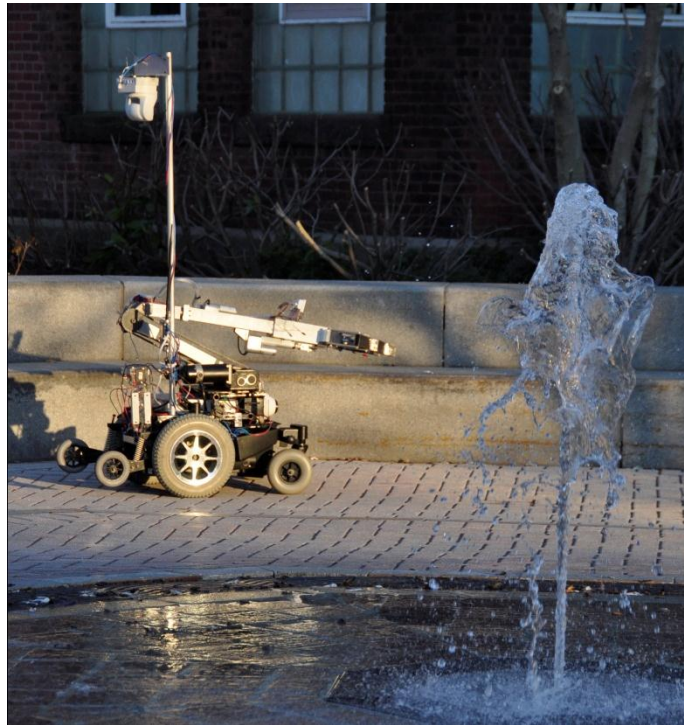# Bomb Disposal Robot

Operations Manual

Last Revision 4/25/11

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Introduction (read first)

Welcome to the WPI bomb disposal robot project. We hope that this project is as much fun to use for you as it has been for us. Please be aware that although the robot has been simplified as much as possible, it still is a complicated machine. Please read this guide thoroughly before using the robot. Also, please report any malfunction (mechanical or software) to Prof. Taskin Padir.

IMPORTANT! This robot is a complex, heavy and potentially dangerous machine. Be EXTREMELY careful in the operation. Do not operate the robot with people close to the arm or gripper. Use wisdom in driving near any objects.

Above all, use common sense. This robot is meant to dispose of bombs, not people.

Safety System

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In order to safely operate the robot, a proper understanding of the safety system must be achieved. This system is a relatively straightforward system built in three steps.

1. The robot has an underlying set of safeties that control the output. This 'master' safety is controlled by the user. At any time during operation, a user can press the start button on the controller to toggle the safety on/off. Note that the UI will indicate the current status.
2. If the robot is not receiving packets from the transmitter, it will automatically safe itself. Once proper communication has been reestablished (i.e. the transmitter has moved back into range) the robot can be re-enabled by re-engaging the safeties (the start button).
3. If the robots limit switches are pressed, the robot will disable that current joints motor output in that direction until the arms position is back within acceptable range.

For a complete diagram of controls, please see the operating instructions.

Startup Instructions

Starting the bomb disposal robot involves activating the 12v and 24v power along with resetting the sbRIO. You also need to activate the controller.
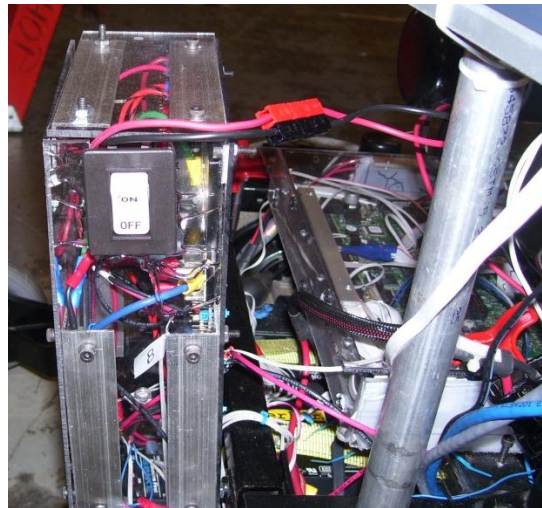
Robot-side:

