

**Team 523: Mixed Reality Wearable for 3D
Body Tracking**

Operations Manual:

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Chapter 1: Alphabetical Parts List

1. APRILTAG ATTACHMENTS (W/APRILTAGS OF FAMILY 36H11)
2. CAMERA MOUNT
3. CPU MOUSE
4. HDMI TO VGA ADAPTER
5. KEYBOARD
6. MICRO USB TO USB A ADAPTER
7. NVIDIA JETSON TX2
8. ROLLING MONITOR STAND
9. SD CARD
10. STEADY STATE MONITOR
11. USB HUB
12. WEARABLE BAND WITH CLASP AND WEBBING BUCKLE
13. ZED MINI STEREOSCOPIC CAMERA

Chapter 2: Bill of Materials (design specific parts)

Part #	Part name	Description	Quantity	Vendor
1	Zed Mini	3D Camera	1	Stereolabs
2	NVIDIA Jetson TX2	Cpu processor Developer kit from NVIDIA	1	NVIDIA
3	USB flash drive	SanDisk Extreme Pro 128 GB	1	SanDisk (Amazon)
4	USB Port Hub	Anker 10 Port 60W data hub w/ 7 USB 3.0 ports	1	AnkerDirect (Amazon)
5	HDMI/VGA adapter	VicTsing HDMI to VGA adapter converter	1	VicTsingDirect (Amazon)
6	Rolling Monitor stand	Rolling monitor stand	1	MountFactory (Amazon)

Chapter 3: Project Objective

The objective of this project is to provide a user interface for a participant in a 3D body scan environment in order to shorten the duration of the overall process by reducing the amount of instructions given by the scan technician to position/orient the participant.

Chapter 4: Wearable Instructions

Section 4.1: Wearable Design



Figure 1: Wearable Photo

Section 4.2: Placing the wearable onto the body

Step 1: Connect the clasp

Connect the magnetic clasp together. Slide the loose end of the wearable through the webbing buckle in order to create a loop (or circle) with the band.



Figure 2: Wearable forming a loop

Step 2: Put on the wearable

Slide the wearable over the fingertips of the hand that will be scanned. The clasp should be placed on the inside of the hand, on the palm.



Figure 3: Wearable placed on the hand

Section 4.3: Tightening the wearable

Step 1: Pull on the band strap

Once the magnetic clasp is positioned correctly, the Velcro band can be tightened by pulling the loose end of the Velcro band against the webbing buckle. The Velcro of the band should be facing hook toward loop. Once the band is tight enough to not allow movement, the Velcro can be attached together. The strap should not be over tightened to the point where the skin on the hand is being moved or compressed.



Figure 4: Schematic of tightening the Velcro band

Section 4.4: Apriltag placement

Each AprilTag has Velcro on the back of it, along with labels indication the direction that it should be placed. AprilTag 1, will be placed on the back of the hand with the center of the AprilTag being lined up with the centerline between the user's ring and middle finger knuckles. AprilTag 2, will be placed on the side of the hand opposite to the thumb. AprilTag 2 should be 90° to AprilTag 1. AprilTag 3 will be placed on the other side of the hand under the thumb, like AprilTag 2, it should be 90° to AprilTag 1.

