

Biometric Autonomous Droid (BAD-2024)

Safety Plan

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1 General Lab Safety Requirements

- Loose hair and clothing should be tied back before working.
- No jewelry, especially any conductive jewelry, should be worn.
- Proper footwear, meaning closed-toe shoes, should always be worn in the lab.
- When appropriate, members should wear safety glasses, which are located in the lab space.

- No food or drink should be consumed in the lab.

2 Participant Constraints

The physical wheelchair, once assembly begins, will be placed in the northeast corner of the ECE Senior Design room. The wheelchair will be sectioned off by yellow tape placed on the floor to warn untrained people to not step into the area. No one outside of this senior design group will be allowed in this area of the room to both protect the wheelchair and the people. There will be a maximum of two people allowed inside the yellow tape at a time. If someone is working on any electrical equipment on the wheelchair, there must be a designated person solely watching outside the designated area. This is also the case when conducting bench work; someone must solely watch at all times. The parts not attached to the wheelchair will either be placed within the designated area for the wheelchair or placed in the cabinet in the northeast corner for storage.

To ensure the safety of anyone working on the wheelchair, someone in the lab must always be accompanied by another member of the senior design team if completing any work. Everyone in the group must be present at our meetings during class from 11:40 am-12:55 pm on Mondays, Wednesdays, and Fridays unless otherwise stated. If working outside this time, each person must be accompanied by another member of the group. Each member of the group must be well rested and not have any non-prescription substances in their system when working on the wheelchair to ensure their safety.

3 Risks Associated with Fabrication of Physical Prototype

3.1 General Considerations

- Do not sit in the wheelchair unattended.
- Only one person may sit in the wheelchair at any given time.
- The wheelchair is designed to hold an individual weighing no more than 200 pounds. Those who exceed the weight capacity should not sit in this wheelchair.
- When working with the wheelchair, members should be alert and aware of any potential obstacles and/or hazards.
- All group members should ensure that they have a clear understanding of the wheelchair's emergency stop system.
- In the case of an emergency during wheelchair testing, members should make sure to take measures to protect themselves and others from harm.
- The wheelchair should be maintained in a clean working environment, free of dirt, dust, and other things that could impair performance and function.

3.2 Assembly

- During the process of assembling the physical components of the wheelchair system, all team members should handle the chair and its associated parts with caution. This means exercising care with any and all components that are heavy, sharp, or pose other potential hazards to the member. Team members must also wear proper clothing that will not get caught on or stuck to any part of the assembly. Before physically attaching

parts of the chair, members should ensure that they have the appropriate knowledge of how to use any power tools before attempting to put pieces together. Members should consult a qualified member of the team, Professor Yu, or contact the Engineering Machine Shop if they have any questions or concerns.

- The wheelchair must not be sat on without proper assembly of all parts. If, once assembled, a team member wants to make a modification to the wheelchair assembly to improve safety, stability, or otherwise, they must inform and express their rationale to the project leader and receive explicit approval before any changes are made.

3.3 Testing

- During safety testing which requires the use of a human user, there should be one team member who is the designated supervisor. This individual should understand the testing procedures being carried out, and be prepared to intervene if necessary.
- Before the wheelchair is to be tested, group members performing tests should make sure to inspect the wheelchair system and ensure all parts are secure and in proper working condition.
- When testing is in progress, other team members should not be near the chair unless authorized to do so by the member supervising testing.
- The wheelchair should not be in use by a team member or outside individual for any reason unless safety testing is being conducted.
- Before testing the wheelchair in self-driving mode, make sure the accessible emergency stop button functions well and allows instant shutdown in case of malfunction or hazard.
- Avoid testing the wheelchair in public areas unless it is equipped with audible alarms to alert bystanders and people nearby.

- A Google spreadsheet log of temperature data, sensor outputs, and any anomalies during tests will be tracked to assess performance trends and potential issues.

4 Machine Shop

The Machine Shop may only be entered if there is a staff operating within the room itself, whether that time is scheduled or not. In order to enter the lab itself, members adhere to the posted safety rules, must not wear any kind of jewelry or loose clothing, and must have close-toed shoes and safety glasses (which can be found right outside the lab). Food and drinks are strictly prohibited from entering the shop itself.

5 Working with Machines

The machines in the machine shop are simple yet very professional pieces of equipment. It is most likely that the machine shop staff will be the ones using these to create your item, but in the rare off chance the student uses these, this is what should be followed. You must understand how to use the equipment you desire to use, and if not, you may ask the instructor for help in using the machine to create the part you wish to. To work with machines as well, you must have a drawing of the part with you to work with the machines and make the edits that you need to the drawing.

6 Engineering Drawings

Drawings for the machine shop should be detailed heavily and approved by them to be used. Failure to get their approval of the detailed drawings will require needing to go back into the drawing and update it overall. The template for the drawings and a set of previously detailed drawings have been provided in the Google Drive folder for the project.

7 Safety Instructions for Electrical Equipment

- All participants will follow the detailed safety instructions provided for each type of electrical equipment.
- Have a fire extinguisher near the workstation, and ensure everyone knows its location and operation.
- Avoid working with high-voltage components alone; adhere to the buddy system for battery and motor handling.
- De-energize electrical parts before working on electrical circuitry. Remember to turn off the power supply terminals while debugging and only turn them on for testing. Make sure all electrical parts (power supply, wave generator, etc) are shut off before leaving the room.
- Keep the bench area dry.
- If you smell anything burning, immediately de-energize the circuit (shut off the power supply) and check the circuit for possible shorts.

