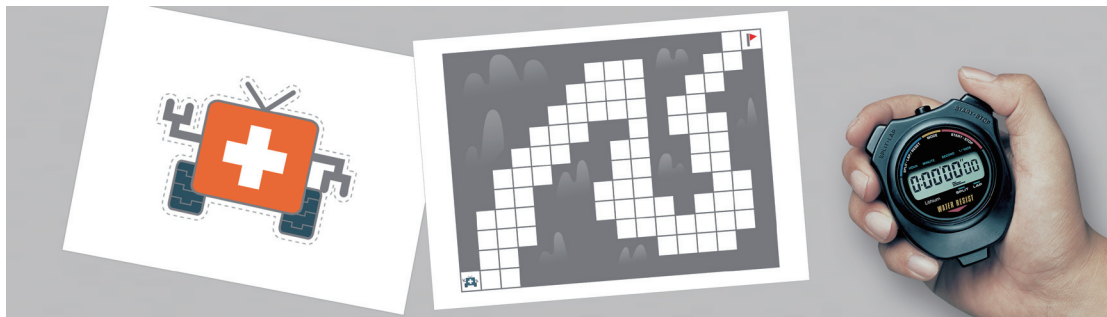
1 Find the number of cases

What is the total number of cases to find the exit for each of the following?
The grey blocks are inaccessible obstacles.

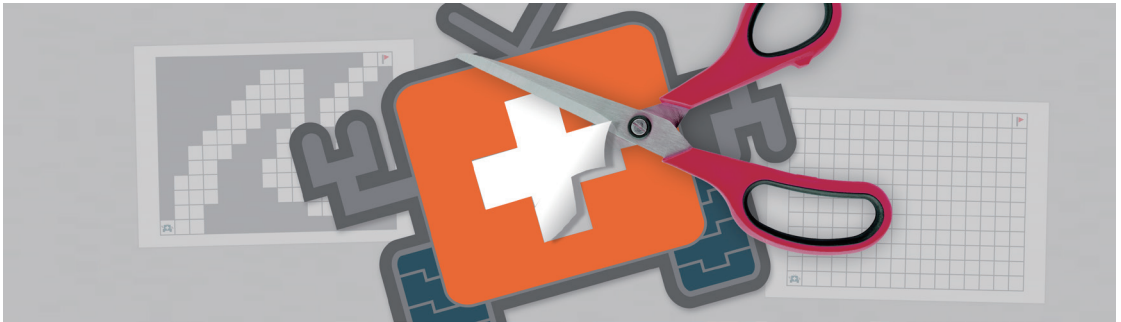
()	()	()	()

2 Find the path using the robot's eye

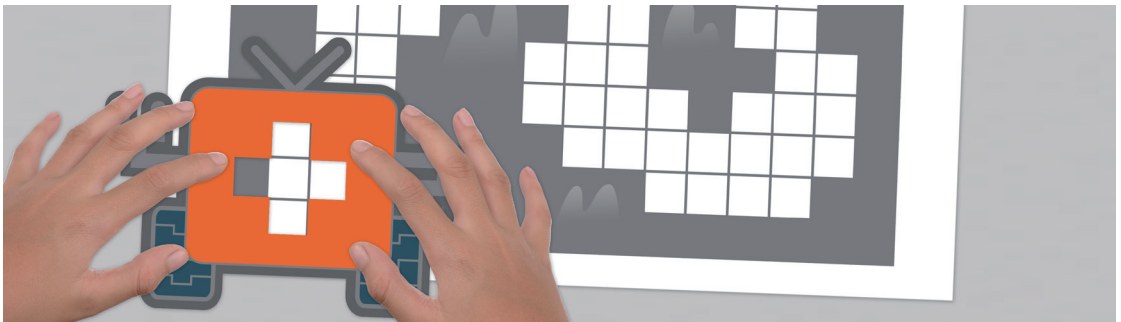
① Have Activity Materials 1-① and 1-② transparent film, scissors, transparent tape and a stopwatch with you. Do not look at Activity Material 1-② in advance.



- ② Cut out the robot. Then, cut out the cross in the middle and attach the transparent film.



- ③ Draw a square on the center of the cross to make the robot's eye.
- ④ Place the robot's eye on the departure point of Activity Material 1-② and move towards the arrival point. Remember, the robot can only move into a white block seen through the transparent cross. It cannot move into a grey block.



- ⑤ Measure and record the duration from departure to arrival. Repeat Step ④ three times and compare the records.

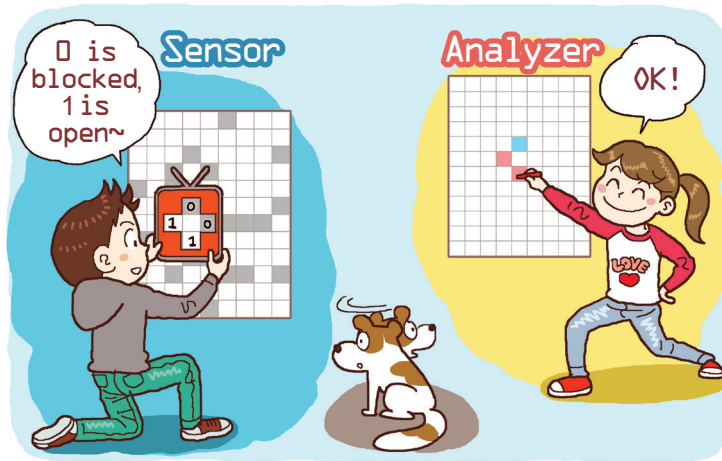
	1st Trip	2nd Trip	3rd Trip
Duration			

- ⑥ Was the duration of your second and third trip longer or shorter than your first trip? What do you think is the reason for this?

3

Find the path with your partner

Form a driverless vehicle team of two with a friend and conduct a pathfinding mission. The Sensor collects information and the Analyzer maps out the path based on the information



- ① Pick a partner, divide the roles and prepare Activity Material 1-①. Turn to Activity Materials 1-③ and 1-④ on pages 18 and 19.
- ② Share the rules for value input. Start with the block to the left of the robot's eye at the center and move clockwise. The value of an inaccessible grey block is 0 and an accessible white block is 1. "0110" means the left and bottom blocks are grey and inaccessible.
- ③ The Sensor places the robot's eye of Activity Material 1-① on the departure point of Activity Material 1-③.
- ④ The Sensor moves along the maze following the white blocks and provides the values for the blocks seen through the transparent cross to the Analyzer.
- ⑤ The Analyzer colors the blocks of the maze of Activity Material 1-④ accordingly.
- ⑥ Repeat Steps ③ through ⑤. Compare the paths used by the Sensor and the Analyzer.

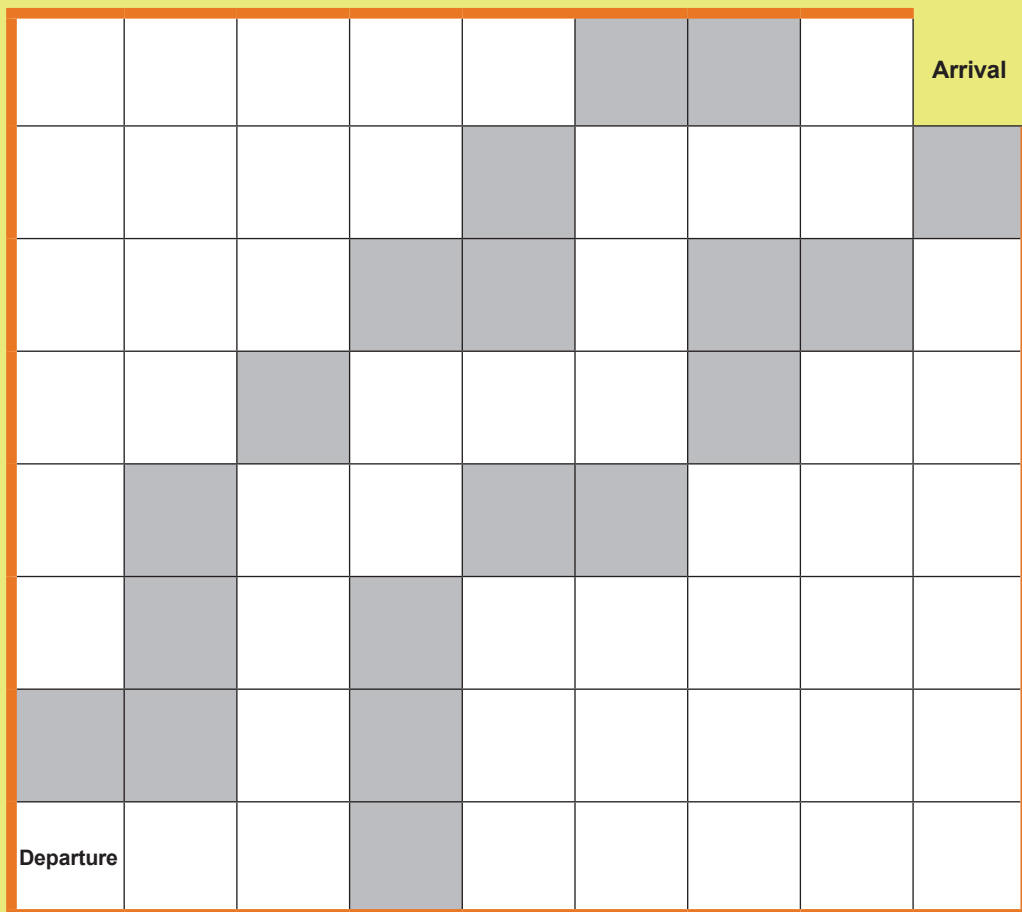
4

Conclusion

Are the paths used by the Sensor and colored by the Analyzer the same? If so, then the information for pathfinding has been accurately provided. In order for driverless vehicles to perform safely, the accuracy as well as the quantity of information about roadway environments is important.

