USER MANUAL

Remote Robot Control BCI system Based on Motor Imagery

NeuroComputing LAB,
Korea Institute of Science and Technology

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User Manual

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Chapter 1

Installation

Under normal conditions, This Program does not impact on any programs already installed. However, only guarantees that programs will interact without problems if the programs concerned have been tested for compatibility. This applies to systems with the Microsoft operating system Windows® 10 or later, provided no modifications have been made to the provided operating system configuration (including official service packs and updates).

System requirements

The following hardware and software requirements must be fulfilled:

- ✓ Operating system: Windows® 10 or later (It may work in lower versions, but we are not sure about that)
- ✓ Minimum configuration: Intel Core i5 or higher, 512 MB of RAM, 8 GB hard disk, graphics adapter with 64 MB of RAM
- ✓ We recommend that a monitor with a screen diagonal of at least 15 inch is used.
- ✓ You must have equipment to acquire brain waves. We provide LSL programs for Biosemi, BrainProduct(actiCHamp), Cognionix, and G.tec (gNeedaccess) equipment. If you use other equipment, please install and use a separate LSL(Lab streaming layer) link program required for that equipment.
- ✓ Since all devices acquire data through LSL, LSL must be available. For more information about LSL, see Lab Streaming Layer (https://labstreaminglayer.org/#/)
- ✓ When installing for the first time, an internet connection is required.
- ✓ Depending on the selected mode, a serial port connection is required.

1. Installing program under Windows

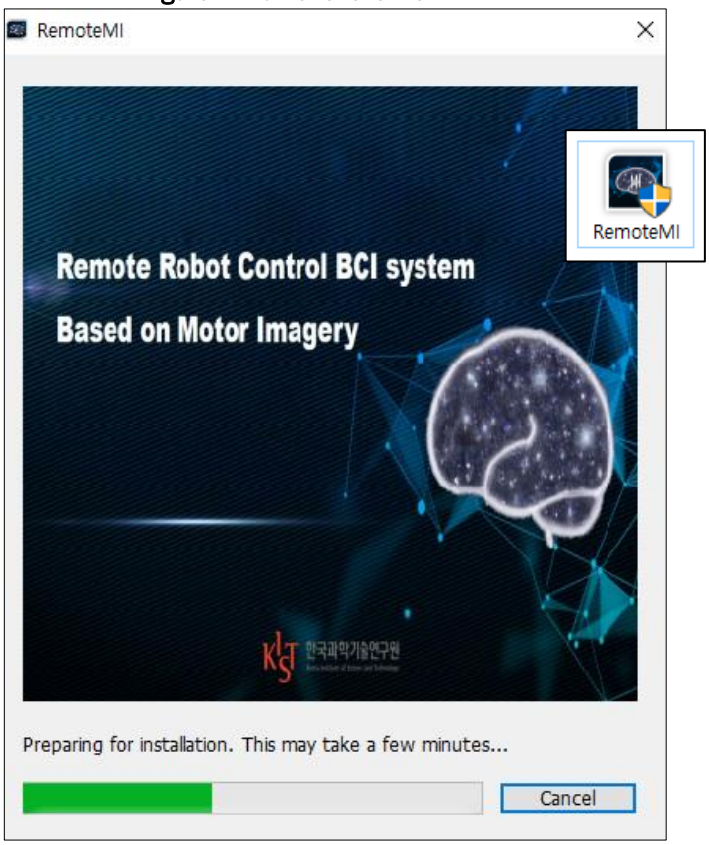
Proceed as follows to install Analyzer under Windows

1 Start Windows

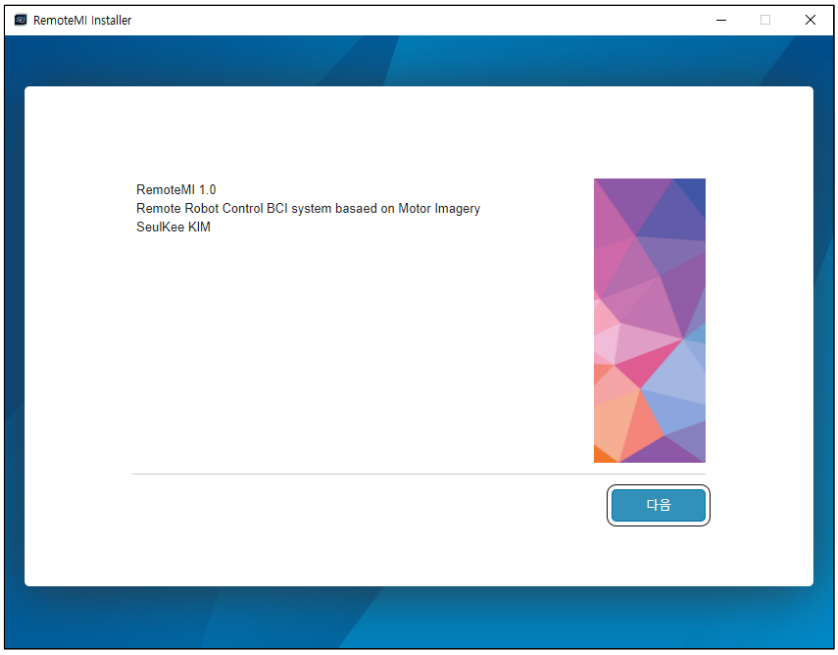
2 Download the program from the link here - NIBCI/IntegrationBCI (github.com) (https://github.com/NIBCI/IntegrationBCI)