8 Labeling Wires and Components

- Apply clear and durable labels on all wiring, including voltage indications and warnings for high-risk areas.
- Use warning stickers for critical components:
 - **Battery:** High-temperature and high-voltage warnings.
 - **Circuitry:** Electric shock hazard warning, and authorized personnel-only warnings.

- Label any components left in shared spaces with part numbers and contact information for responsible team members.

9 Soldering Lab Safety

Some components, including through-hole and surface-mount device soldering, will need to be soldered during the assembly of our projects. We will need to use the soldering lab to assemble those components. However, the soldering lab contains equipment that can injure users if improperly used. To avoid personal injury, we must follow the soldering lab's guidelines and rules and learn how to use the equipment properly. This includes wearing safety glasses while in the lab and securing long hair and loose clothing. There are signs in the lab with instructions, as well as phone numbers for people to contact in case of an emergency. Extra soldering waste needs to go in the barrel labeled "Soldering waste." Team members were encouraged to attend the IEEE soldering workshop to learn how to solder and use the lab properly. Members are also responsible for cleaning up after themselves to ensure the lab remains clean and safe.

9.1 Soldering Iron

The soldering iron is used for through-hole and some surface mount soldering. Because it gets very hot to melt solder, users must exercise caution while using it. They should only hold it by the grip and never touch the tip once the iron has been turned on. When a user is not actively using the soldering iron, it must be placed in its holder so that it doesn't touch anything and burn it. Use the brass wool to clean the tip of the soldering iron. Soldering irons must be turned off while not in use and should never be left unattended.

9.2 Boards and Components

Components being soldered will become hot, so team members should only touch recently soldered components once they have had time to cool down. Some elements are also polarized, so team members should understand the markings on the components so they solder them correctly. Soldering components, especially electrolytic capacitors, the wrong way can lead to injury.

9.3 Fume Extractor

Solder is made of various metals. When it is heated, it releases fumes that can be harmful if inhaled. The soldering lab has fume extractors that filter the fumes so the harmful materials don't end up in the air. Therefore, whenever users are soldering, they should run the fume extractors and solder near the extractor. When done soldering, turn the fume extractor off.

9.4 PCB Oven

For surface mount soldering, the lab has a PCB oven to melt solder paste on a PCB. However, Adam Smith must train users before using the oven, and team members must only use it once they have received training. After users have received training, they must be aware that the boards will be hot when they come out of the oven, so users should not touch the boards until they have had time to cool. Once users are done with the oven, they should put it away correctly to ensure the lab stays clean and the oven isn't damaged.

10 24V Battery Protocol

- Cover battery terminals to prevent accidental shorts, and connect them to a switch and power distribution board with fuses.

- If a fuse blows, immediately turn off the power supply/disconnect the battery and identify the current overload.
- Keep battery storage isolated from the system frame and have a universal spill kit ready for any accidental acid or alkaline spills.
- A warning light will indicate battery testing or system operation, ensuring all team members are aware.
- Wear appropriate clothing including insulated gloves and no metal jewelry.
- Use proper insulated tools when working on electrical circuitry.
- Avoid shorting the positive and negative terminals of the battery and de-energize the circuit by disconnecting the battery when not in use.
- Remove excess moisture from the skin by wiping hands before working on the battery and cables

11 Voltage Regulators

- Follow all protocols highlighted in section 10 regarding working with high-voltage.
- Before connecting regulators with the battery the validity of the design must be tested.
- The design will be tested with a separate voltage source, additionally, voltage measurement must be taken to ensure the design is correct.
- Ensure proper safety standards when testing including correct wear, emergency shut-off, and use of proper tools for measurements.

12 Motor Safety Protocol

- The motor operates on 24 V which can produce a high amount of torque. Securely mount the motor to prevent movement or disconnection during testing.
- Wear safety glasses and appropriate clothing (rubber-soled shoes, no loose clothing, and hair secured) when working near the motor or rotating parts.
- Turn off all power if working on the motor and cables.
- Ground yourself before working on the to prevent any shock or damage.
- Check fuses to see if the circuit is protected.
- Avoid touching the motor after extended use in case the motor temperature is hot.

13 Wheel Safety

- The wheels on all ends are supporting the rest of the wheelchair as well. Do not lift the wheels with your hands in any situation to operate on them.
- Wear appropriate safety gear (no loose clothing) when working with wheels as well.
- Turn off all power if working with the wheels.
- If the wheels need to be modified in any possible way, carefully detach the wheels from the assembly and ensure the rest of the wheelchair is positioned properly to ensure nothing is damaged while the wheels are detached.

14 Sensors

- **Temperature Warnings:** The LiDAR sensor and the Raspberry Pi may heat up during long periods of operation, especially in poorly ventilated areas. Avoid touching

the interior of these devices immediately after extended use to prevent damage. Use protective cases where applicable.

- **Cooling System:** Use fan systems/heat sinks wherever possible to maintain an optimal temperature building.
- **High-Frequency Output:** Ultrasonic sensors can emit high-frequency sound waves that can interfere with hearing aids and other devices.

15 In case of Accidents

All incidents should be reported to the team and Professor Yu as soon as possible. In case of an emergency, call Public Safety at the emergency number: (610) 330-4444. If there is a non-emergent matter that requires attention from campus officials, call Public Safety at their non-emergency phone number: (610) 330-5330.