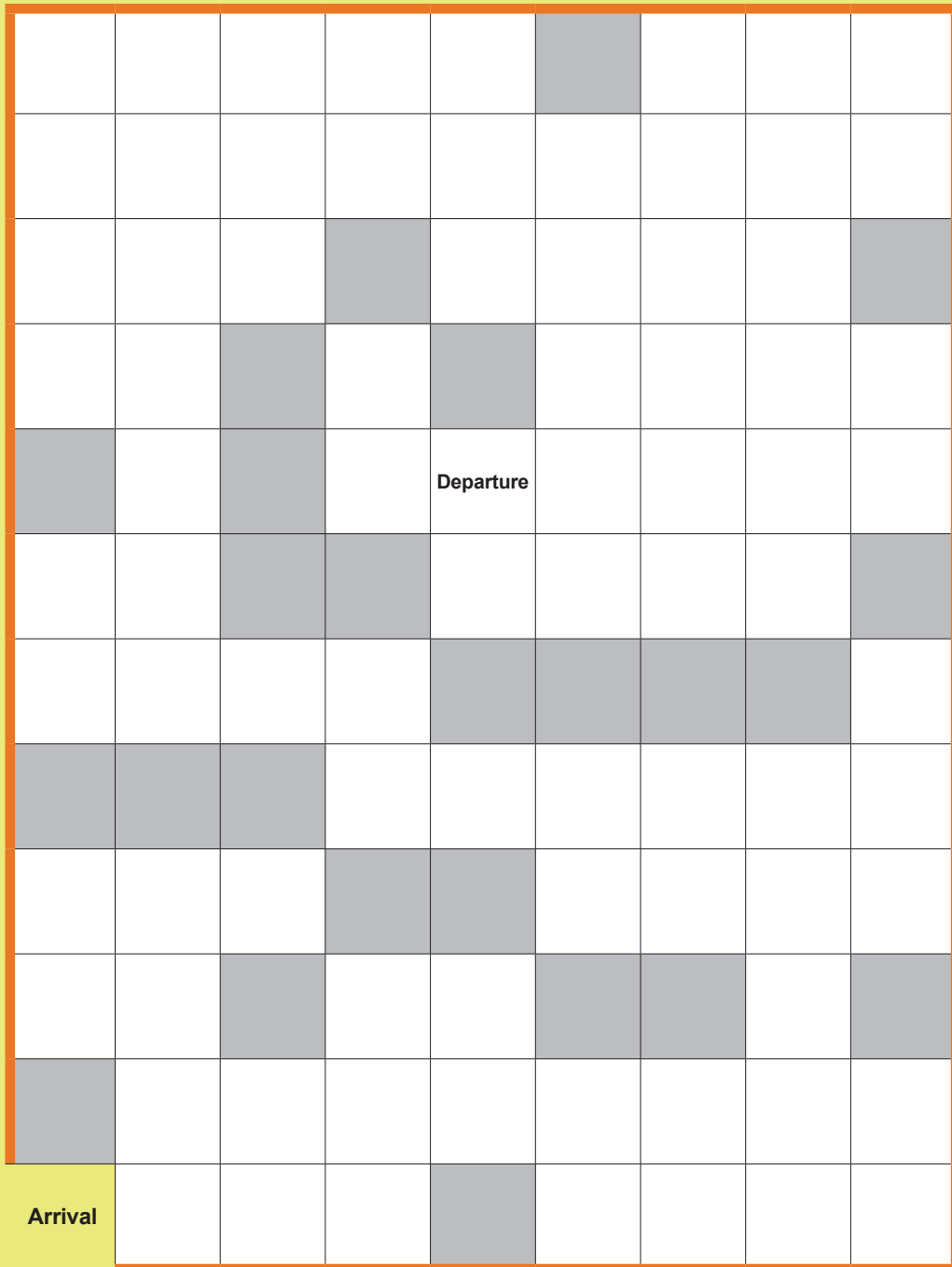
Find the Path Using the Robot's Eye

Try to complete
this mission by yourself!



Find the Path with Your Partner

For the Sensor



Find the Path with Your Partner

For the Analyzer

				Departure				
Arrival								

PART 2

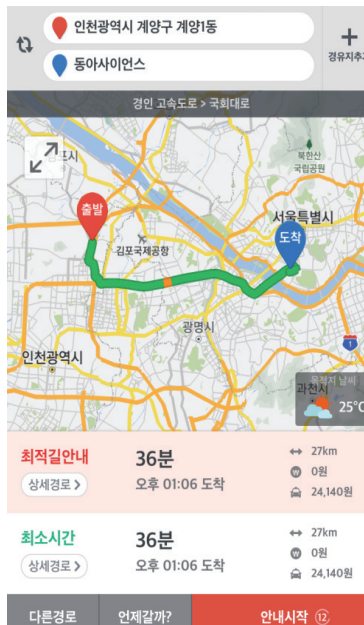
Recommended target

Elementary creative experience activities

Relevant subjects

Practical course, elementary school

Find the Shortest Route!



Driverless vehicles recognize roadway conditions in real-time by rapidly analyzing information collected via sensors and GPS using a data processor. The amount of information collected stands at one gigabyte per second. For comparison, one gigabyte is equivalent to a full-length feature film.

Driverless vehicles instantaneously analyze this vast amount of information and make decisions on the car's direction and speed. Playing a central role in this decision-making process is a software program that consists of a variety of algorithms. An algorithm refers to a collection of rules and procedures required to conduct a mission or solve a problem.

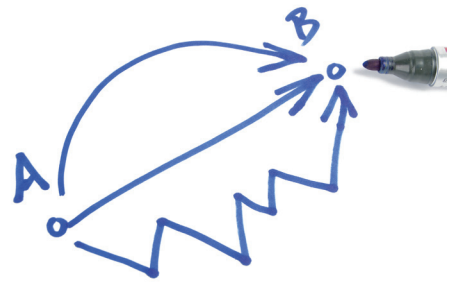
To reach the destination safely, accurately, and speedily!

The most important part of pathfinding is, of course, reaching the desired destination. However, it is also crucial to find the shortest route. Have you ever tried to find and use the shortest route in everyday life? Provide an example or two below.

Today, most vehicles are equipped with a navigation system. Smartphone apps that serve the same purpose are also popular. A navigator is expected not only to take the user to the desired destination but also to inform the user of the shortest route.

The same is expected of driverless vehicles. Whether driven by a human or by an automated system, the vehicle uses the shortest path algorithm when searching for its route. The shortest path here can either be the one with the physically shortest distance to the destination or a route that travels further but takes the shortest amount of time.

The shortest path algorithm, as suggested by its name, is being employed in diverse fields that require short cuts. It is applied when finding the most efficient subway transfer route, searching optimal ways to reach a destination using public transportation, arranging buildings for urban planning and designing electronic circuits.



Dijkstra's Algorithm - most noted shortest path finder

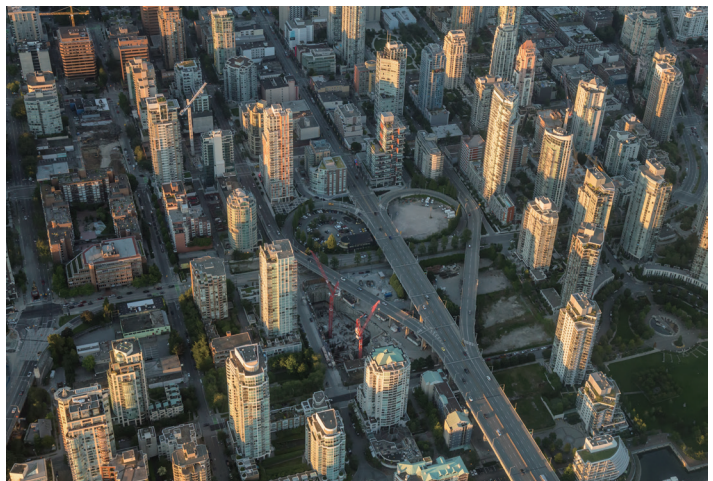
Dijkstra's Algorithm is known as the most noted shortest path algorithm. It was conceived by Dutch computer scientist Edsger Dijkstra and was published in 1959. It is a solution for finding the shortest path between different locations.