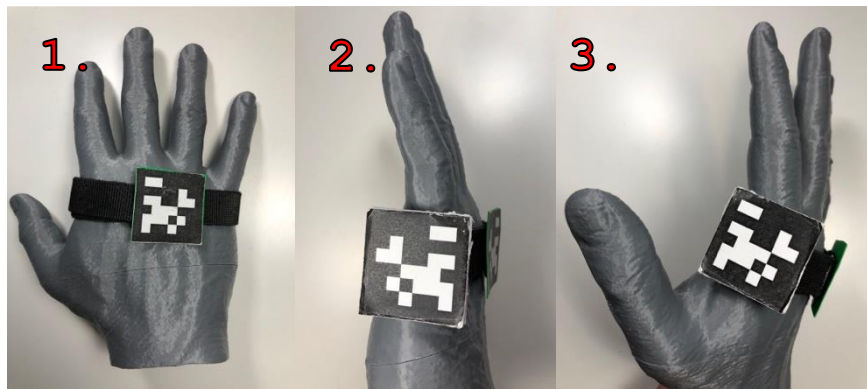


Figure 5: Wearable placed on hand with Apriltags attached

Section 4.5: Removing the wearable

The user will remove the wearable via the magnetic clasp instead of undoing the Velcro strap. Because the magnetic force is working in the perpendicular (or normal) direction, the user will want to shear the clasp in the parallel direction. The magnetic clasp has arrows on each side to indicate the direction to push so that the magnets will easily separate. When removing it is vital that the user does NOT shift his/her hand. If the hand is shifted, the hand will not be positioned correctly for the scan. The removal process can be seen in figures XXX below. Depending on the hands position and orientation the wearable will drop to the floor with ease or will have to be carefully removed with the other hand to insure not to shift the position of the hand.

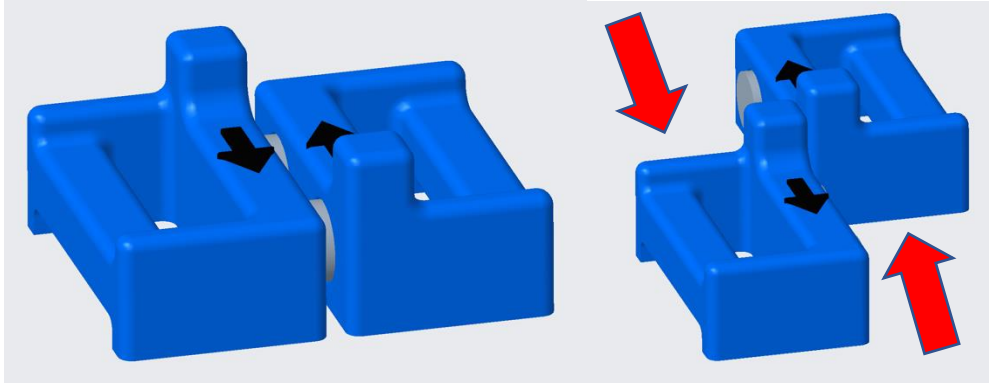


Figure 6: Wearable removal

Chapter 5: Monitor & Camera Instructions

Section 5.1: Monitor Set-up and Placement

Step 1: Fasten monitor to the mobile stand



Figure 7: Mobile monitor mount

The monitor mount is compatible with most monitor mounting setups. Pictured below is a typical bolt mount pattern.



Figure 8: Typical monitor bolt mount pattern

Step 2: Connecting the hardware with the monitor

After connecting the mount onto the mobile stand, connect the monitor to power. After confirming power, connect the monitor to the NVIDIA Jetson TX2 (which should be placed on the tray of the mobile monitor mount) via HDMI cable (NOT INCLUDED).