3 Open the folder and double click Integration.exe to run the program. (See Figure 1)

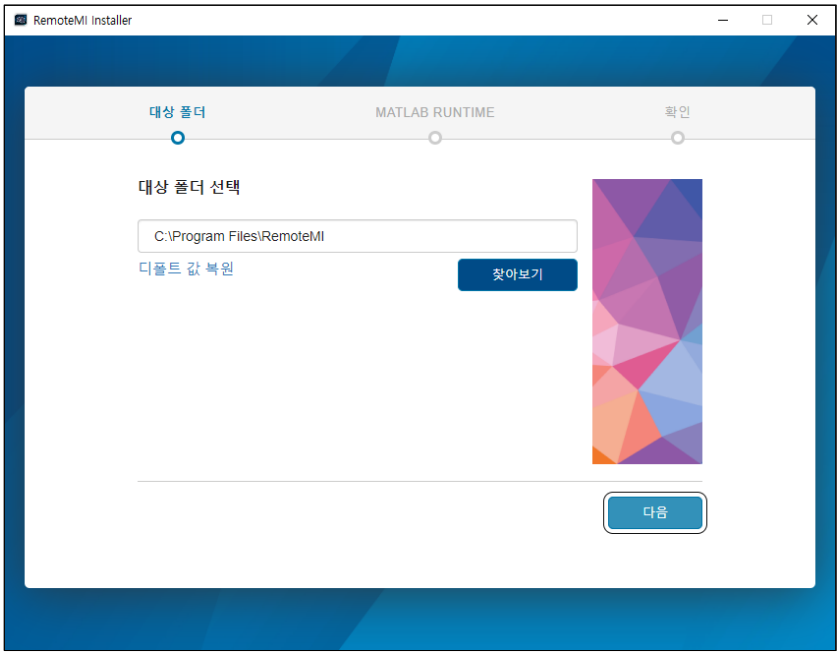
Figure 1. Run this .exe file



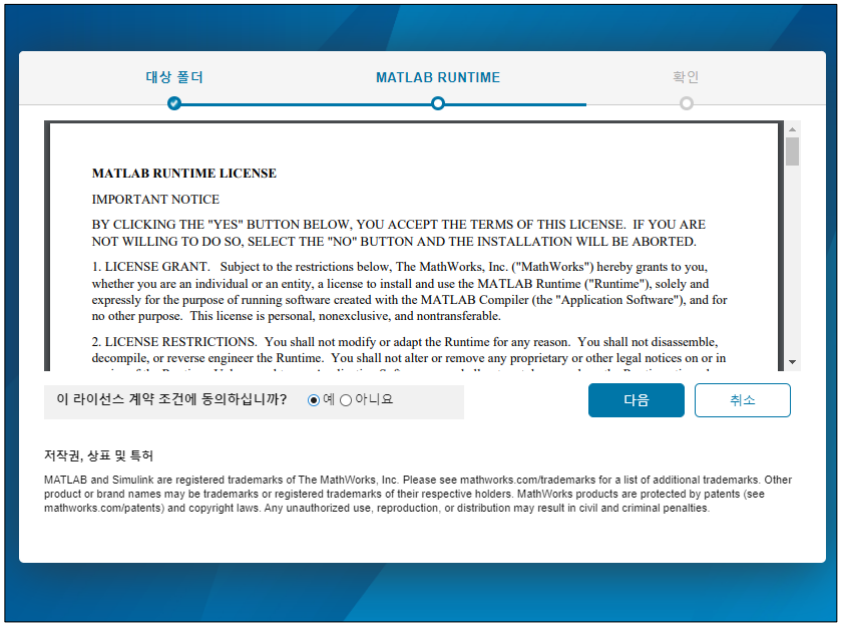
4 Click the Next.



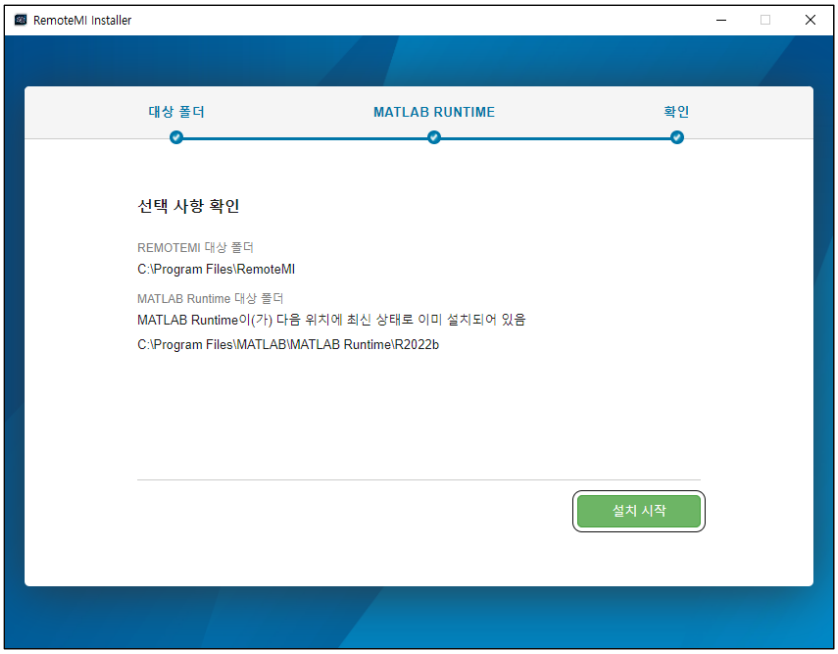
5 After checking the installation path, click Next.



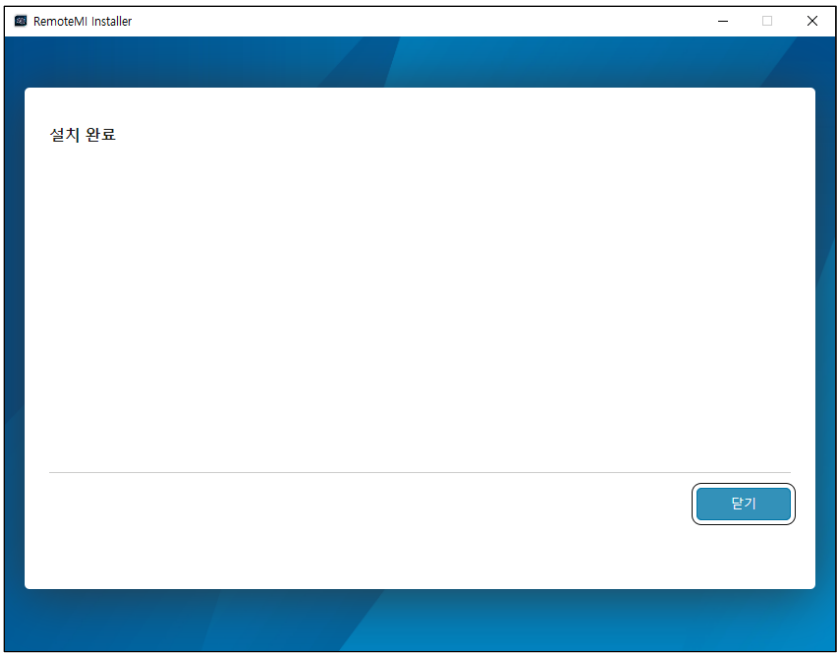
6 This program requires the runtime environment MATLAB. If MATLAB Runtime is not present on your system, then a message is displayed.



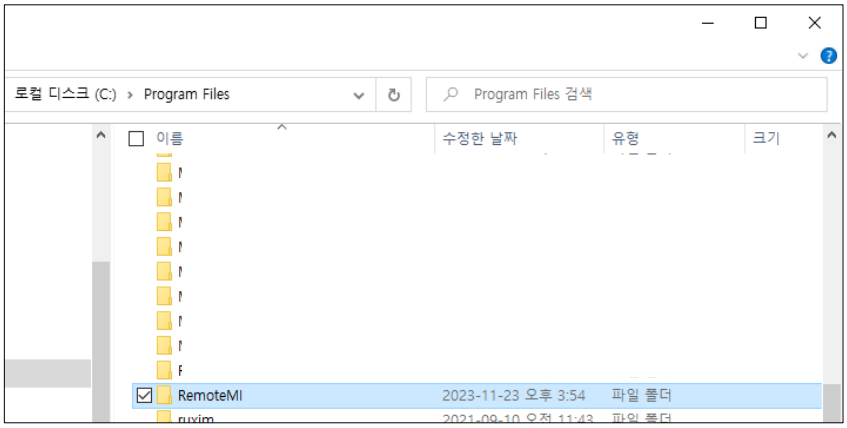
7 After checking the installation environment for MATLAB Runtime, click Start Installation.



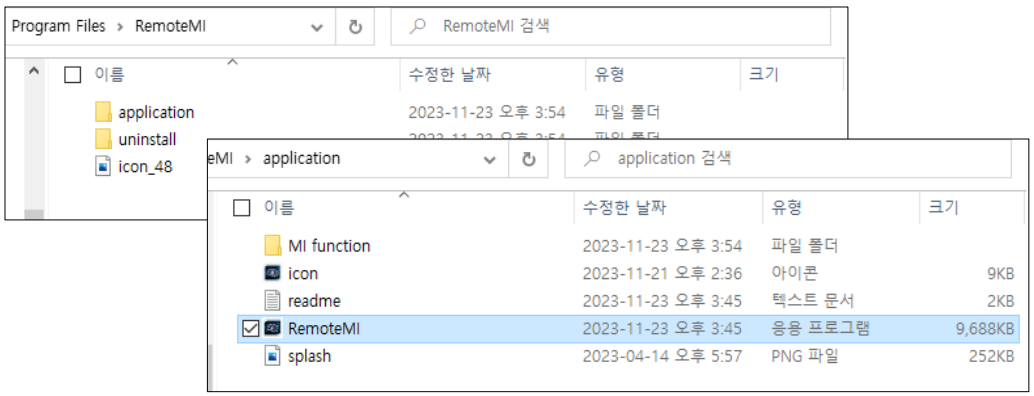
8 When installation is complete, click Close.