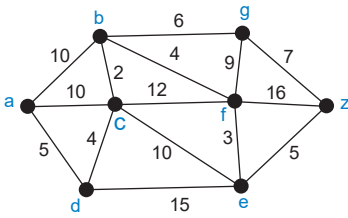
Dijkstra's Algorithm starts by marking each location as a dot and each path connecting two locations as a line. It then transforms the variables needed for finding the shortest path (distance, travel time and cost) into numerical values. These numerical values are “weights*.” With a longer distance, more travel time and greater cost, the weight increases. Therefore, the easiest-to-access and fastest route has the lowest weight. Normally, multiple routes exist to reach a destination. You can

* weight

A weight is a numerical value that indicates the relative importance of a certain comparison item, such as cost, time and distance.

Dijkstra's Algorithm, used to find the shortest path, is also employed in arranging buildings and designing electronic circuits.





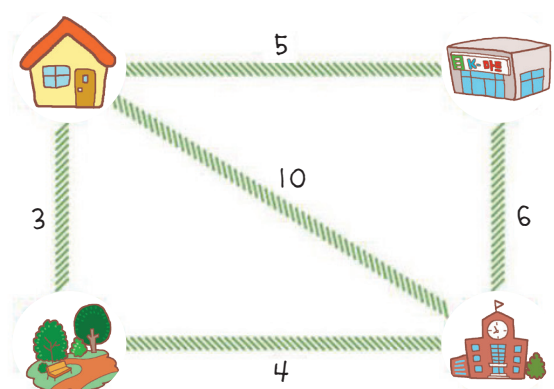
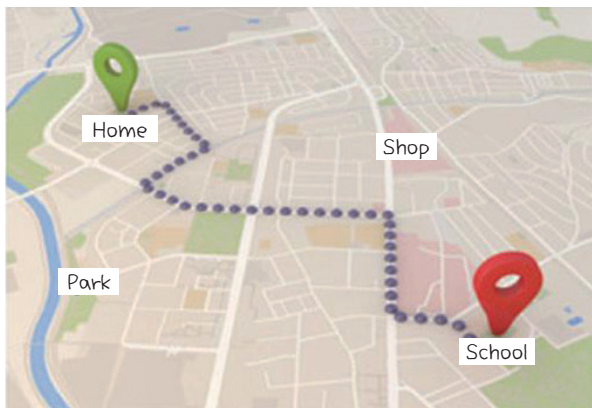
Dijkstra's Algorithm defines weights for all paths connecting two locations, adds up the weights of all paths leading to the final destination and compares the results to find the shortest path.

go directly to a destination or drop by different locations on your way. All possible paths have weights. Dijkstra's Algorithm calculates the weights of all the paths leading to the final destination, compares the results and selects the one with the lowest total as the shortest path.

Finding the shortest path from home to school

Let's find the shortest path from home to school using Dijkstra's Algorithm.

A shop and a park are located between home and school. All paths connecting two among the four spots should be marked with lines.



Home, school and all the spots in between are marked as dots and the paths connecting two spots as lines, with their weights* written down. A park and a shop are located between home and school. A weight may be determined based on many different variables, such as cost. For example, the park can be reached on foot, but the shop only by bus. It costs more to reach the latter, so the path leading to the latter should be given a higher weight. As such, the weight between home and the park is 3, while the weight between home and the shop is 5.

The path leading straight from home to school may appear to be the shortest, but it can only be traveled on a bus that drives along a terribly winding road. The weight of this path is 10. However, there

is a short cut between home and the park and between the park and school. As the path from home to the park was given the weight of 3, the path from the park to school, which appears slightly longer, was given a weight of 4. With the path from home to the shop given a weight of 5, the path from the shop to school was given a weight of 6.

Now, let's find the shortest path from home to school.

There are three options to reach school: going straight from home to school, passing through the park and passing by the shop. As mentioned, Dijkstra's Algorithm adds up the weights of all possible paths and selects the route with the lowest total as the shortest path. Like this, let's add up the weights given to the different paths. The path directly from home to school has a weight of 10. The path from home to school via the park has a weight of 7 (with the first leg at 3 and the second at 4). The path from home to school via the shop has a weight of 11 (with the first leg at 5 and the second at 6). As can be seen, the second option with the weight of 7 is the shortest path.

The above problem was fairly simple, with all the options to reach school easily identifiable and comparable. However, in the real world, pathfinding problems are much more complex and therefore it is far more difficult to find the shortest path. This is why driverless vehicles require highly advanced computers that can instantaneously calculate weights using the algorithm and sort out the path with the lowest weight.

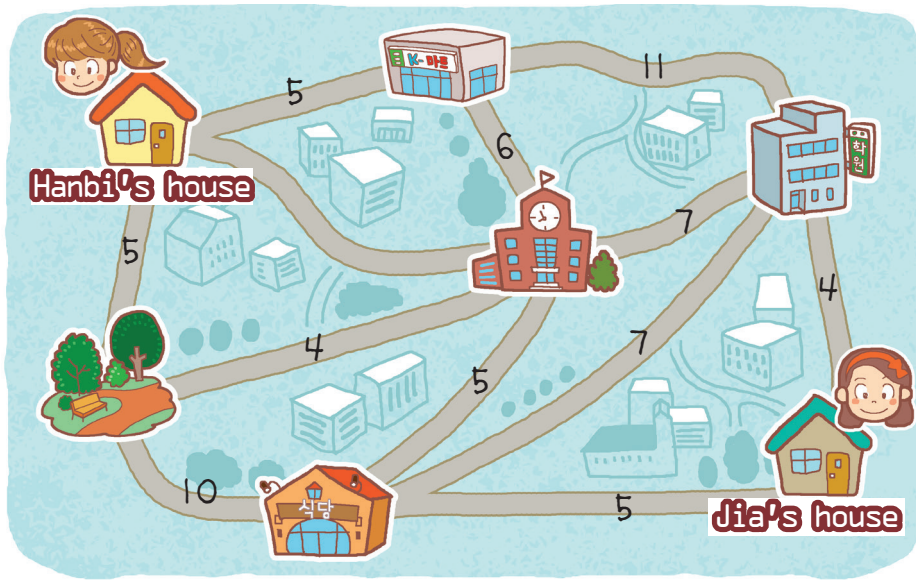
Path			
	Home-Park-School	Home-School	Home-Shop-School
Weight	$3 + 4 = 7$	10	$5 + 6 = 11$

Three ways and weights from home to school

Help Hanbi Find the Shortest Path!

Hanbi set out to visit his friend Jia's house. But, she wasn't sure which path was the shortest. How can Hanbi figure it out? Let's find the answer using Dijkstra's Algorithm, the most commonly used solution for shortest-path problems. The path with the lowest weight is the shortest path!

What to prepare writing supplies



Activity

1 Fill in the weights for the spots directly accessible from Hanbi's. Leave the rest empty.

Spot	Hanbi's	Park	Restaurant	School	Shop	Library	Jia's
Weight 1	0						

2 The closest to Hanbi's among the three directly accessible spots is the park. Set the park as the new departure point and fill in the weights of those spots directly connected to the park. Make sure to add the weight of the park (3) to each weight. Do not change the weights of the library and shop that cannot be reached directly. As the park is used as the departure point in this stage, it cannot serve as one in the next stage.

Spot	Hanbi's	Park	Restaurant	School	Shop	Library	Jia's
Weight 1	0						
Weight 2	0						

If the newly calculated weight is smaller than the one calculated in the previous step, the smaller value is left as the final weight.

- 3** Use the shop as the new departure point as it has a lower weight than the restaurant and school, and recalculate the weights of the school and library directly accessible from the shop. Make sure to add the weight of the shop (5) to each weight. Do not change the weights of the spots not directly reachable.

Spot	Hanbi's	Park	Restaurant	School	Shop	Library	Jia's
Weight 1	0						
Weight 2	0						
Weight 3	0						

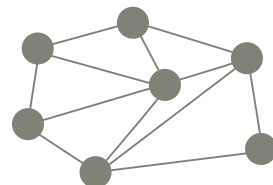
- 4** Use the school as the departure point as its weight is lower than those of the restaurant and library, and recalculate the weights of the restaurant and library.

Spot	Hanbi's	Park	Restaurant	School	Shop	Library	Jia's
Weight 3	0						
Weight 4	0						

- 5** Use the restaurant as the departure point as its weight is lower than that of the library, and recalculate the weight of the path connecting the library and Jia's.

Spot	Hanbi's	Park	Restaurant	School	Shop	Library	Jia's
Weight 4	0						
Weight 5	0						

- 6** Alter the weights on the map and find the shortest path between the two spots.



PART 3

Recommended target
Elementary creative experience activities

Relevant subjects
Practical course, elementary school

Make Your Own Driverless Vehicle!

A driverless vehicle is the embodiment of cutting-edge sensor technology, data processing technology and analytical technology. Driverless vehicles operate autonomously by undergoing three stages: the information-collecting stage (perceiving) to gather roadway information, the decision-making stage (judging) to make decisions based on the collected information and the vehicle control stage (controlling) to operate the vehicle in accordance with the decisions.