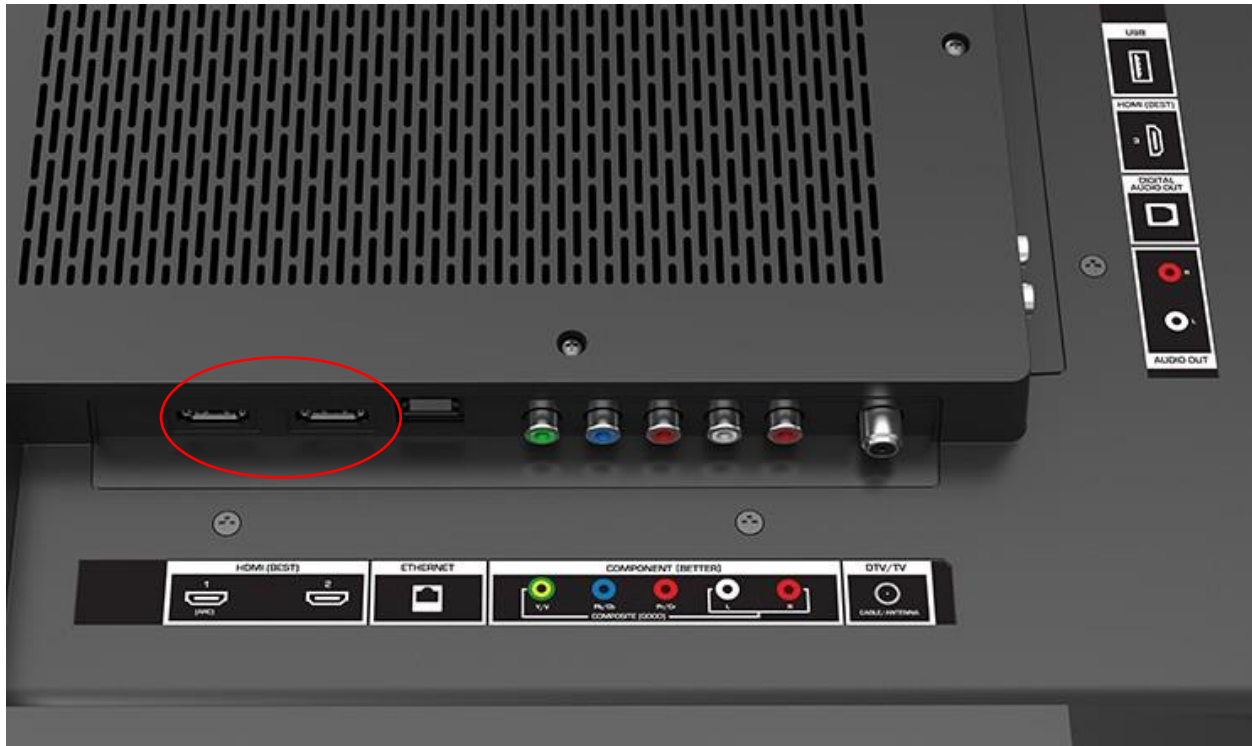


Figure 9: Typical plug in ports on a TV/monitor

Once connected check that the monitor is on the right input source if the screen does not appear. The brightness level should be easily viewable but too bright to the point of causing strain for the user. Likewise, the brightness should be high enough so that the user is no straining to make out what is on the screen.

Step 3: Adjusting and positioning of monitor

The mount can be seen in figure 7, the stand allows for adjustments for height and tilt of the monitor. The mounted monitor with the stand should be positioned in the scan space so that the monitor will be seen clearly by the participant, but not interfere with the scanner. The monitor must not be more than 10 meters away from where the scan participant should be positioned.

Section 5.2 Camera set-up and placement

Step 1: Attach the mounting clamp to the ZED Mini

On the bottom of the Zed Mini, you will find a hole with a bolt thread. Carefully thread the mounting bracket for the Zed Mini into the threaded hole. Be careful to avoid forcing a turn.