(ensure batteries are in the robot and connected prior to start)
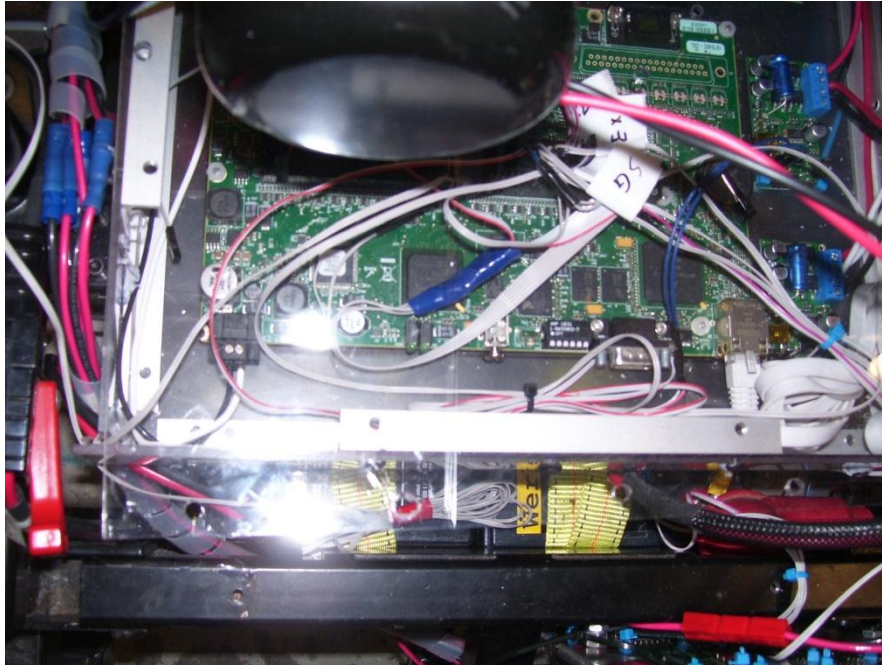
1. Activate the 24v power with the breaker along the side of the robot.

2. Activate the 12v power with the white switch along the back of the robot.

3. wait one minute for the systems to power up, then restart the sbRIO by hitting the white button along the side of the device.

4. Activate the mechanical clutch for the drive system on the robot. It's the small black lever on the front of the robot.

The robot should now be powered up and ready to go.

Controller Side:

1. Plug in 360 controller and directional antennae into two usb ports on the laptop.

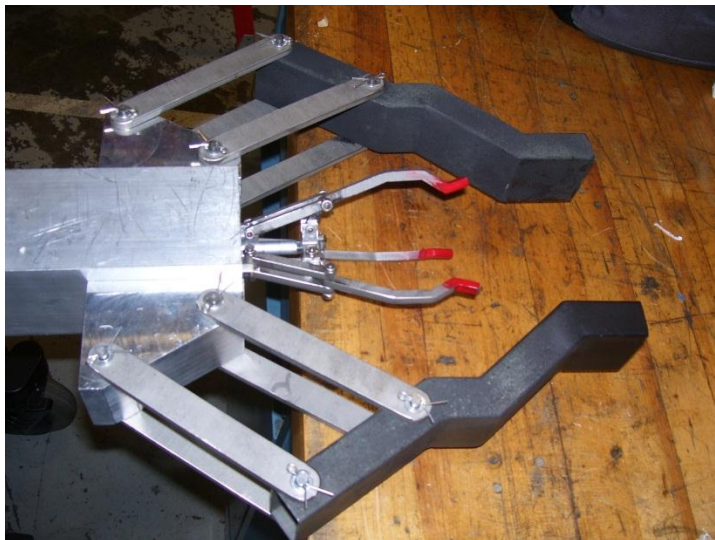2. Double-click on the MQP_GUI icon on the desktop.