* How big is one gigabyte?

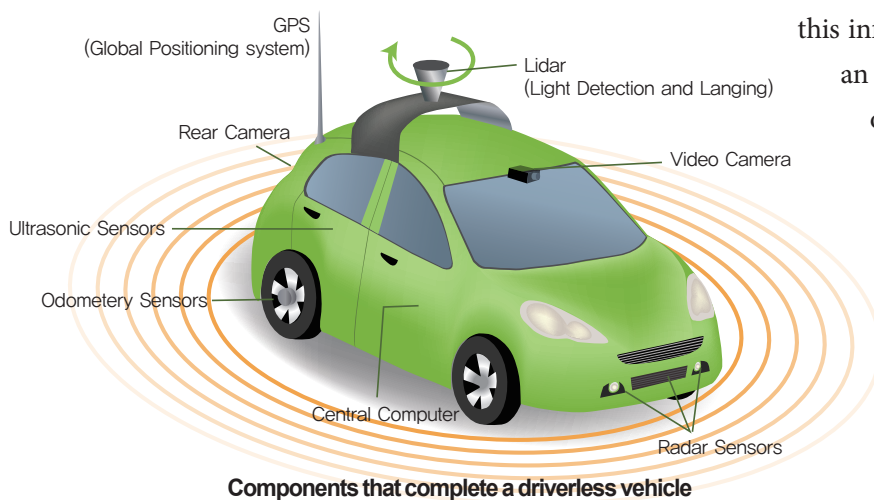
A byte is a unit of data. As giga means “billion”, one gigabyte is equal to one billion bytes. Typically, one full-length feature film is one gigabyte of data. Therefore, delivering one gigabyte in one second is the same as downloading one full-length feature film in just one second.

Information-collecting stage - sensors

Diverse sensors such as radar, cameras and GPS mounted on the vehicle play the role of human eyes that collect information. They identify the vehicle’s current position, distances to obstacles and other cars and the presence of pedestrians.

Lidar collects information by emitting laser lights that reflect against targets, measuring the elapsed time until the lights return and scanning their shapes. The cameras produce visual records of the roadway environments, while the GPS obtains the vehicle’s coordinates using satellites. All

this information is delivered at an overwhelming speed of one gigabyte* per second.



Decision-making stage - software

Collected information is analyzed and various decisions on driving tasks are made. This stage is performed by the software, which is carefully designed by applying algorithms to prepare for expected and unexpected situations.

The software identifies the distances to and sizes of surrounding objects by analyzing information attained through the radar. It also compares video images sent by the cameras with stored video data to more accurately make out the surroundings and make appropriate decisions. It compares the coordinates attained via GPS with its map data to pinpoint the vehicle's current location.

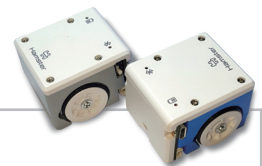
The software is in charge of making overall driving decisions by piecing together all the information obtained, such as when to make a right or left turn, when to change lanes and whether to attempt quick braking. As each and every decision determines safety, algorithms are the heart and soul of driverless vehicles.



The interior of Driverless Vehicle unveiled in January 2017. © Steve Lagreca/Shutterstock.com

Vehicle control stage – mechanical devices

In this stage, a motor elaborately operates according to the decisions made by the software and controls the vehicle's performance. As disparities can exist between what is sensed by the software and what is actually performed by the vehicle, eliminating such disparities through stringent testing is critical. Through Activity III, you will see that a gap can occur between the distance input and the distance actually covered by a robot. The two must coincide for driverless vehicles to be able to stay on the road and reach their destinations safely.



+ Hamster Robot

Hamster Robot is a small-sized robot about four centimeters in height. It is equipped with sensors and wheels, and thus is capable of sensing obstacles while on the move. Most importantly, it has a built-in electronic board, to which coded orders can be uploaded to make it carry out desired missions. This is how it can play the role of a driverless vehicle.

Activity ③

Turn Hamster Robot into an SDV

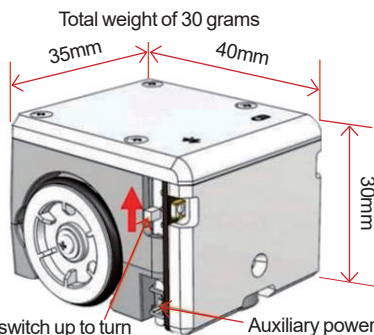
Driverless vehicles collect information on roadway conditions using their sensors. They then use their software to decide in which direction and how they will move. Activity III is designed to help students build their own driverless vehicles by utilizing Hamster Robot mounted with multiple sensors and ENTRY.

What to prepare Activity Materials 3—① through 3—③, Internet-connected computer, Hamster Robot

Activity

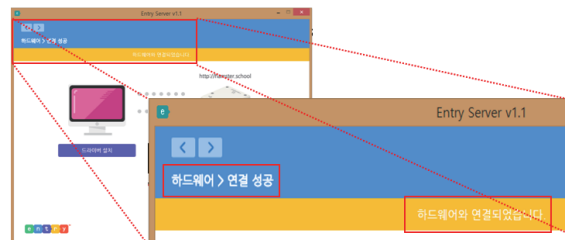
1 Connecting ENTRY and Hamster Robot

- ① Access ENTRY <https://playentry.org> and download the hardware connection program.
- ② Install the driver that connects Hamster Robot to the computer and click Hamster.
- ③ Insert the dongle into the computer's slot.
- ④ Switch on Hamster and bring it close to the dongle.

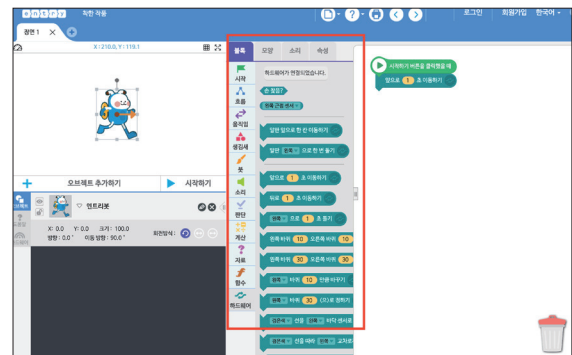


Flip the switch up to turn it on and flip the switch down to turn it off.

- ⑤ When “Connection Successful” appears on the screen, return to the ENTRY site.

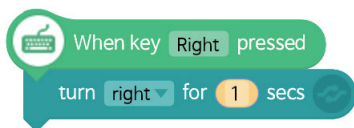
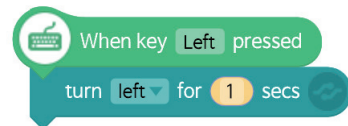
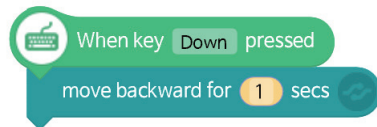


- ⑥ Check if Hamster-related commands have been generated by clicking “Connect Hardware” on the Hardware Tab.



2 Learn the basic movements of Hamster Robot

- ① Practice moving Hamster around freely by using the following keys.



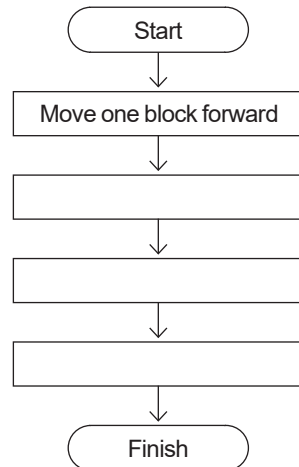
- ② Use Activity Materials 3-① and 3-② to measure the distance covered by Hamster in one second and the time spent to rotate 90 degrees.

Distance forward		centimeters
Distance backward		centimeters
90 degrees to the left		seconds
90 degrees to the right		seconds

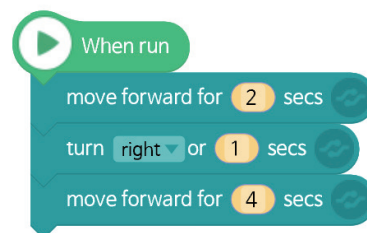
- ③ Use Activity Material 3-③ and move Hamster to the arrival point.

※ Remember that the duration varies by Hamster, so make adjustments as necessary.

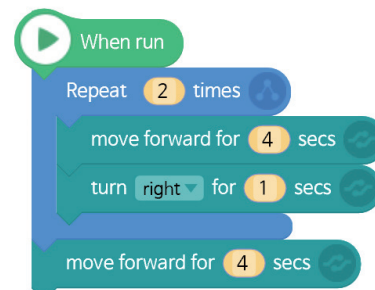
- ③-1 Complete the following flow chart to move Hamster to the arrival point. Manually move Hamster in accordance with the chart.