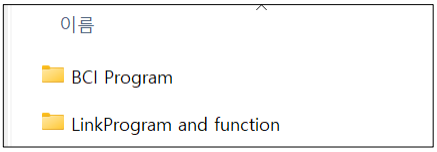
9 If you check the installation path, the **RemoteMI** folder has been created.



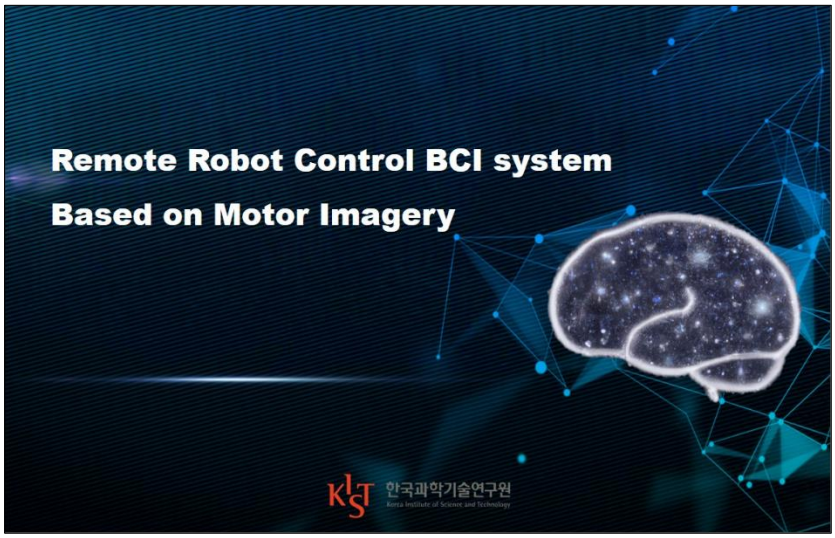
10 Enter the folder and enter the application. Find the **MealAssistant.exe** in the Application folder.



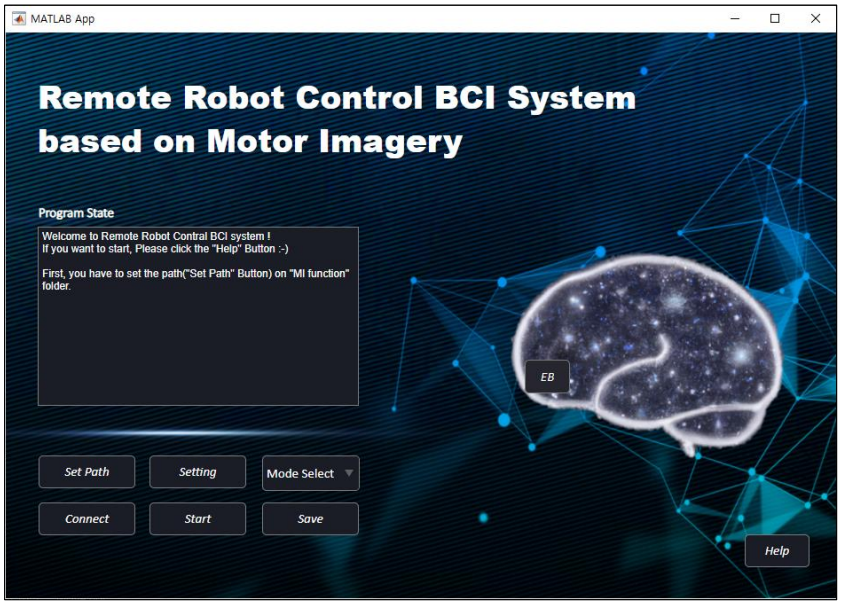
11 **Copy "RemoteMI.exe" and "MI function" folder to the BCI Program folder** created after installing BCI Integration. You can run the file by selecting *BCI Program-Robot control with MI* in the BCI Integration program.