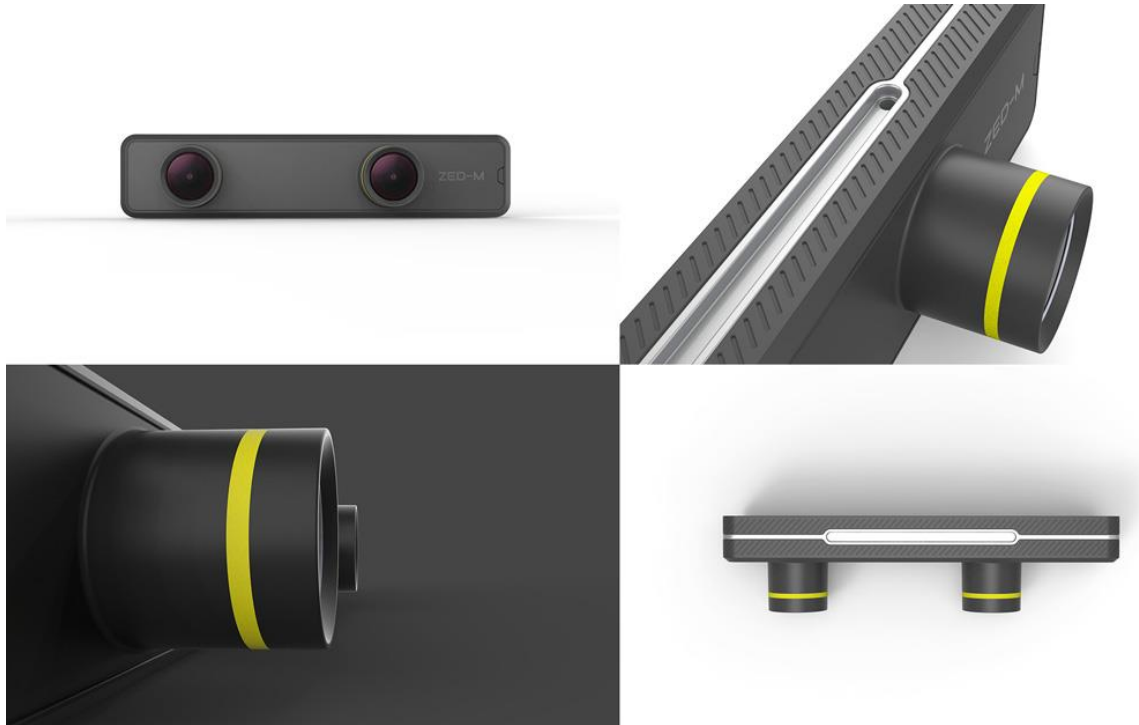


Figure 10: Zed Mini from front, top, and side angle

Step 2: Clamp the Zed Mini onto the monitor

Carefully mark the center of your monitor (you may need a measuring tape or ruler). Once the center has been marked, clamp the mounted camera onto the monitor. Make sure to straighten the camera once it is clamped and fastened to the monitor. Camera should be parallel with the monitor so that when the user is facing the monitor they will be seen by the camera.

Chapter 6: Computer Software/Hardware Setup

Section 6.1: Electronics Setup

- *Software Requirements:**
- (a) OS: Linux on Ubuntu 16.04 (Xenial)
 - (b) JetPack 3.2 (the NVIDIA Jetson TX2 must be flashed with this from a separate host computer if it has not been already)
 - (c) CUDA 9.0
 - (d) ZED SDK for Jetson TX2
 - (e) ROS: Kinetic
 - (f) ROS node: zed-ros-wrapper
 - (f) ROS node: apriltags2_ros

Step 1: Connecting the USB hub to the NVIDIA Jetson TX2

Connect the Micro-USB to USB A adapter to the NVIDIA Jetson TX2 and then connect the USB hub to the adapter. Connect the AC adapter from the hub to a nearby outlet.

Step 2: Placement of the keyboard & the mouse

Place the keyboard and the mouse next to the NVIDIA Jetson TX2 on the tray of the mobile monitor mount. From here, plug in the keyboard and the mouse into the USB hub.

Step 3: Powering the NVIDIA Jetson TX2

Connect the AC adapter from the NVIDIA Jetson TX2 to a nearby outlet. Press and hold the power button on the NVIDIA Jetson TX2 for ~1 second to turn it on. Log into the NVIDIA account using the password: nvidia

Step 4: Running the ROS node: apriltags2_ros

After logging in, open a terminal by pressing (CTRL-ALT-T). From here, continue to type:

```
$ roslaunch apriltags2_ros continuous_detection.launch
```

After this point, the ZED Mini should be able to track the AprilTags on the wearable while ROS will be displaying their relative pose within Rviz.