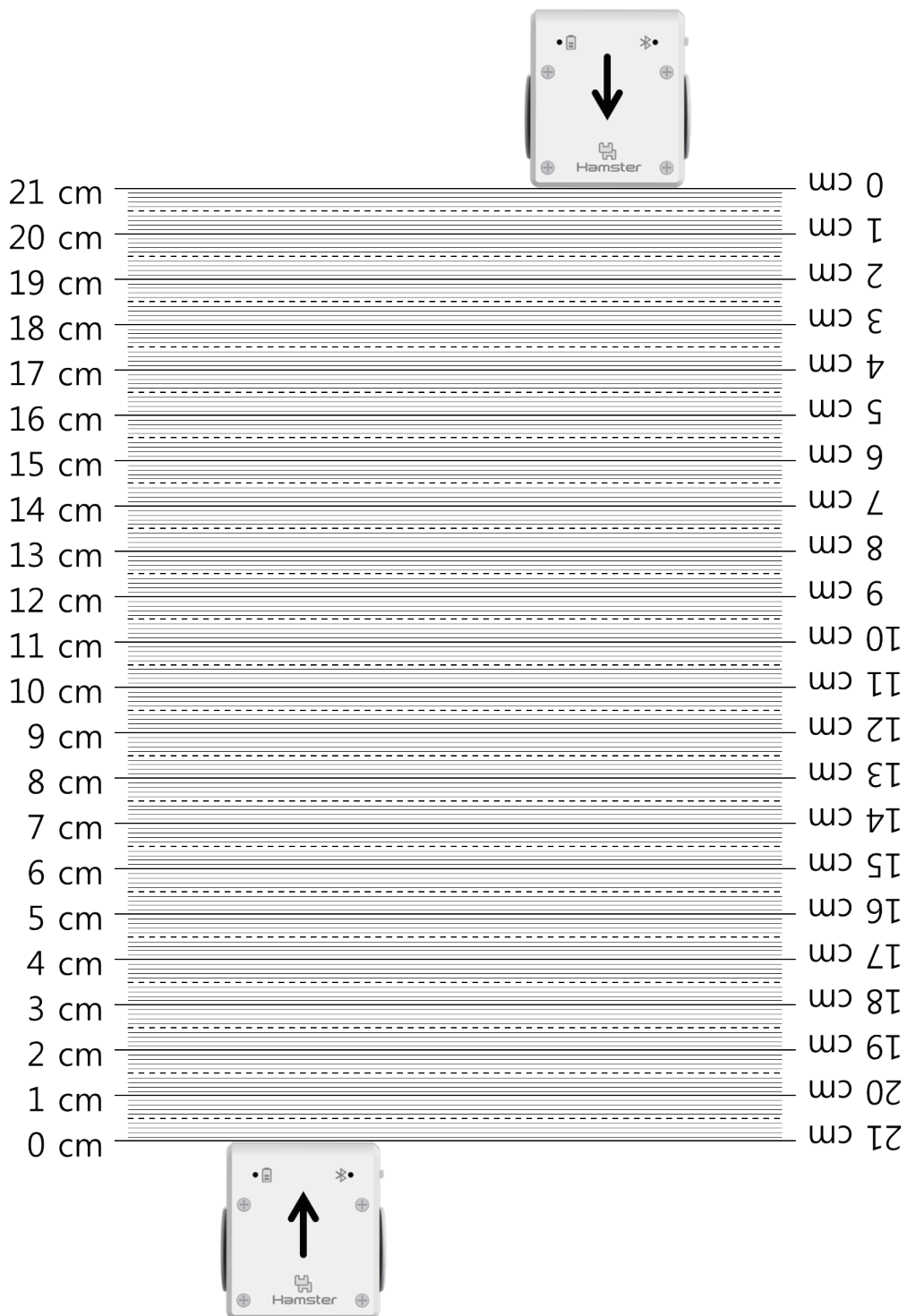


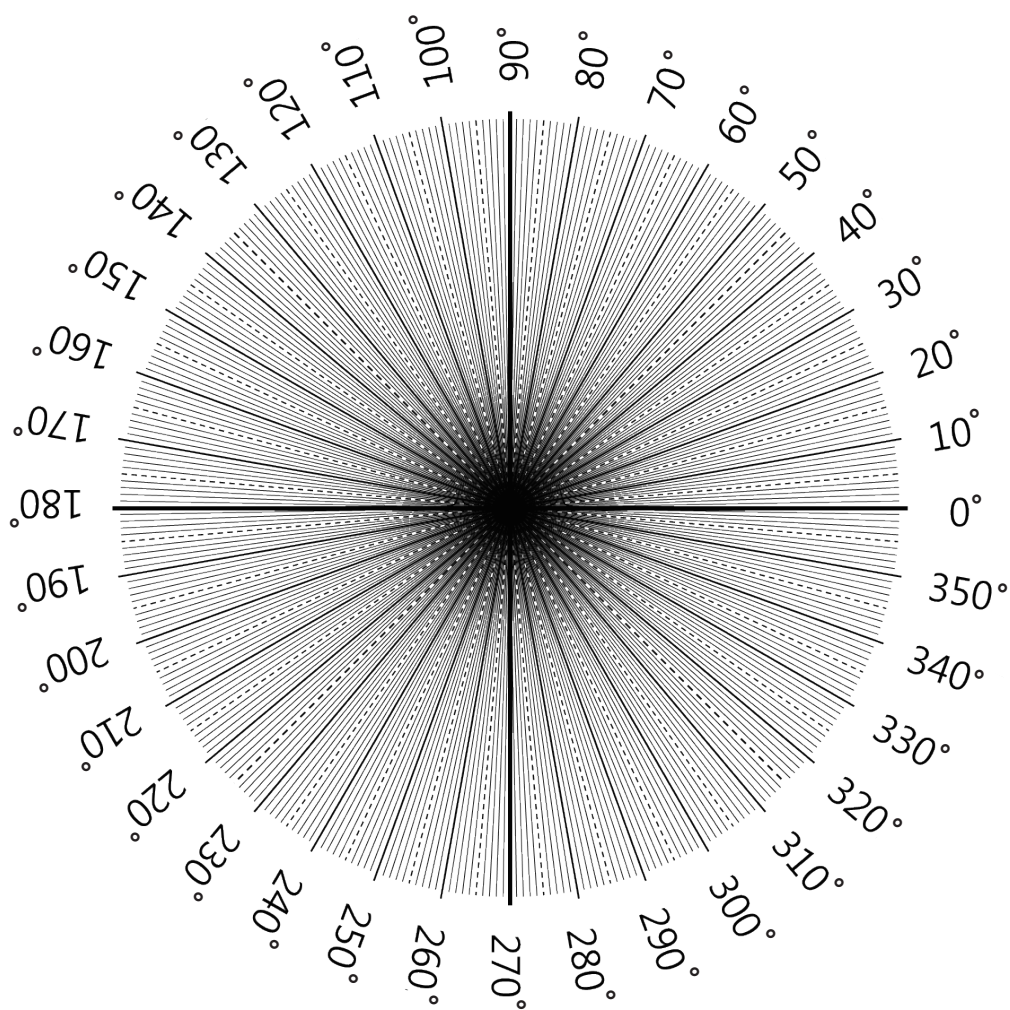
- ③-2 If the chart appears feasible, code each move by using the following blocks.