12 The program startup background appears as shown below.

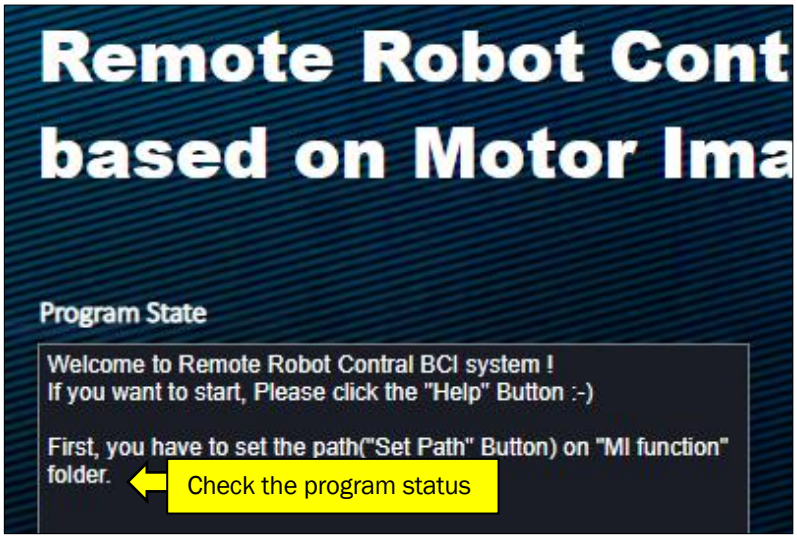


13 If the program runs as follows, you are ready to use Integration for BCI.

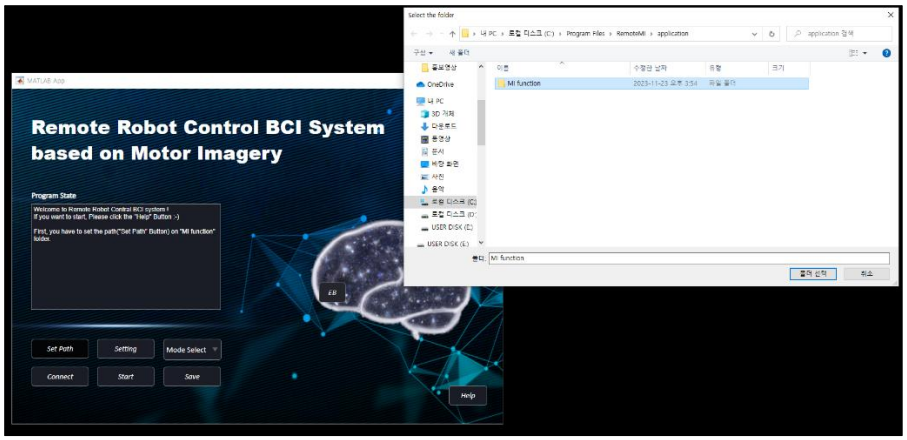


2. Running the program and how to use it

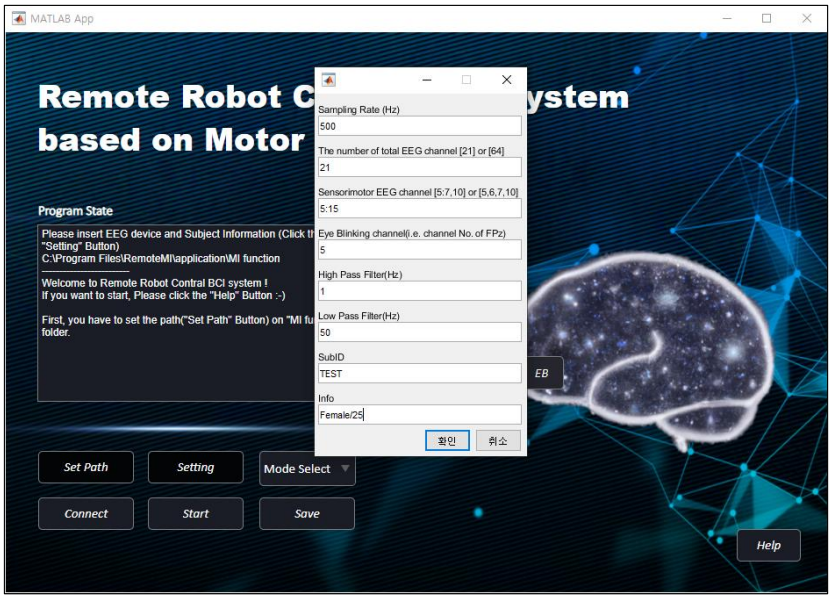
1 Check the program status window as shown below. You can get help on how to perform through the program status window.



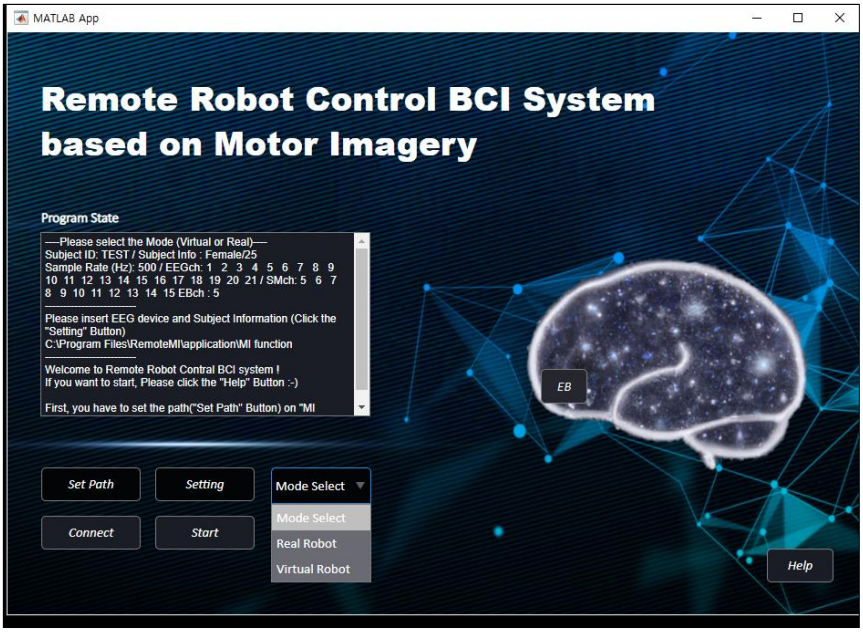
2 Click the “Set Path” button, and select the **“SSVEP function”** folder



3 Press the **"Setting"** button and enter the EEG information such as *sampling rate* and *channel index* you want to measure. *SubID* and *Info* can be entered as options.



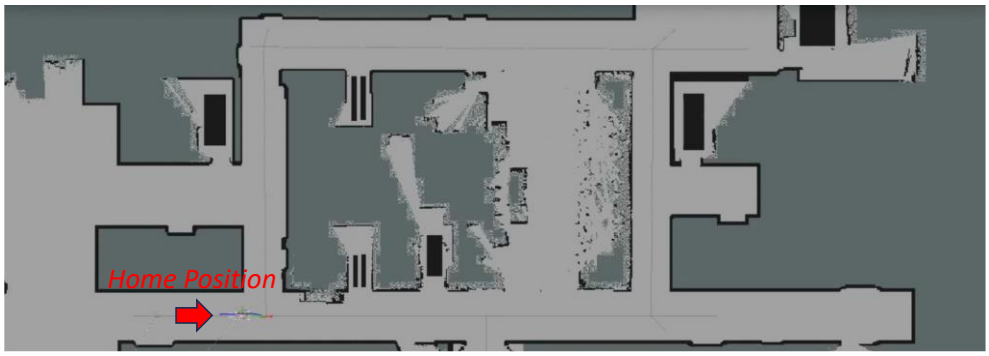
4 Open the *Mode Select toggle* and **select the Remote Robot Control Mode** you want to use



- ***Real Robot***: When you want to use it while communicating with an actual robot in a remote location using EEG.
- ***Virtual Robot***: When you want to experience the EEG system in a virtual environment through a monitor without a remote robot.

4-1. If you select **“*Real Robot*”**, **the Remote Contorl robot** must be connected.
Please prepare our robot, Minibot. Please charge the battery in advance. The robot's operating time is approximately 3 hours with the entire framework running.

1) To perform a real robot scenario, place the robot in the initial location. The robot performs scenarios on the first floor of the International Cooperation Building. You can use the remote control to move the robot. At this time, please indicate the direction and location as shown below.



<Robot's Home Poisition>


<Joystic for robot operation>

2) Please connect to the network. There are several ways to connect to the network. First, please use the guest Wi-Fi on the first floor of the International Cooperation Center. Second, please configure a separate local network. The key is that all devices must be on the same network.
3) Please prepare a remote PC. The remote PC handles data and operation of the robot from a remote location instead of the moving Minibot.

4) Please remotely connect to the robot PC from the terminal of the remote PC.

```
$ gogoMinibot #ssh -X kist@minibot-pc
```

5) Please run Roscore. It runs automatically during Roslaunch, but it is recommended to run it separately for the stability of the framework.

```
$ roscore
```

6) Please activate the serial port

```
$ ./serial_import.sh
```

Below is the activation Bash syntax.

```
#!/bin/bash
sudo chmod 666/ /dev/ttyACM0
sudo chmod 666/ /dev/ttyUSB0
```

7) Please run the robot navigation basic package.

```
$ roslaunch sc_navigation navigation.launch
```

8) Run the BCI connection framework package

```
$ roslaunch sc_interaction interaction_robot.launch
```

9) Return to the remote PC prompt.

10) Please run joystick-related Bash.

```
$ ./serial_import.sh
```

Below is the activation Bash syntax.

```
#!/bin/bash
sudo chmod xpad
sudo xboxdrv --silent
```

11) Please run the BCI framework interaction package.

```
$ roslaunch sc_interaction interaction_user.launch
```

12) Please run the navigation connection and GUI package.

