**User Interface Manual and System Operation**

# Table of Contents:

[Table of Contents: 1](#_Toc195375411)

[Summary 1](#_Toc195375412)

[UserInterface 2](#_Toc195375413)

[Operating the System 3](#_Toc195375414)

[Joystick Control 4](#_Toc195375415)

[Button Functions 4](#_Toc195375416)

# Summary

This document describes the functions of the user interface and contains operation instructions for operating team 205’s assistive robotic aid. There are eight interactable systems on the instrument panel: the joystick, two switches, and five buttons. The joystick is a three axis joystick, with two buttons on top for additional manipulation of the robotic arm. The switches are used as a system enable and a joystick enable, and the five buttons are used to save specific functions for the robotic arm. Together, these systems allow the user to manually control the robotic arm including pitching the end effector, as well as programming and recalling specific locations of high value to the user.

To access tutorial videos, use the QR code below and navigate to the “Tutorial Videos” folder. Find the video that corresponds to the correct instructions below. The tutorial videos are annotated and follow the same procedure as described below.

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# UserInterface

A close up of a control panel

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Joystick Buttons

Switch 2 (S2)

Switch 1 (S1)

LED 1 (LED1)

LED 2 (LED2)

Button 5 (B5)

Button 4 (B4)

Button 3 (B3)

Button 2 (B2)

Button 1 (B1)

Joystick 1 (JSTK1)

LED 3 (LED3)

Figure . Physical User Interface

**Joystick 1 (JSTK 1):** JSTK 1 is used to manually control the robotic arm, where forward-backward movement of the joystick corresponds to forward-backward movement of the robotic arm, left-right movement of the joystick correspond to left-right movement of the robotic arm, and twisting of the joystick corresponds to up-down movement of the robotic arm (see S. Joystick Control).

**Switch 1 (S1):** S1 is used to change the system state from static into joystick control mode. When the system is in static mode, the joystick and buttons are inoperable, and the software is not running any commands. When the system is in joystick control mode, the joystick and buttons are operational and normal movement occurs.

**Switch 2 (S2):** S2 is used to enable and disable the joystick for safety purposes. S2 mounts between the power from the ESP32 to the joystick, completely removing energy from the joystick when switched off.

**Button 1 (B1):** B1 is used as the unstow/ready/home function for the robotic arm. Pushing B1 will cause the arm to move from its current position to its defined “home” position.

**Button 2 (B2):** B2 is used to program and run the drinking function. When programming, the system will require the user to save four point that will designate the path from the drink to the user. After programming the function, pushing B2 will path to the drink, and move through the saved positions to the user, then back to the drink location.

**Button 3 (B3):** B3 is used to program and put the arm in stow1 position. Pushing B3 will cause the arm to move through a linear path from its current position to its stow1 position.

**Button 4 (B4):** B4 is used to program and put the arm in its stow2 position. Pushing B4 will cause the arm to move through a linear path from its current position to its stow2 position.

**Button 5 (B5):** B5 is used to operate the LED located on the end effector of the robot.

**~~LED 1 (LED1):~~** ~~LED1 indicates the system status, if LED1 is lit up, the system is operational. If the LED is off, then the system is not operational, but is still powered on.~~

**~~LED 2 (LED2):~~** ~~LED2 indicates whether JSTK1 is receiving power. If LED2 is lit up, the joystick is receiving power. If the LED is off, then only the joystick has been disconnected from power.~~

**\*LED 1 and 2 were removed from the final prototype as they were causing electrical issues that could not be resolved\***

**LED 3 (LED3):** LED3 is the indicator for the buttons, showing which mode the system is in and specifically what part of the function the system is in. LED3 behavior will be described more in “Button Functions” Section

# Operating the System

Powering on the system:

* To power on the system, flip the **switch on the battery** to the “I” state (so that the “I” is depressed).
* The robotic arm will now run through setup code to go to an initial “ready position”. Please ensure that the immediate space around the robotic arm is clear to prevent any interruption.
* Once the robot arm has stopped moving and **LED3** blinks briefly, the setup has been completed.