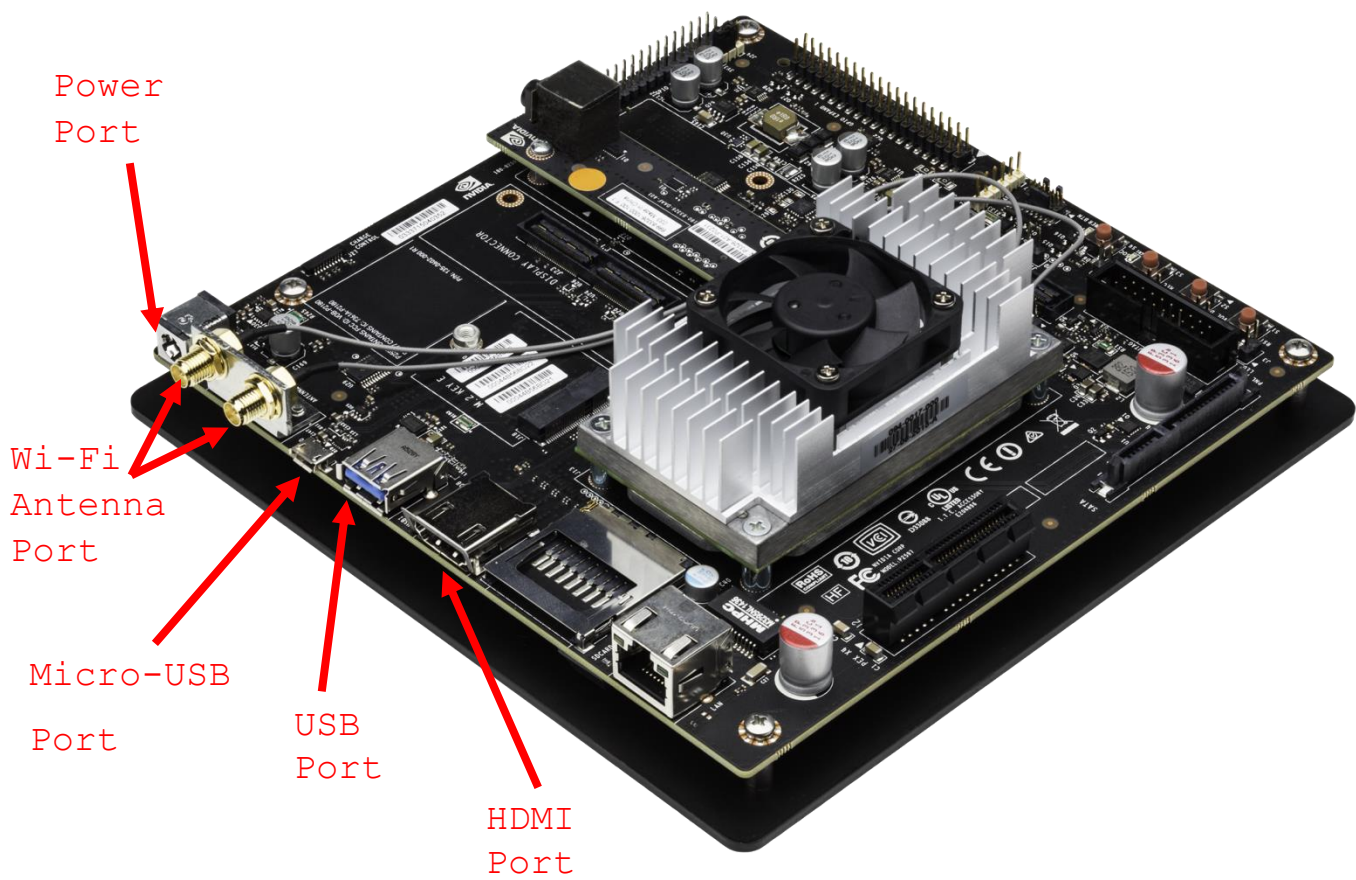


Figure 11: Port map for the NVIDIA Jetson TX2

Chapter 7: Trouble Shooting

Section 7.1 Wearable:

- a. Magnet will not stay secured:
 - i. The user is over tightening the Velcro band.
- b. Wearable will not stay still:
 - i. The strap is not tight enough.
- c. The AprilTag will not stick:
 - i. The wearable is inside out.