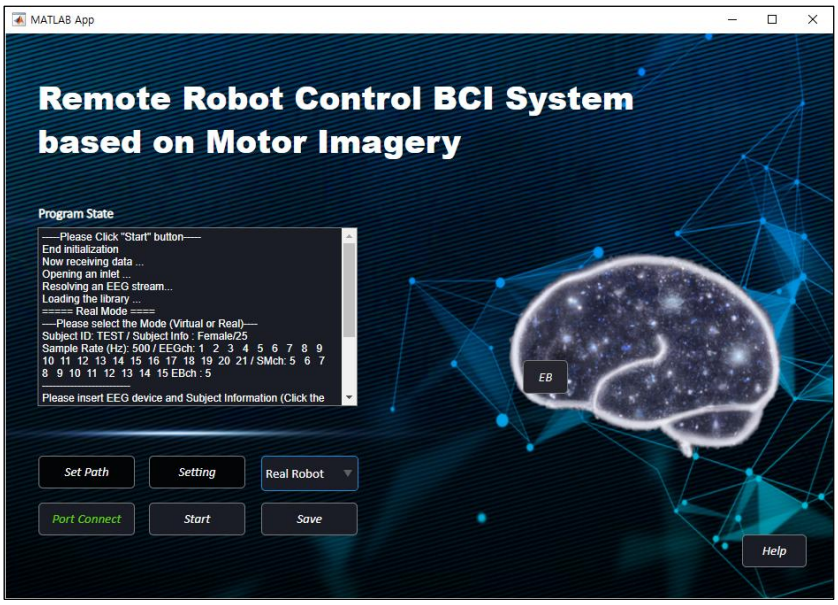
```
$ roslaunch sc_gui start_ver2.launch
```

13) When using Firebase to send and receive external data, please run the Firebase package (Option)

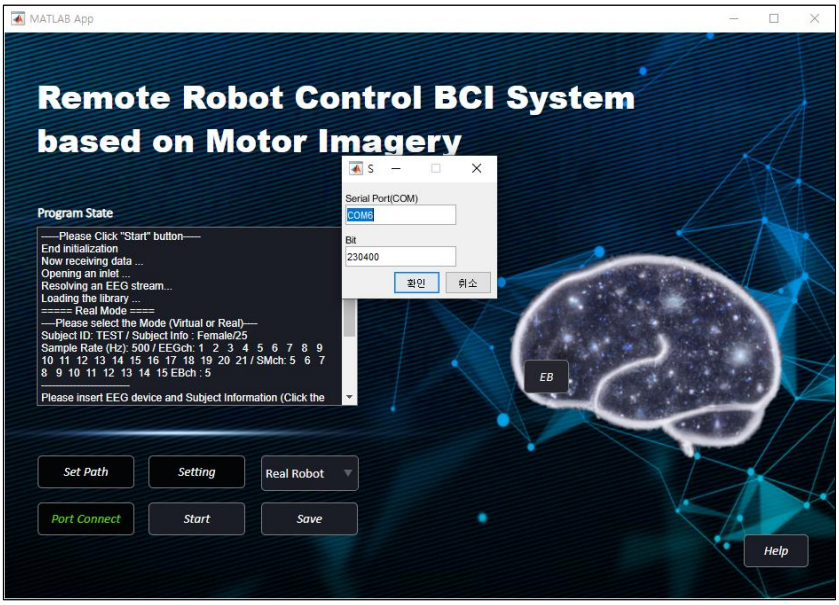
```
$ roslaunch db_interface db_interface.launch
```

14) Now you can view the actual interaction screen and run the scenario.

After connecting with Remote Robot, the “**Connect**” button will change to green.



Press the green 'Port Connect' button and
enter the **Serial port name and bit information**



If LSL is installed properly, the program status below appears.

.

Now, you can start the BCI program by pressing the **“Start”** button.

The operation of the remote robot follows the following protocol.

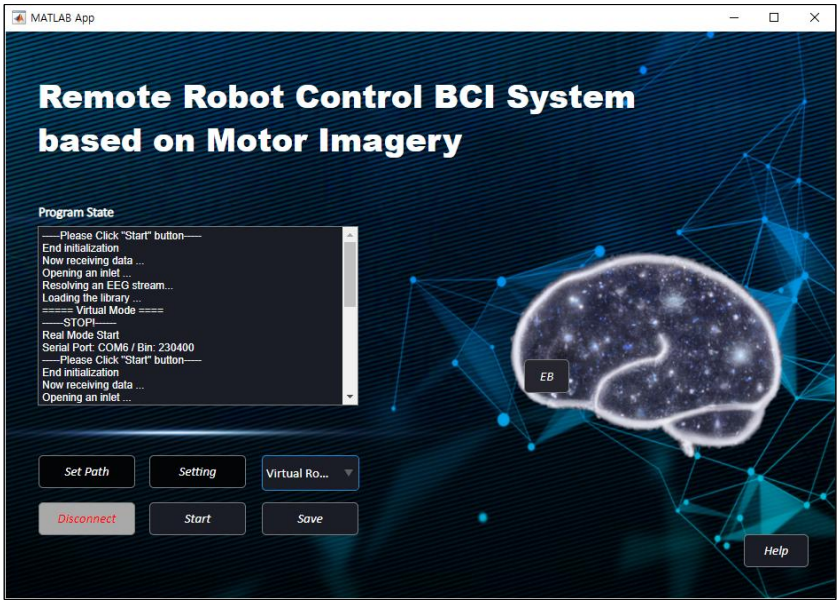
1) You need Server Computer for communication with ROS and BCI. Also, you need BCI computer with MATLAB. Between Server Computer and BCI computer Connected with serial port.
2) After connection, Link the cloud server where you want to communicate data.
3) Run ROS and BCI system through the following process 4-1 3).
4) You can see the camera view along with arrow directions. The yellow arrow indicates the route the robot can take. Perform MI on the arrow in the desired direction among the yellow arrows.
   - Up arrow: Go command. Imagine foot movement
   - Right arrow: Right rotation command. Imagine movement on the right hands
   - Left arrow: Left rotation command. Imagine moving your left hands

5) Start the BCI system by blinking or pressing the EB button. After performing Motor Imagery, check the selected MI results through the BCI system.

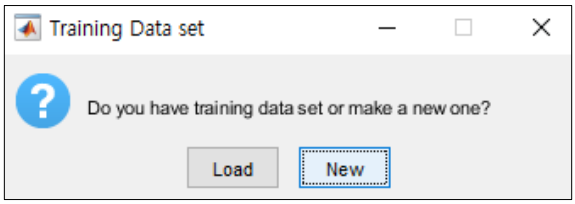
6) When the Remote Robot is facing in the desired direction, stop rotating by blinking or pressing the EB button.

7) When rotation stops, the remote robot moves in that direction.

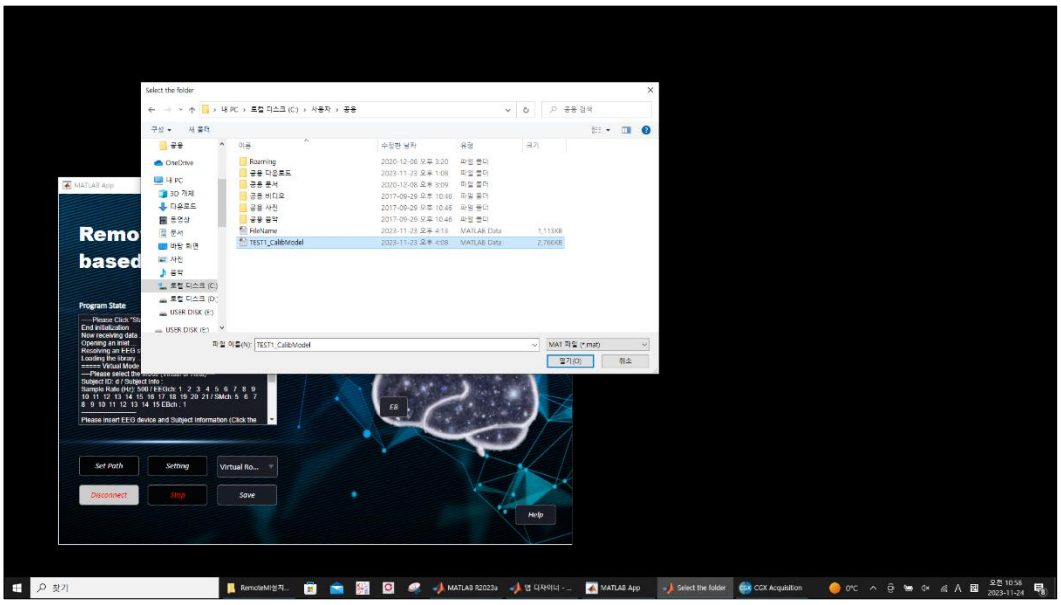
4-2. If you select “**Virtual Robot mode**”, do not need to click the “Connect” button. When you click the **"Start" button**, If LSL has been installed properly, the program status below will appear.