Operating the system:

* Once the setup has been completed, switch **S1** to the on position (such that the “I” is depressed). The buttons are now operational.
* Switch **S2** to the on position (such that the “I” is depressed).
* The joystick is now operational, ~~both~~ **~~LED1~~** ~~and~~ **~~LED2~~** ~~should be lit~~. The system is now fully operational and should be treated as such.

Powering off the system:

* Move the robot to the location to be stored at (ideally, programming **B3** to be the stow position when turned off saves time and simplifies the power off process).
* Switch **S2** to the off position (such that the “0” is depressed). The joystick is now inoperable.
* Switch **S1** to the off position (such that the “0” is depressed). The buttons are now inoperable.
* Switch the **power switch on the battery** to the off position (such that the “0” is depressed). The system is now powered off.
* Note that there are rubber bands on the robotic arm that are used as dampeners during motion. When the system is completely switched off, these rubber bands may cause motion due to the elastic properties. It is recommended that either the stow1 or stow2 positions be programmed to a location where the rubber bands are maximally stretched or minimally stretched.

# Joystick Control

Twisting the top of the joystick clockwise will move the arm up (+Z)

Twisting the top of the joystick counterclockwise will move the arm down (-Z)

+X

A black knob with two buttons

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Open the end effector

Close the end effector

-Y

+Y

-X

# A close up of a control panel AI-generated content may be incorrect.Button Functions

**B1: Button 1 is used to program and recall the ready/home position.**

To save a position:

1. Hold **B1** for five seconds (count in your head) then release
2. **LED3** will begin flashing after two seconds
3. The system is now in “Programming” mode
4. Using the joystick, move the arm into the position that you would like to save for the ready/home position
5. Push **B1** briefly then release to save this position, **LED3** will go static for one second, then turn off
6. The position for **B1** has now been saved in the memory for later recall
7. The system is now in joystick control mode and can be normally operated

To recall the ready/home position:

1. Push **B1** for one second or less, then release
2. **LED3** will go static, and the arm will move to the previously saved position for the ready/home position, the joystick is inoperable during this movement
3. Once at the saved position, **LED3** will turn off, and the system will return to joystick control mode and operate normally

**A close up of a control panel

AI-generated content may be incorrect.B2: Button 2 is used to program and run the drink function.**

To program the drink function:

1. Hold **B2** for five seconds (count in your head) then release
2. **LED3** will begin flashing after two seconds
3. The system is now in “Programming” mode
4. Using the joystick, move the arm to the position of the portable cupholder that contains the drink such that the top if the handle is resting inside the end effector of the robot
5. Push **B2** briefly then release to save the drink position, **LED3** will go static for one second, then continue flashing
6. Using the joystick, move the arm to a first safe position that extends outside the dimensions of the case. Assuming the system is mounted on the lefthand side of the chair, it is recommended that the first safe position be forward and left of the system

A machine with a black arm

AI-generated content may be incorrect.A machine with a long arm

AI-generated content may be incorrect.

1. Push **B2** briefly then release to save the “safe1” position, **LED3** will go static for one second, then continue flashing
2. A machine with a large arm

   AI-generated content may be incorrect.A machine with a black handle

   AI-generated content may be incorrect.Using the joystick, move the arm to a second safe position that extends outside the dimensions of the case. Assuming the system is mounted on the lefthand side of the chair, it is recommended that the second safe position be forward and right of the system
3. Push **B2** briefly then release to save the “safe2” position, **LED3** will go static for one second, then continue flashing
4. Using the joystick, move the arm in front of the user where the drink should end up
5. Push **B2** briefly then release to save the “user” position, **LED3** will go static for one second, then turn off
6. You have now saved the path that the drink function will take when it is called. The drink will pass through the four points saved during this process, please ensure that there is adequate clearance for the drink to pass through these points. If there is not, restart the process at **Step 1** to resave new positions for these four points

To run the drink function:

It is recommended that the robot be positioned in its ready/home position before running the drink function. The robot always moves linearly between two points and is not equipped with obstacle avoidance. Before running the drink function, ensure the path between the current position and the first safe position that was previously programmed is not obstructed.

