

Turret Control Tutorial

The purpose of this tutorial is to learn how to manipulate an Interbotix Turret via the Graphical User Interface tool (Figure 1) shown below and/or an original SONY PS4 controller. As you probably already know, a Turret is a pan and tilt mechanism. In this tutorial, the joint responsible for panning is called 'pan' while the joint responsible for tilting is called 'tilt'. Please note that all joint positions are in degrees.

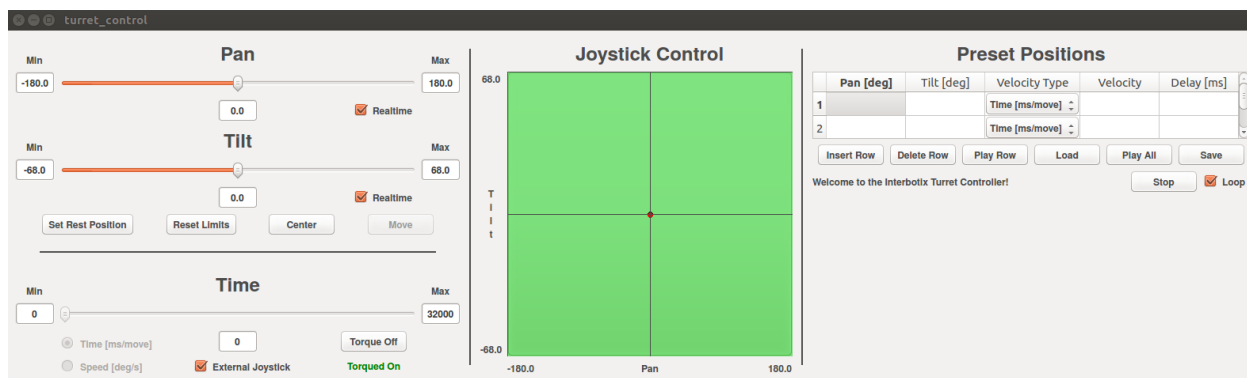


Figure 1: Complete graphical user interface tool

There are three main features that this tool offers. A summary of them are provided here and are explained in further detail below. From left to right, they are:

- **Independent Joint Control** - allows a user to manipulate the 'pan' and 'tilt' joints individually
- **Combined Joint Control** - allows a user to manipulate the 'pan' and 'tilt' joints simultaneously
- **Sequence Control** - allows a user to create a sequence of 'pan' and 'tilt' positions that the Turret should follow at specific times

Independent Joint Control

As mentioned above, this feature allows a user to manipulate the 'pan' and 'tilt' joints individually. It encompasses all the controls and textboxes shown in Figure 2. To move a joint, a user has two options:

- **Position Slider** - just click and drag a 'pan' or 'tilt' slider bar, and the corresponding physical joint on the Turret will follow in real time (if the **Realtime Checkbox** is checked)
- **Position Goal Display** - just type a desired position (in degrees) in the textbox centered underneath the 'pan' or 'tilt' slider bar, and the corresponding physical joint on the Turret will rotate there

Besides for the controls mentioned above, there are also ways that the user can customize their experience. They are:

Displays/Checkboxes

- **Position Min/Max Displays** - if a user would like to constrain the motion of the 'pan' or 'tilt' joint, that range can be specified using the **Position Min** and **Max Displays**; just type the desired minimum or maximum (in degrees) in their respective textboxes; by default, the values shown are the absolute minimum and maximum that a joint can reach
- **Realtime Checkbox** - if checked, the physical joint on the Turret will immediately follow the user-specified position (either triggered by a change in **Slider** position or text in the **Goal Display**); if unchecked, the joint will not move to the desired position until the **Move** button is pressed
- **External Joystick Checkbox** - when checked, toggling the buttons on the PS4 controller will cause the Turret to move; when unchecked, toggling the buttons on the PS4 controller will have no effect on the Turret

Buttons

- **Move** - moves the joints to the positions indicated in the 'pan' and 'tilt' **Goal Displays**; it is only enabled if at least one of the **Realtime Checkboxes** are unchecked
- **Center** - moves the 'pan' and 'tilt' joints to '0' degrees
- **Reset Limits** - if a **Min/Max Display** is changed, pressing this button will reset the min/max limits for both joints to their default values
- **Set Rest Position** - the 'Rest Position' should ideally represent the Turret position such that if the motors were torqued off, the Turret would not move regardless of how much weight was on top of it; to set it, rotate the 'pan' and 'tilt' joints to the desired 'rest' positions, and click this button; you will be asked if you would like the Turret to go to the 'Rest Position' whenever exiting the window or when pressing the **Torque Off** button
- **Torque On/Off** - when the joints are torqued on, it means that they will respond to user-specified commands and keep their position to the best of their ability; when torqued off, the joints will not respond to user-specified commands and can be freely rotated manually.