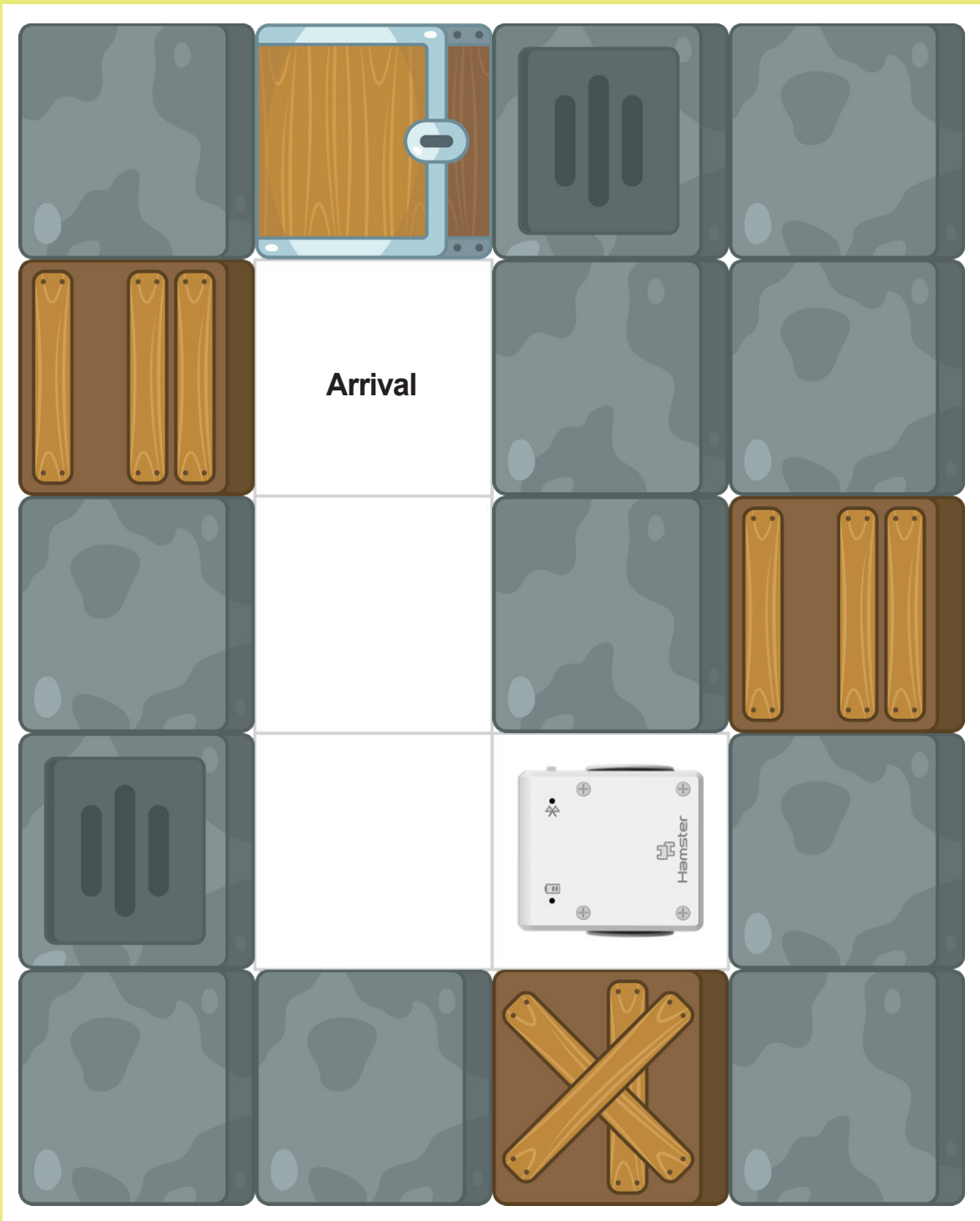


- ③-3 Commands can be coded more simply by using repeaters.









3

Treasure hunt using Hamster Robot

What to prepare Activity Materials 3-④ through 3-⑦

Suitable for 2-4 persons

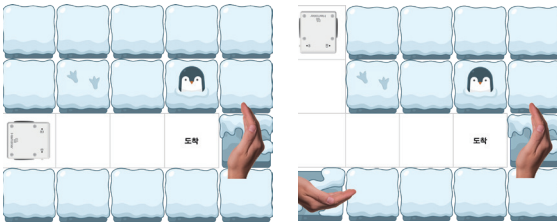
Method After the opposition team has placed a treasure and obstacles on the board, move your Hamster and find the treasure within the time limit of 5 minutes.

* The time limit may be adjusted.

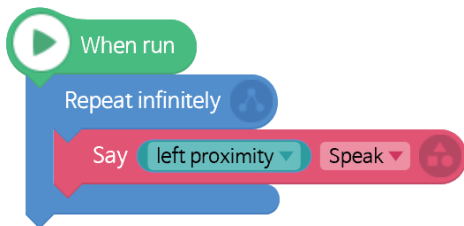
* Place a hand as an obstacle at allowed points.

* Conditions may be added (i.e. “turn on the red direction indicator when rotating”, “make a sound when reaching the arrival point”, etc.)

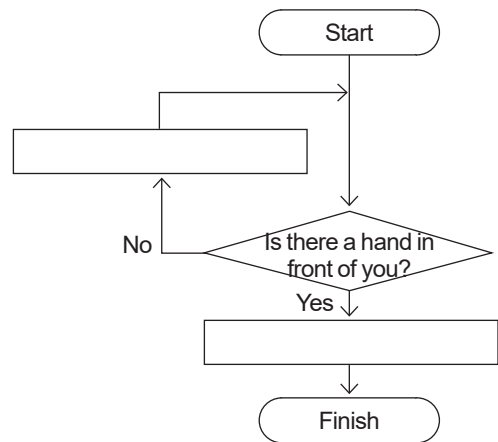
- ① Use Activity Materials 3-④ and 3-⑤ to move and avoid obstacles.



- ② Observe the changing value of Hamster's proximity sensor.



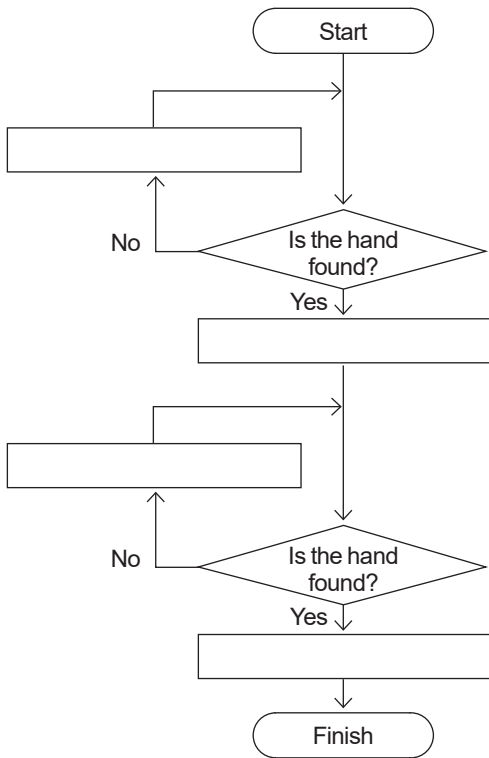
- ③ Complete the following chart taking the hand into consideration.



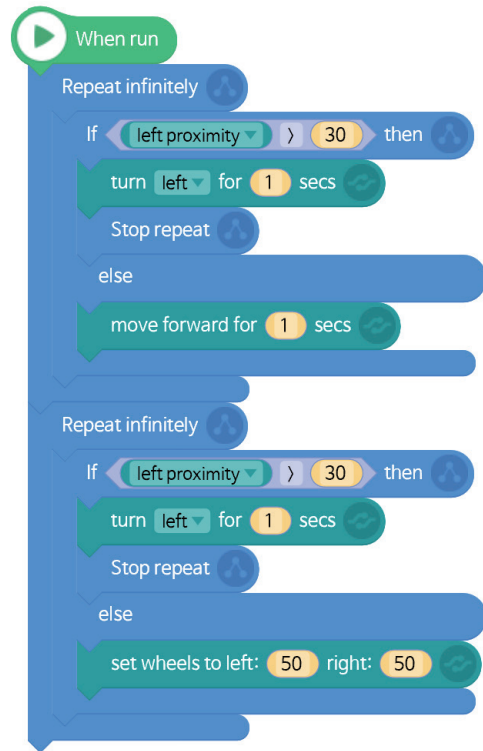
- ④ Move Hamster to the block with the hand by using the following blocks.



- ⑤ Complete the following chart taking into consideration when to rotate when finding a hand while moving forward.



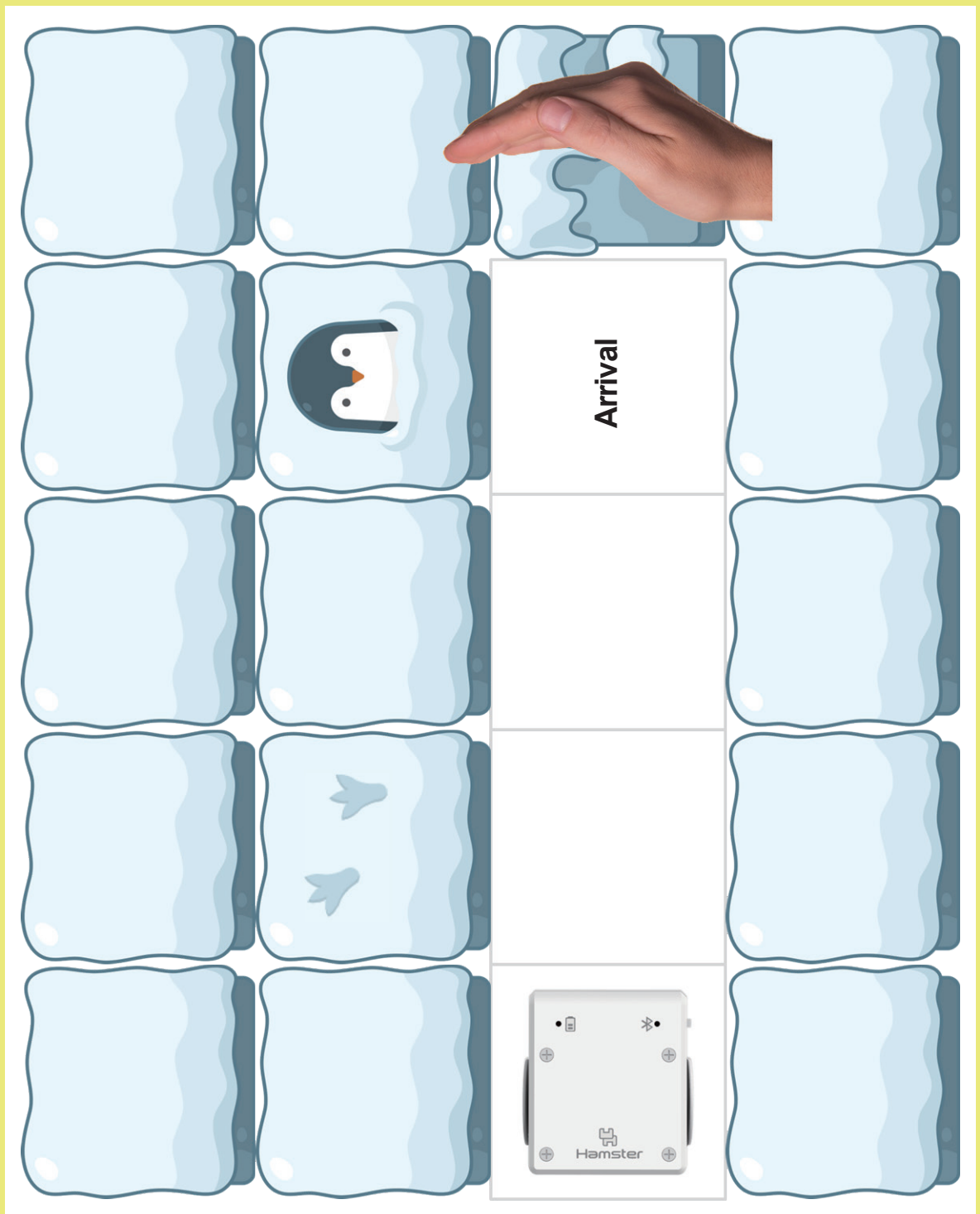
- ⑥ Move Hamster to the arrival point by successfully moving around obstacles using the following blocks.