1. Push **B2** for one second or less, then release
2. **LED3** will go static, and the arm will initially move to the “safe1” position
3. Next, the arm will move 200 mm above the “drink” location and open the end effector. Then the arm will move down to secure the handle in the end effector. The arm will then move back up 200 mm above the “drink” location
4. The arm will move to the “safe1” position
5. The arm will move to the “safe2” position
6. The arm will move to the “user” position. At this point, the arm will stop moving. The position can now be adjusted using the joystick in the event that the saved position is too far away from the user. Please note that at this time, the system is still operating within the drink function and is not in normal joystick control mode, it is only allowing the user to adjust the drink position around their face for these moments.
7. Once the user is finished drinking, push **B2** briefly, then release
8. The arm will move to the “safe2” position
9. The arm will move to the “safe1” position
10. The arm will move 200 mm above the “drink” position. At this point the arm will stop moving. The position can now be adjusted using the joystick in the event that the portable cupholder is not aligned with the cupholder on the chair. **IF THE POSITION IS ADJUSTED, THE CUP MUST BE MANUALLY LOWERED INTO THE CUPHOLDER USING THE JOYSTICK.** Please note that at this time, the system is still operating within the drink function and is not in normal joystick control mode, it is only allowing the user to adjust the position for these moments.
11. Push **B2** briefly, then release. The arm will move to the originally programmed “drink” location. If you made adjustments in the last step and manually moved the portable cupholder into the wheelchair mounted cupholder, then this operation should return the handle to the saved position. If you did not make any adjustments in step 10, then the robot will lower the portable cupholder in the cupholder mounted on the wheelchair.
12. The robot open the end effector to release the portable cupholder, then move up 200mm
13. The arm will move to the “safe1” position
14. The drink function is now complete and the system has returned to normal joystick control mode. It is recommended to push **B1** and return the arm to the ready position before operating the system

A close up of a control panel

AI-generated content may be incorrect.**B3: Button 3 is used to program and recall the Stow1 position.**

To save a position:

1. Hold **B3** for five seconds (count in your head) then release
2. **LED3** will begin flashing after two seconds
3. The system is now in “Programming” mode
4. Using the joystick, move the arm into the position that you would like to save for the “stow1” position
5. Push **B3** briefly then release to save this position, **LED3** will go static for one second, then turn off
6. The position for **B3** has now been saved in the memory for later recall
7. The system is now in joystick control mode and can be normally operated

To recall the ready/home position:

1. Push **B3** for one second or less, then release
2. **LED3** will go static, and the arm will move to the previously saved position for the “stow1” position, the joystick is inoperable during this movement
3. Once at the saved position, **LED3** will turn off, and the system will return to joystick control mode and operate normally

A close up of a control panel

AI-generated content may be incorrect.**B4: Button 4 is used to program and recall the Stow2 position.**

To save a position:

1. Hold **B4** for five seconds (count in your head) then release
2. **LED3** will begin flashing after two seconds
3. The system is now in “Programming” mode
4. Using the joystick, move the arm into the position that you would like to save for the “stow2” position
5. Push **B4** briefly then release to save this position, **LED3** will go static for one second, then turn off
6. The position for **B4** has now been saved in the memory for later recall
7. The system is now in joystick control mode and can be normally operated

To recall the ready/home position:

1. Push **B4** for one second or less, then release
2. **LED3** will go static, and the arm will move to the previously saved position for the “stow2” position, the joystick is inoperable during this movement
3. Once at the saved position, **LED3** will turn off, and the system will return to joystick control mode and operate normally

A close up of a control panel

AI-generated content may be incorrect.**B5: Button 5 is used to turn on and off the end effector LED**

**B5** is used to toggle the LED on and off. Pushing **B5** will turn the LED on. Pushing **B5** again will turn the LED off. Unlike the other buttons, LED3 will not turn on.