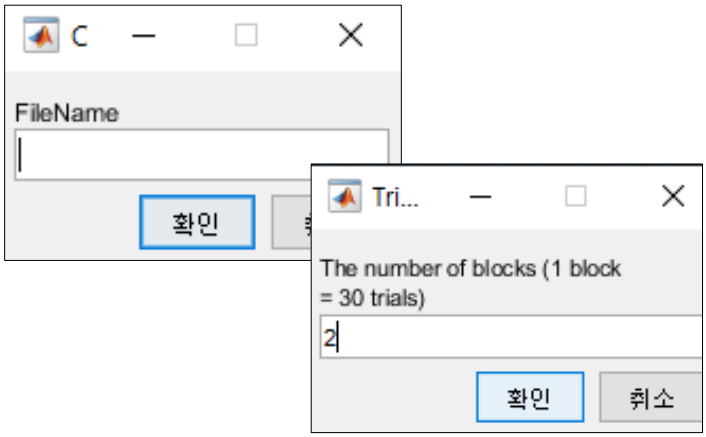
You can select a **training mode** depending on whether you have a training set or load existing data (.mat).



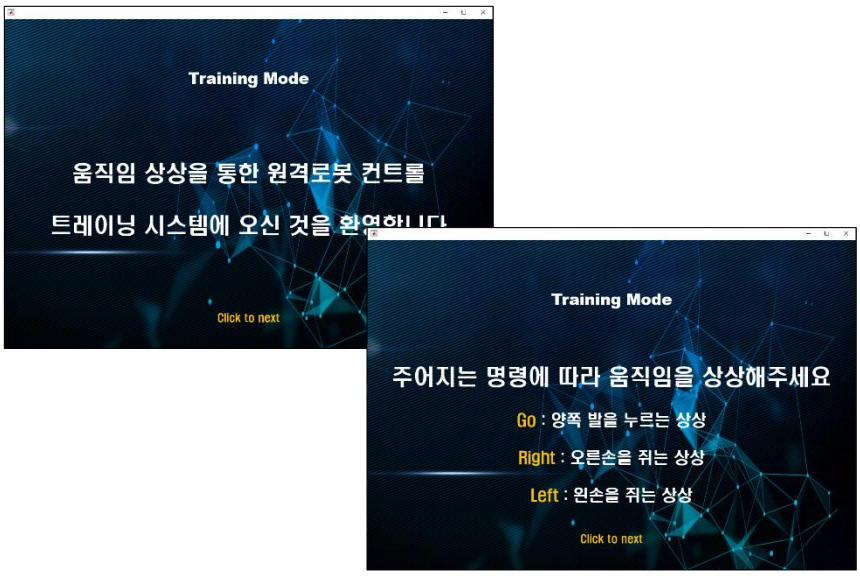
If you have a training dataset, press **Load** to load Training data.



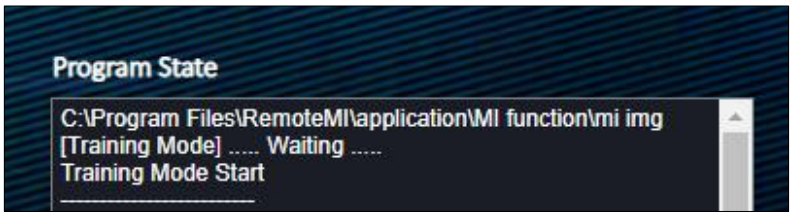
If you do not have a training dataset, press **New** to run Training mode.
Enter the file name to save and the number of trials to perform.



When you **click on the screen**, the virtual environment mode starts.

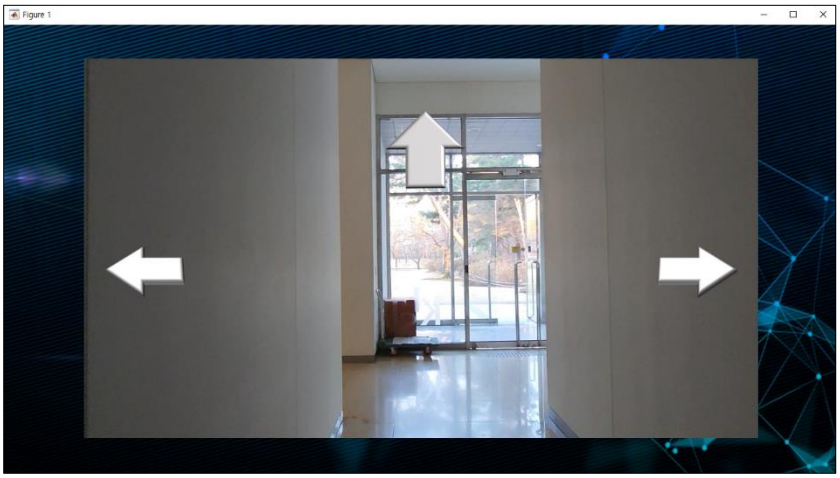


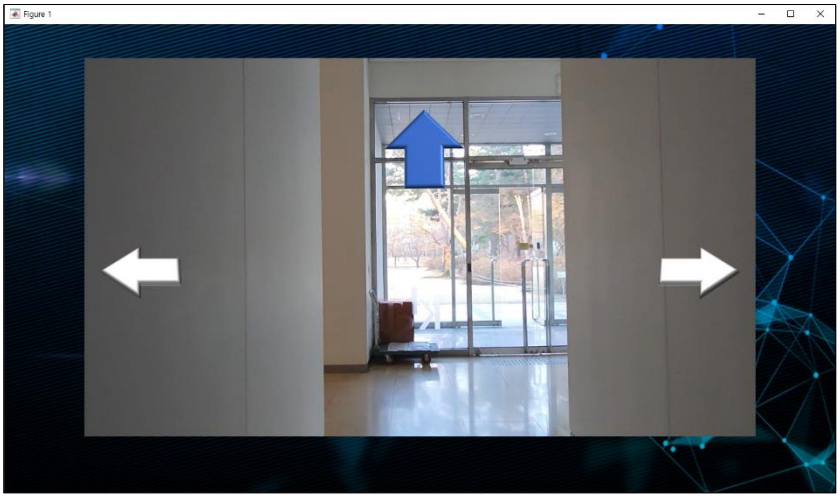
Please wait a moment for the video to load. After loading, a virtual video is presented on the monitor that can be viewed through the remote robot.



Look for a moment in the three directions shown in the video. Then imagine the movement indicated by the direction indicated by the blue arrow.