The system should be ready for operation.

Shutdown Instructions

In order to properly shut down the robot, the following steps must be taken.
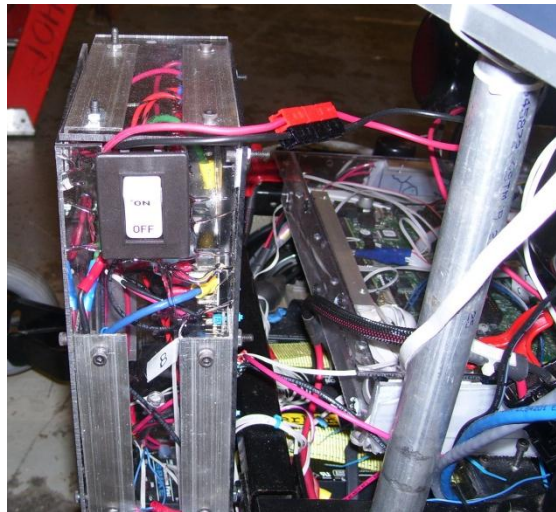
1. Ensure that the both grippers are not closed in stressed position before shutdown.
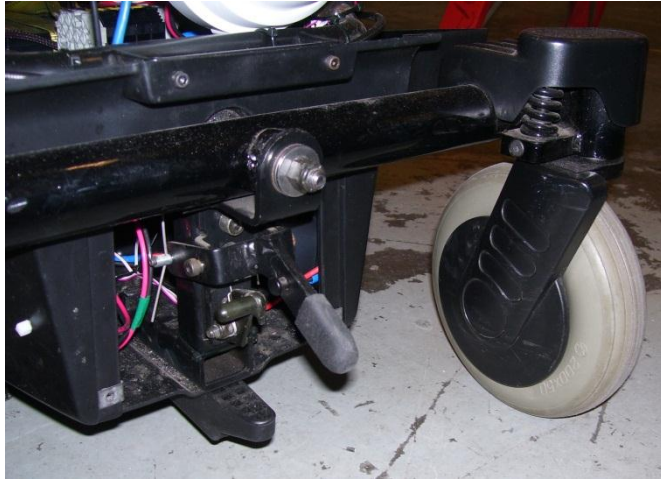

2. (Important) Safety the robot through UI control to activate breaks. (start button)

3. Power the 24v system off by pressing the red breaker button on the side of the robot.

4. Power the 12v system off by pressing the white breaker button on the back of the robot.

5. Disengage the drive motors on the front of the robot.

6. Unplug Xbox 360 controller and antennae from the laptop. Put objects away.

Charging Instructions

Charging the robot should be done after every use. Preferably, the robot should not charge unsupervised or in a combustible area.

To charge the robot:

1. Ensure robot is powered down.

2. Unplug both batteries from the robot through the Anderson connectors.
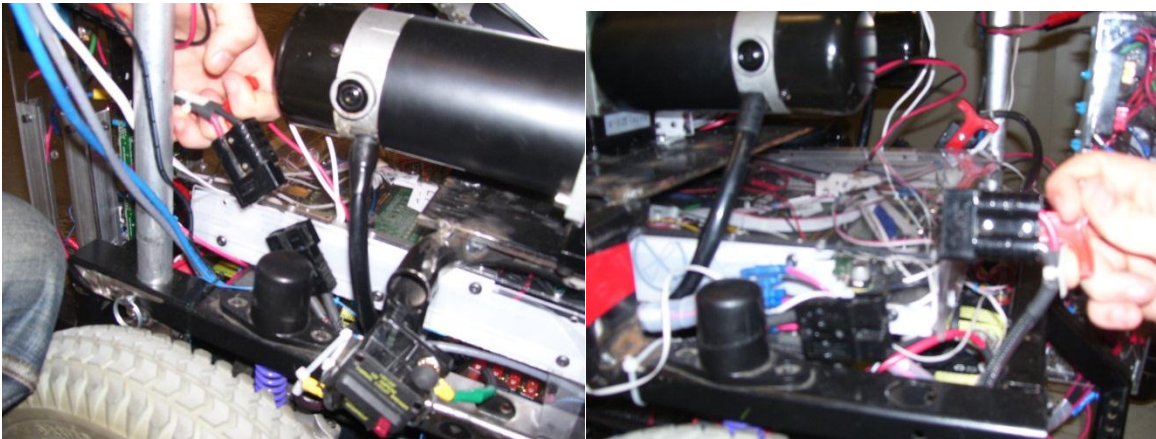
3. Plug both Anderson connectors into the battery charger. It does not matter which goes to which.