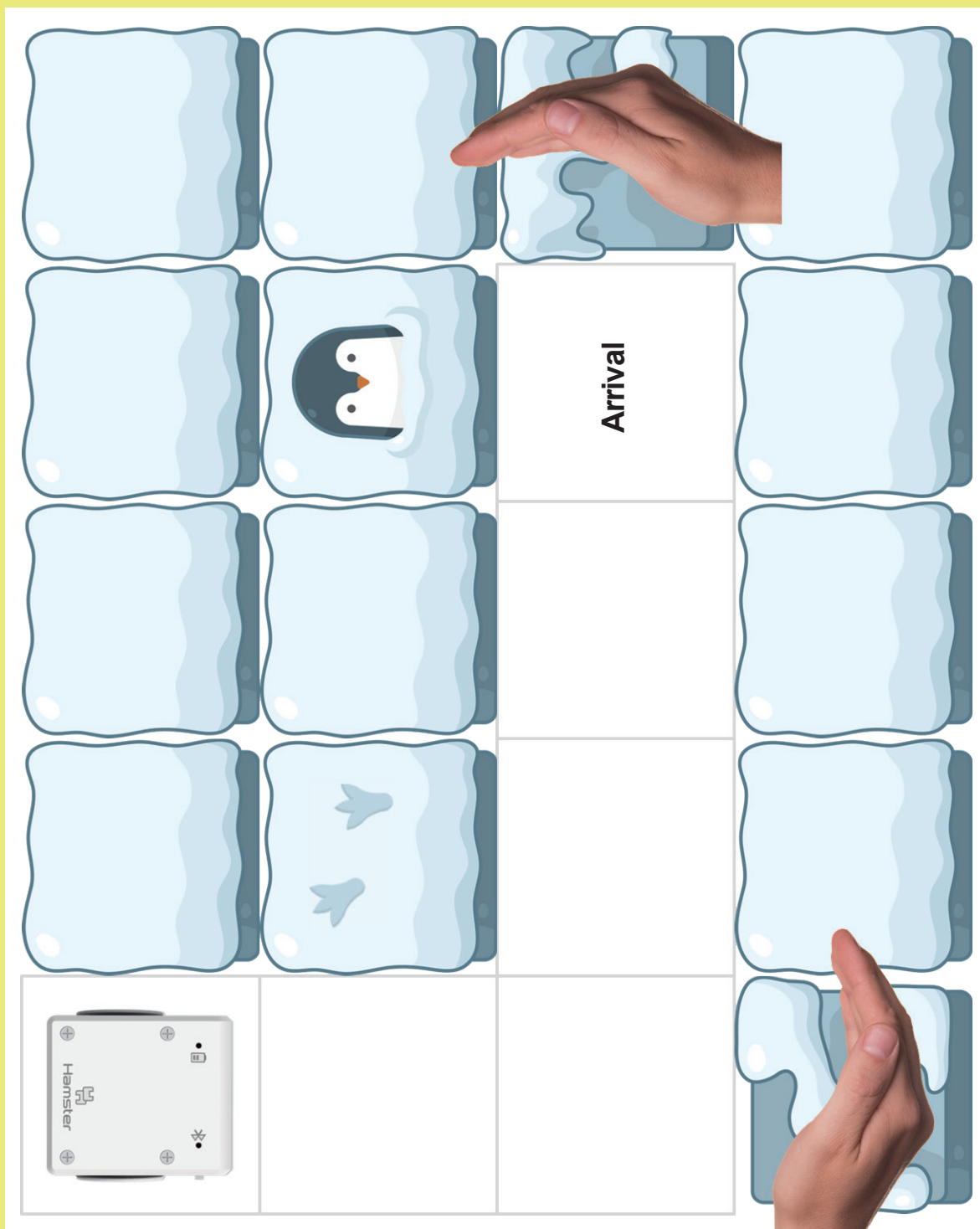


- ⑦ Place the treasure and obstacles of Activity Material 3-⑦ on Activity Material 3-⑥ as you wish. The other team will try to find the treasure with Hamster within 5 minutes. The time limit may be adjusted.

4 Conclusion

Briefly write down what you think you have achieved through this activity.









Board for Treasure Hunt Using Hamster



Automobile engineering expert

IT companies such as Google, Apple and Tesla have all jumped into self-driving vehicle research, which is already witnessing heated competition between major automobile makers such as Hyundai Motor Company and Audi. Technologically speaking, self-driving vehicles are already on the verge of completion. However, liabilities for accidents and security issues have yet to be resolved. Despite this, it is certain that the era of self-driving vehicles will arrive in the near future. For this reason, an increasing number of experts capable of integrating existing engineering technologies with sensor and AI technologies is needed.

What do they do?

- Plan and supervise the development and production of vehicle bodies, engines and braking systems
- Review and analyze data on mechanical devices, power systems and hydraulic systems to develop new designs
- Design a vehicle structure that can ensure driving stability, economic feasibility, optimal displacement and improved operating performance; supervise and readjust the production, remodeling and repairing of parts and overall vehicles to make sure finished products coincide with the original design
- Test and evaluate vehicle performance, determine whether the design can be altered and seek causes and solutions for any problems that may arise during production
- Apply rapidly evolving IT technology to vehicles and design and produce vehicles that operate autonomously

Driverless vehicle-related jobs

Vehicle manufacturing	Quality control engineer, quality accreditation expert, product manufacturing manager, industrial safety and risk manager, industrial engineer, industrial machinery installer, automobile design engineer, collision test researcher
Parts development	Engine design engineer, steering system developer, air conditioning system developer, electronic parts developer, test and evaluation researcher, device design engineer
Application of IT technologies	Auto AI researcher, rechargeable battery researcher and developer, battery system researcher and developer, software developer, network system analyzer, system operation manager, computer system analyzer

The auto industry has created a multitude of related professions. Many of these are related to mechanical engineering, but those related to IT technology continue to increase.



Related majors

Auto
engineering

mechanical
engineering

mechanical
design

precision
mechanical
engineering

lectrical
engineering
and electronic
engineering

All majors related to engineering can be applied to automobile engineering, which has evolved continually since the Industrial Revolution. However, the recent emergence of electric vehicles called for the adoption of new technologies related to motors and batteries. As a result, electrical engineering and electronic engineering have become critical to the industry.

Furthermore, the range of IT parts used in the industry, from sensors to automated control systems and self-driving systems, is continually increasing. The importance of these electrical and electronic parts continues to expand, with their share in a vehicle's manufacturing cost reaching as high as 40%. The convergence of disciplines in the automobile industry, as in other fields, has become essential.



Required aptitude

- Logical, analytical and creative thinking skills are required to understand an automobile's mechanisms and develop new models and technologies.
- A cooperative spirit and people skills are required as collaboration with experts of diverse fields takes place frequently.
- Those who are research-minded, full of curiosity and meticulous about what they do have an advantage.



Expert interview

I study future vehicle technology. I specialize in hybrid and electric vehicles, which have emerged as the center of attention due to environmental concerns. Our lab team recently produced Armadillo-T, a microminiature foldable electric vehicle that made headlines.

When moving on to graduate school, it is most important to choose the right area of research. In order to become an expert, you must dedicate yourself to a certain area for an extended period of time. The wrong choice will only lead struggles. I have also undergone many difficult times, but I was able to overcome them as I was engaged in my favorite subject: automobiles.