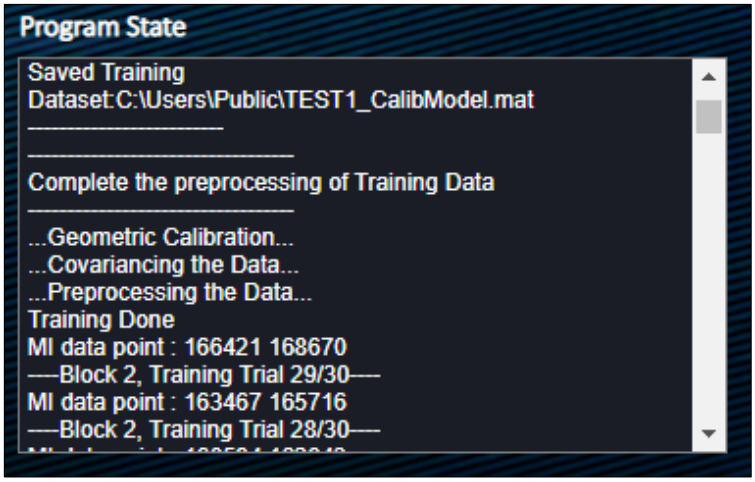
- Right: Imagine squeezing and opening your right hand
- Left: Imagine squeezing and opening your left hand.
- Up: Imagine pressing both feet



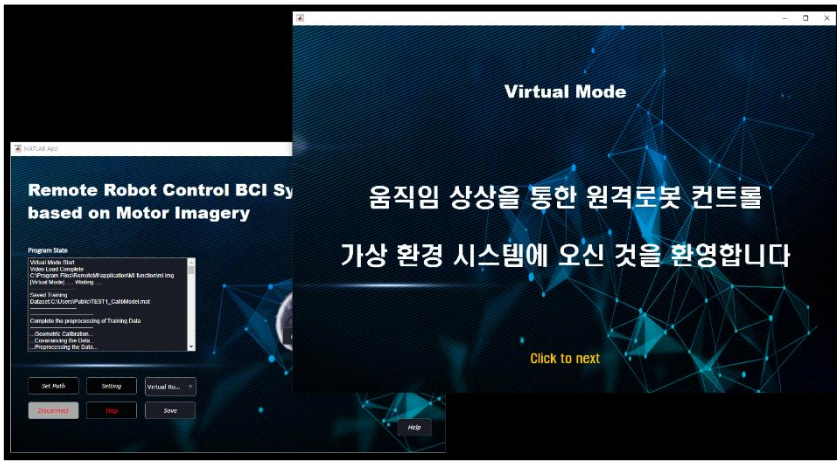


You can check the training progress in Program state.

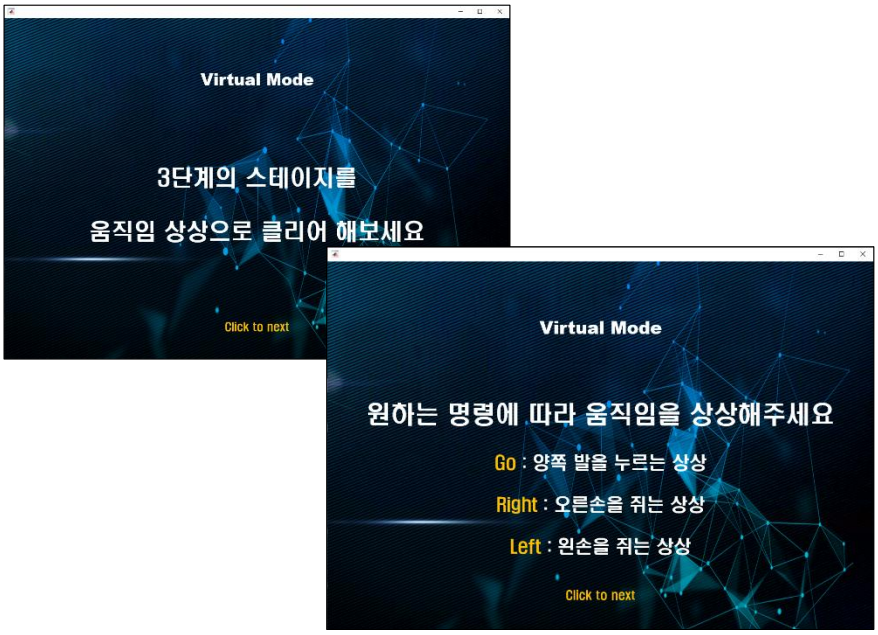
When training is completed, the **'File name_CalibModel.mat'** file is saved in **C:\Users\Public**.



Immediately following, **Virtual Mode** is presented.



Virtual Mode consists of clearing three stages through Motor Imagery.



Perform Motor Imagery to get to the target destination on the given map.

[STAGE 1]

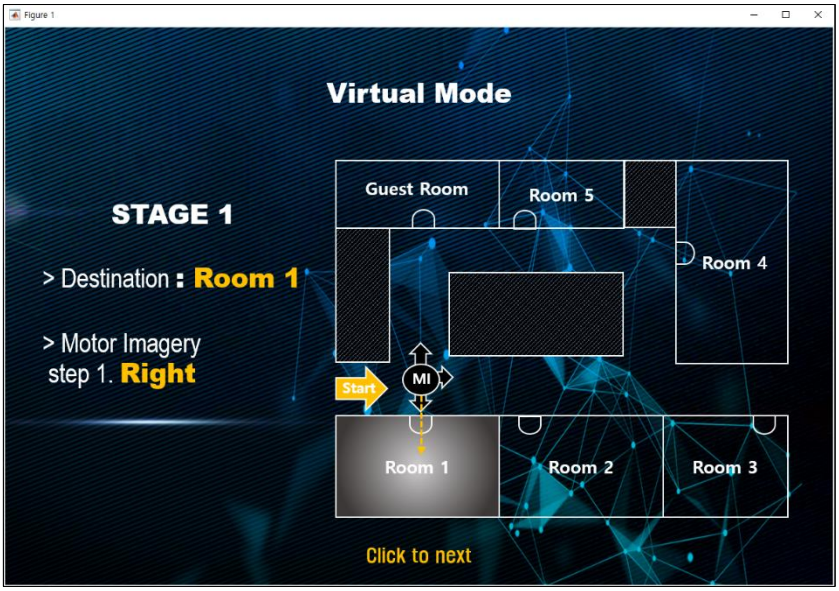
- Destination: Room 1
- MI command: Right

[STAGE 2]

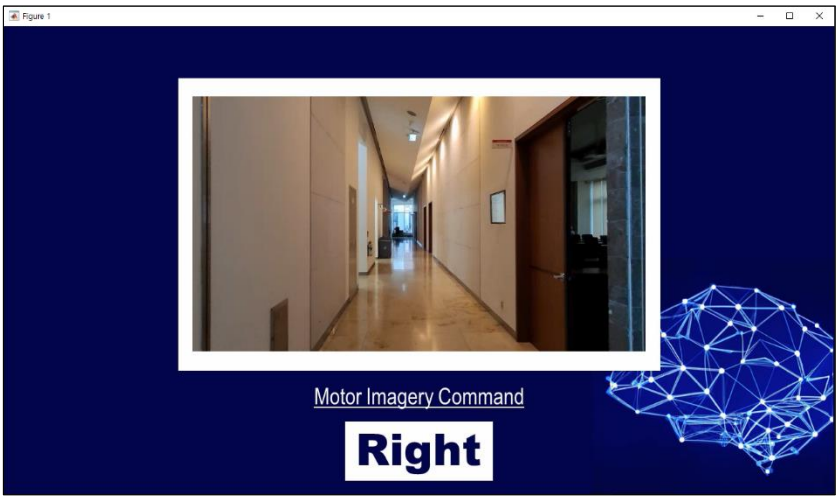
- Destination: Room 2
- MI command: Go-Right