Section 7.2 Monitor:

- a. The screen is black:
 - i. The input source may not be on the right selection.
 - ii. The HDMI cable might not be plugged in all the way to the monitor or the NVIDIA Jetson TX2.
 - iii. The monitor/computer may not be getting power.

Section 7.3 Camera:

- a. Camera is not connecting to the computer:
 - i. The cable attached to the camera needs to be removed and flipped over.
 - ii. The cable may not be fully inserted to the computer or the camera.
 - iii. Make sure that you have downloaded the proper SDK from ZED's website and that you have the necessary dependencies to run the ZED Mini.

Section 7.4 Software:

- a. The camera's point of view can't be seen within Rviz:
 - i. Go to the `catkin_ws/src/apriltags2_ros/launch/continuous_detection.launch` file and make sure that you have remapped the "image_rect" and "camera_info" to the topics which your camera is outputting. If you have your camera driver running (in this case it would be: `roslaunch zed_wrapper zed.launch`) and then in a new terminal, type `rostopic list` and then search for the topics that are the synonymous to the aforementioned topics. In this case, "image_rect" should be remapped to `zed/rbg/image_rect_color` and then "camera_info" should be remapped to `zed_rbg_camera_info`. Accordingly, in this same file, make sure to set the default value of "camera_frame" equal to `zed_camera_center`.

- b. The AprilTag is not being tracked:
 - i. Make sure that in Rviz the frame selected is "zed_camera_center".
 - ii. In the displays section on the left-hand side of Rviz, make sure that the TF icon is selected and that the zed_camera_center is checked.
 - iii. Click the "image" icon on the left-hand side of the screen in Rviz to see if the AprilTag is in the camera's point of view.
 - iv. Make sure that the AprilTag has a big enough white border so that the camera can more easily see a contrast between the AprilTag and the background.
 - v. Make sure that the AprilTag is not covered in any way.
 - vi. Go to the catkin_ws/src/apriltags2_ros/config/settings.yaml file and specify which tag_family you are trying to track as well as make sure that the tag you have is of the same family.
 - vii. Go to catkin_ws/src/apriltags2_ros/config/tags.yaml file and make sure that the number associated to the AprilTag you are trying to track is specified within the "standalone_tags" array.
- c. How can I change the ideally posed .stl file in Rviz?
 - i. Go to the catkin_ws/src/apriltags2_ros/launch/continuous_detection.launch file and make sure that at the end of the first "<param_name=..." the path is set to the proper .urdf or .xacro file which has your .stl file in it.
 - ii. Go to your .urdf file or your .xacro file and make sure that the first lines of code underneath "<robot name = "insert name of .stl file" />" :


```

<joint name="something_joint" type="fixed">
  <parent link="zed_camera_center" />
  <child link="insert name of .stl file" />
  <origin xyz="0 0 0" rpy="0 0 0" />
</joint>

```
 - iii. Additionally, within this same file, make sure that your .stl file is headed to the correct path.

- d. How do I change how translucent this ideally posed .stl file is?
 - i. Within the same file from the previous step, go to the material section and replace the last number within the "rgba" line. If the number is 1, the image will be fully seen, but if the number is 0, then it will be completely clear.
- e. I cannot see the ideally posed .stl file
 - i. Make sure that in Rviz the "RobotModel" icon is selected and under the drop down menu of this icon, make sure that next to the "Robot Description" label it says "robot_description". If it does not, then just type it in.
 - ii. Within the Rviz displays on the left-hand side of the screen, make sure that the TF icon is also selected and in the dropdown, be sure that the Frame for your .stl file is selected as well.