4. Plug in charger to wall power. When charging, the light will be just red. Once the batteries are done charging (1-5 hours depending on how low it was) the green light will also turn on.

To reconnect the robot:

1. Ensure both breakers are in the off position (12v and 24v)
   (Refer to above sections if this step is unclear)

2. Disconnect batteries from the charger.
3. Plug batteries back into the Anderson connectors. The batter plug should plug into the corresponding side.
4. Unplug and put away charger.

Operating Instructions (needs to be done)

Figure 1: Gamepad Control Pin-out

There are a couple different modes the GUI can be in, but regardless of the mode some settings will always remain the same. An example of this is the left joystick, which is assigned to an arcade-style (single joystick) driving control. The user will need to be able to drive the robot at any time and in any mode. The most important button that always has the same functionality is the "Start" button, which sends an enable or disable "Emergency" packet to flip all the safety switches at once. With regards to different modes, the user can always hit "X" to cycle through "camera mode" and "arm mode" while "A" is used to switch between inner and outer gripper modes. Since these buttons determine the functionality of the remaining three axes, they need to be able to change them at any time. It should be noted that these modes do not exist on the robot-side, they're only to assist the operator with sending the right packets when s/he means to. The left bumper can be used to cycle through and select main arm links, even though they can only be controlled in "arm mode", and the right bumper can always cycle through the different camera feeds.

The right joystick (or non-driving joystick if the controls are reconfigured) has a 40% threshold setting, compared to the driving joystick's 15%. The minimum threshold for any joystick should be 15% because when released, the joystick rarely returns to the exact center and in testing was found to be up to 15% off the center-point on a single axis. These threshold values mean that the operator needs to push the joystick along an axis more than the threshold before the values stray from zero, and from that point to their max value they are scaled from 0-100. This ensures that even with a large or different threshold value, an analog axis will always return a value between zero and 100. The reasoning behind having these threshold values is because it's rather difficult to push a joystick along only one axis without going a little bit to the side or crossing into a different quadrant in the 360 degree "joystick workspace." It is especially important for the non-driving joystick to have a larger threshold because each axis controls a completely different motor. For instance, in "arm mode" the Y-axis controls the movement of the selected main link and the X-axis controls either the extension & retraction of the inner gripper (if inner-gripper mode is also selected), or the rotational wrist joint's movement. In "camera mode", that same joystick controls the pan & tilt speed for the main camera feed if it has PTZ functionality (if not, it does nothing). Similarly, the right trigger zooms in and the left trigger zooms out in this mode (but again, only for PTZ cameras). In "arm mode" the triggers control the opening and closing of either the big gripper or the little gripper, depending on what gripper-mode it is in. All of the current modes and selected links/cameras are shown on-screen, as it would be far too confusing to try and remember which mode combination is active.

Troubleshooting (FAQ)

a) *Q: Why is the robot not responding?*

A: Did you reset the sbRIO during startup? Restart system to fix problem

b) *Q. The arm works, but the robot can't drive. I think I hear the motors working though.*

A: The motor drive is not engaged. Press the lever in the front of the robot to activate the gearbox. Refer to startup section as to detailed location.

c) *Q: Crap, I think I broke something. What should I do?*

A: You should immediately stop using the robot, shut it down and report the incident to Prof. Taskin Padir. (tpadir@wpi.edu)