[STAGE 3]

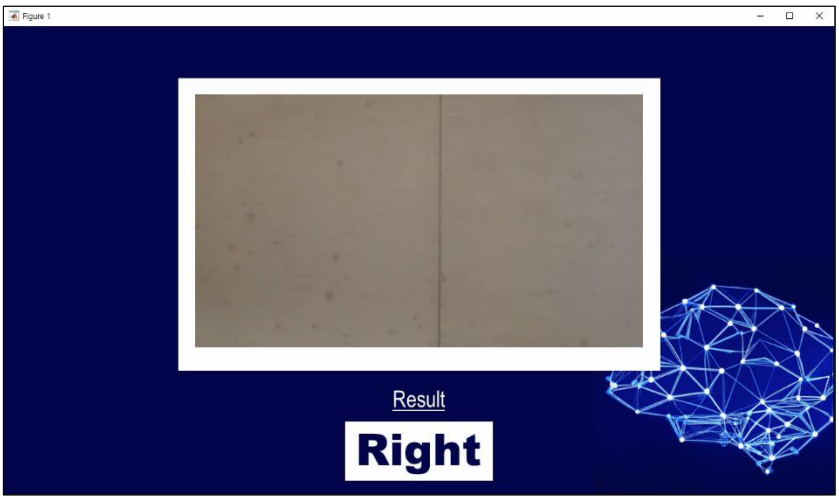
- Destination: Room 4
- MI command: Go - Left - Right



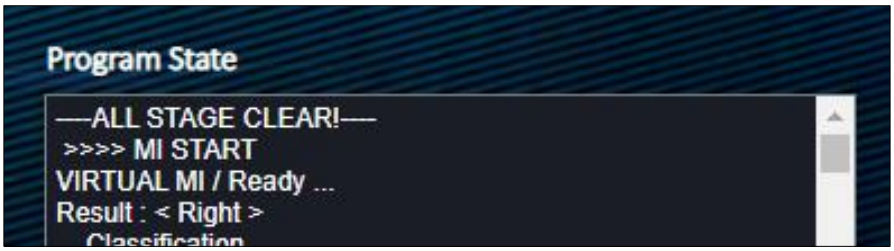
While the robot moves straight, command the next direction to go through Motor Imagery.



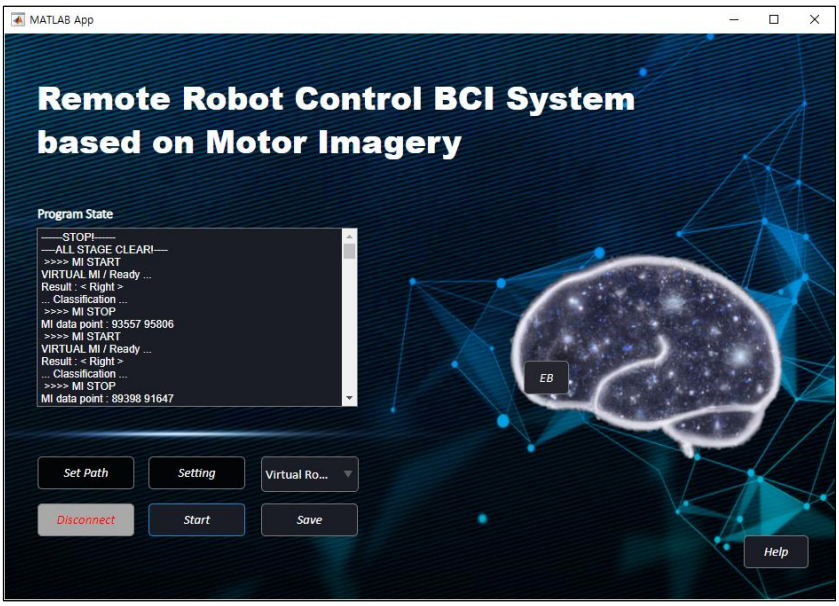
The results of Motor Imagery are presented in video.



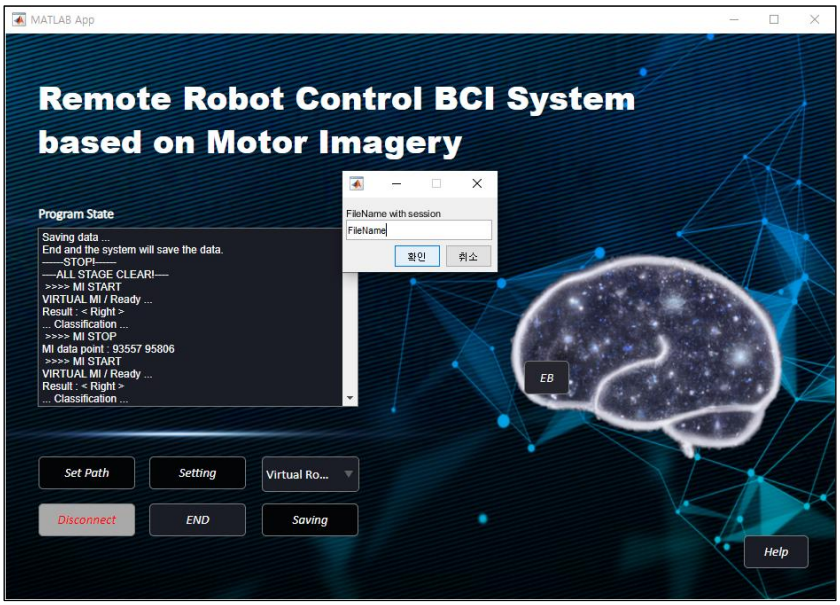
You can check the accuracy by clearing all three stages.



If you want to quit, press the **“STOP”** button.

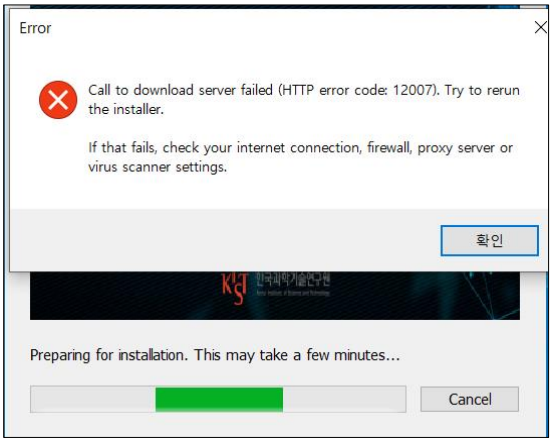


5 If you want to save the recorded EEG data, click **“SAVE”** button.

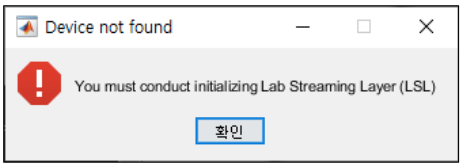


3. If you have some problem with this program

Case 1. When installing an executable file, if the following message appears, check your Internet connection. An Internet connection may be required during initial installation.



Case 2. If Program status is stopped at LSL_loadlib after pressing START, check whether the device you want to use supports LSL. Check whether LSL communication is open through the LSL link program provided by each device.
For more information, please check https://labstreaminglayer.org/#/



Case 3. If the welcome message or the virtual environment does not run after pressing “START”, check whether you have set the path to the **“MI function”** through **“Set path”** button.

For any other problems, please contact us through our website and we will respond as soon as possible.