Graduated from the Department of Mechanical and System Design Engineering at Hongik University; earned a master's degree at The Cho Chun Shik Graduate School for Green Transportation at KAIST; currently working on his doctorate at The Cho Chun Shik



SDV contest



Written by
Sang-Hyun Im (Incheon seoknam middle School)



Product overview

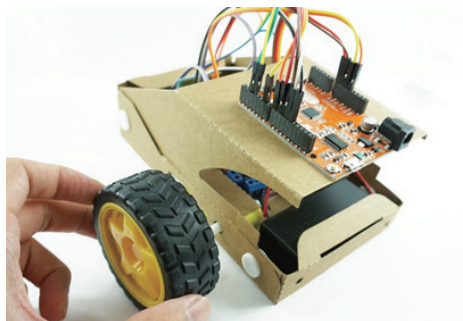
■ Product function

Assembled into and operated as an SDV

■ How it works

Cruises along the road and dodges obstacles

■ Product picture

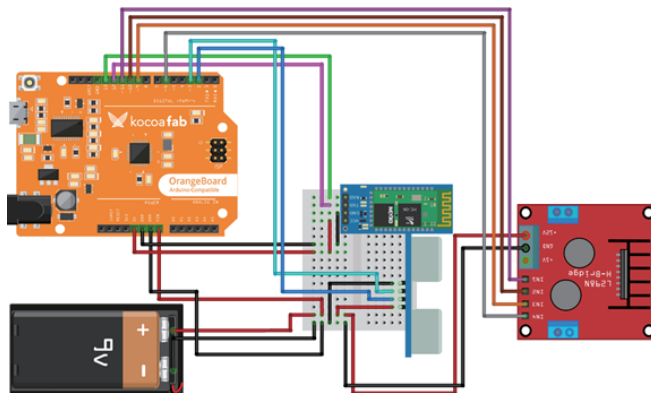


With cables connected



Completed

■ Product structure



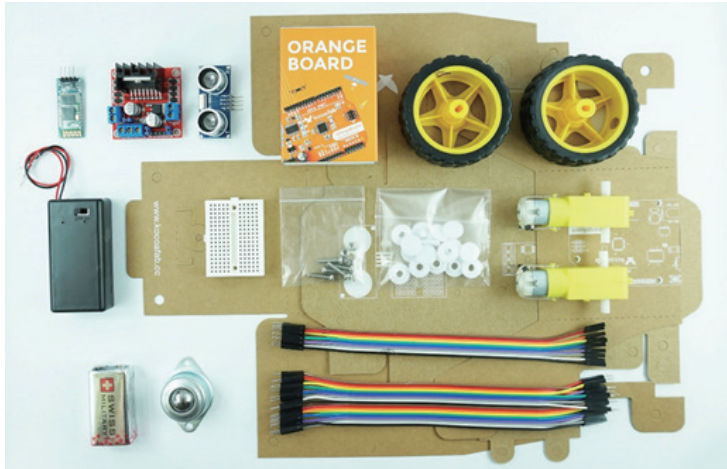
Circuit diagram



Production overview

- **Production time** : Around 1 hour and 30 minutes
- **Needed materials and tools**

- Cardboard car body (3)
- OrangeBoard (1)
- Motor gear (2)
- Motor driver (1)
- Bluetooth module (1)
- Ultrasonic sensor (1)
- Breadboard (1)
- Jumper cable
- Illumination sensor and LED (G, R, Y)
- Resistor (330Ω, 10kΩ)
- Piezo buzzer and push button
- Variable resistor and USB cable
- Wheels and ball casters
- Screwdriver (tools)
- Bolts and rubber rings
- Plastic bolts and nuts
- 9V battery and battery holder



■ Key production principles

connecting Arduino circuit

Introduction to the functions of self-driving vehicles using OrangeBoard, parts and sensors

■ What requires attention in production

- ❶ Do not touch the parts with wet hands as this can cause a shock.
- ❷ Remember that the parts have polarity.
- ❸ Fasten the parts well to their positions.
- ❹ Remember that the motor may be activated and move when the power is connected.

■ Required knowledge and functions

- ❶ How to program using ENTRY or Sketch
- ❷ How to use Arduino (OrangeBoard) and breadboard
- ❸ How to activate sensors and servo-motors by connecting them with breadboard and Arduino
- ❹ How to use smartphone apps

SW Education Module Textbook

❶ Artificial Intelligence

❷ **Driverless Vehicles**

❸ IoT(Internet of Things)

❹ Virtual Reality

❺ CRISPR

❻ Space Launch Vehicles

❼ Natural Disasters

❽ Smart Medicine

❾ Game Engines

❿ Sports Statistics

SW Education Module Textbook ❷ Driverless Vehicles

Driverless Vehicles and Future Transportation

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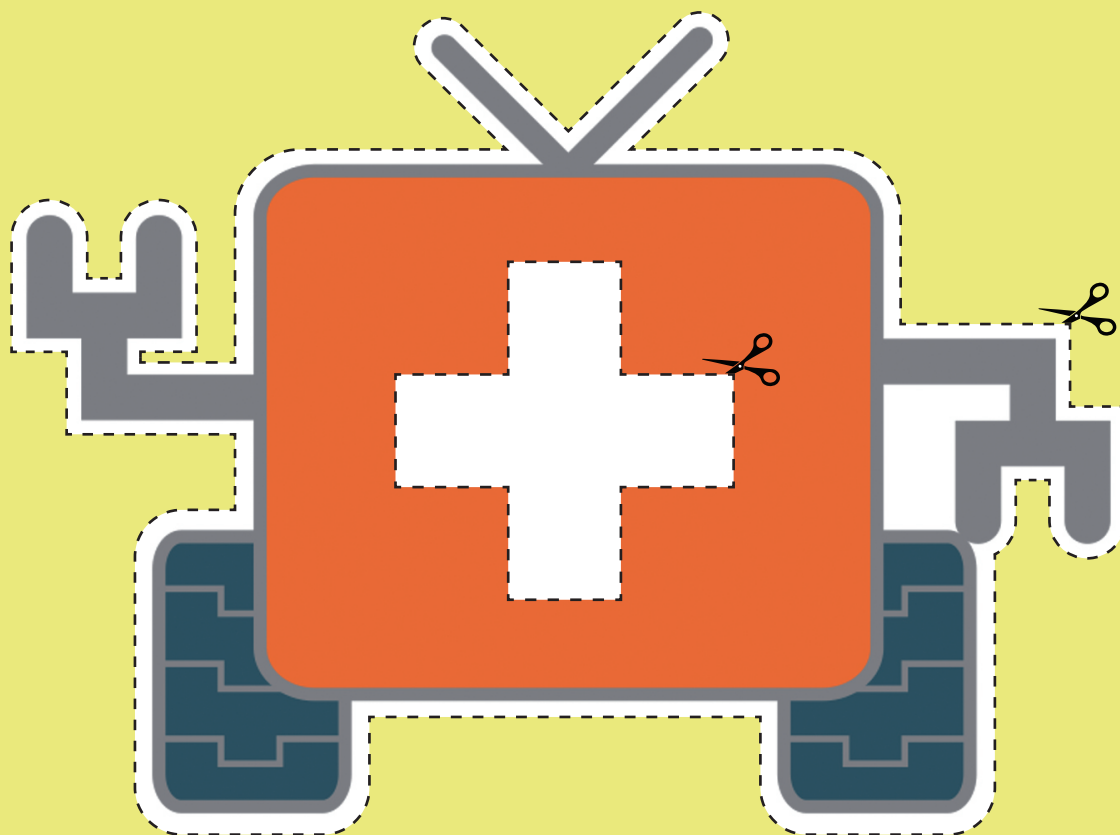
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※ Cut out the cross in the middle, attach a piece of transparent film to the reverse side and mark a dotted line along the robot's eye at the center in the shape of a square.

Computational Thinking Map

1. Era of Driverless Vehicles

Activity 1



Problem Decomposition

Exploring the principle of informational input into the robot



Recognizing Patterns

Searching the patterns through which the robot's eye finds the path



Abstraction

Expressing information input through the robot's eye in numbers

2. Find the Shortest Route!

Activity 2



Problem Decomposition

Analyzing and collecting weights for different routes between departure and arrival points on a map



Recognizing Patterns

Exploring the principle for calculating weights and finding the shortest path



Abstraction

Showing weights varying by departure point in a table



Making an Algorithm

Making an algorithm using pseudocodes or a flow chart to find the shortest path



3. Make Your Own Driverless Vehicle!

Activity 3



Problem Decomposition

Exploring the principle of Hamster Robot's operation



Recognizing Patterns

Finding the principle for eliciting Hamster Robot to move around obstacles and reach its destination



Abstraction

Extracting key elements required to move autonomously using the sensor and expressing them in simple signs or illustrations



Making an Algorithm

Making an algorithm allowing Hamster Robot to move around obstacles and reach its destination



Automation

Making a program for Hamster Robot to move around obstacles and reach its destination

software

education module



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