Velocity

- **Time [ms/move] Checkbox** - with this option selected, the value shown in the **Velocity Goal Display** represents the number of milliseconds it should take for the 'pan' and 'tilt' joints to get to their desired positions, no matter what their current values are; thus, the 'pan' and 'tilt' joints could have different speeds but will always arrive at their respective goal positions at the same time
- **Speed [deg/s] Checkbox** - with this option selected, the value shown in the **Velocity Goal Display** represents the speed at which both joints will operate; thus the 'pan' and 'tilt' joints will rotate at the same speed but will not necessarily arrive at their respective goal positions at the same time
- **Velocity Slider** - just click and drag the 'velocity' slider bar to the desired value; at slider bar release, the velocity will be updated
- **Velocity Goal Display** - just type a desired velocity in the textbox centered underneath the 'velocity' slider bar, and the velocity will be updated accordingly

- Velocity Min/Max Displays** - if a user would like to constrain the speed at which the 'pan' or 'tilt' joints operate, that range can be specified using the **Velocity Min** and **Max Displays**; just type the desired minimum and maximum in their respective textboxes; by default, the values shown are the absolute minimum and maximum; for **Time [ms/move]** mode, the default range is from 0 - 32000 milliseconds; in this case, a value of '0' means that the joints will operate as fast as possible, while a value of '32000' means that it will take 32 seconds for the joints to arrive at their goal positions; for **Speed [deg/s]** mode, the default range is from 12 - 180 deg/s; in this case, a value of '12' means that both joints will rotate at 12 deg/s, potentially arriving at their respective goal positions at different times

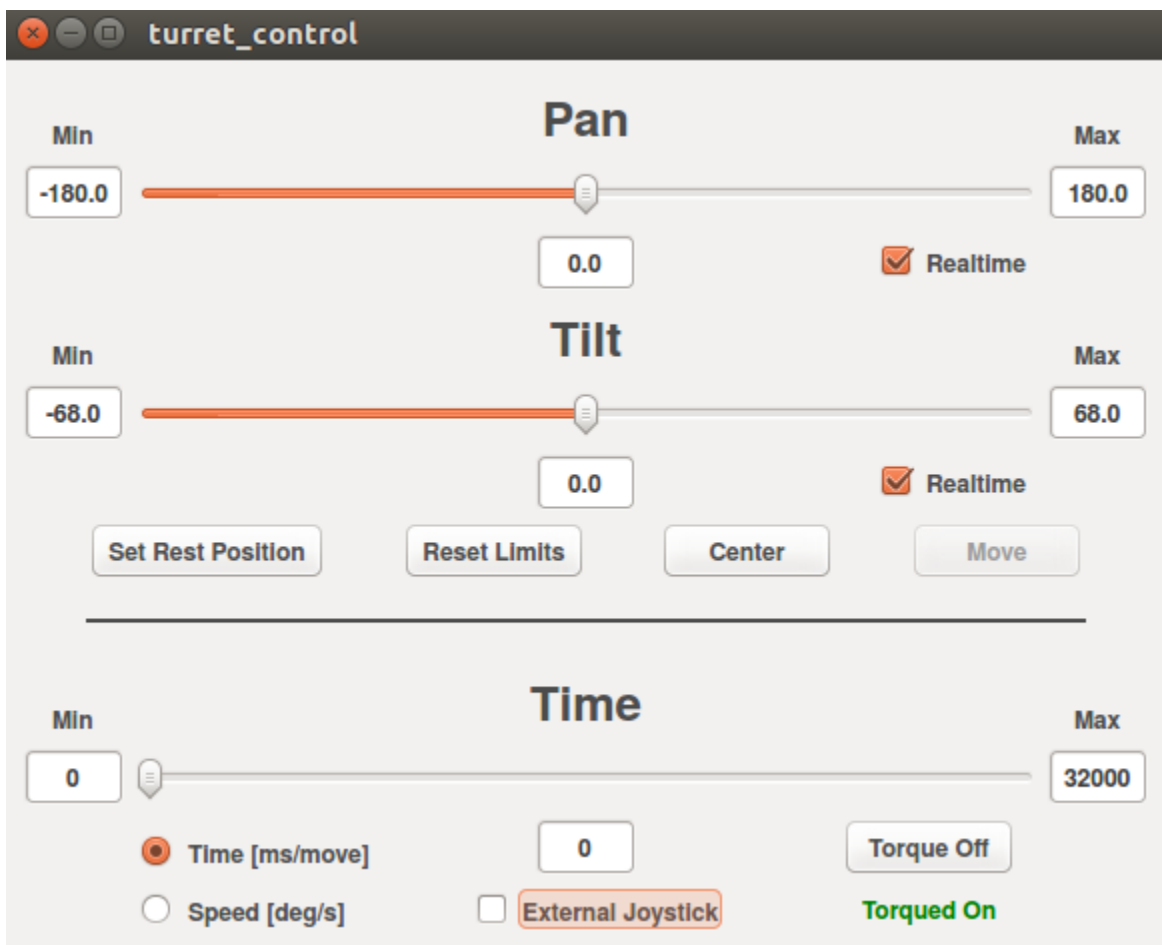


Figure 2: Individual Joint Control Interface

Combined Joint Control

As mentioned above, this feature (Figure 3) allows a user to manipulate the 'pan' and 'tilt' joints simultaneously. To do so, click and drag anywhere within the 'green' box. If the **Position Min/Max Limits** were changed, the 'green' box will shrink/expand accordingly. Otherwise, there are three main elements to this mock 'Joystick' control. They are:

- **Crosshair** - represents the desired goal positions for the 'pan' and 'tilt' joints and should follow your cursor
- **Red Circle** - represents the current positions of the 'pan' and 'tilt' joints
- **Black Circle** - represents the home position (0 degrees) for the 'pan' and 'tilt' joints

Note: this feature is strictly a position control system. Feel free to adjust the velocity of the joints with the **Velocity Slider** or **Velocity Goal Display** before and/or during the use of this tool

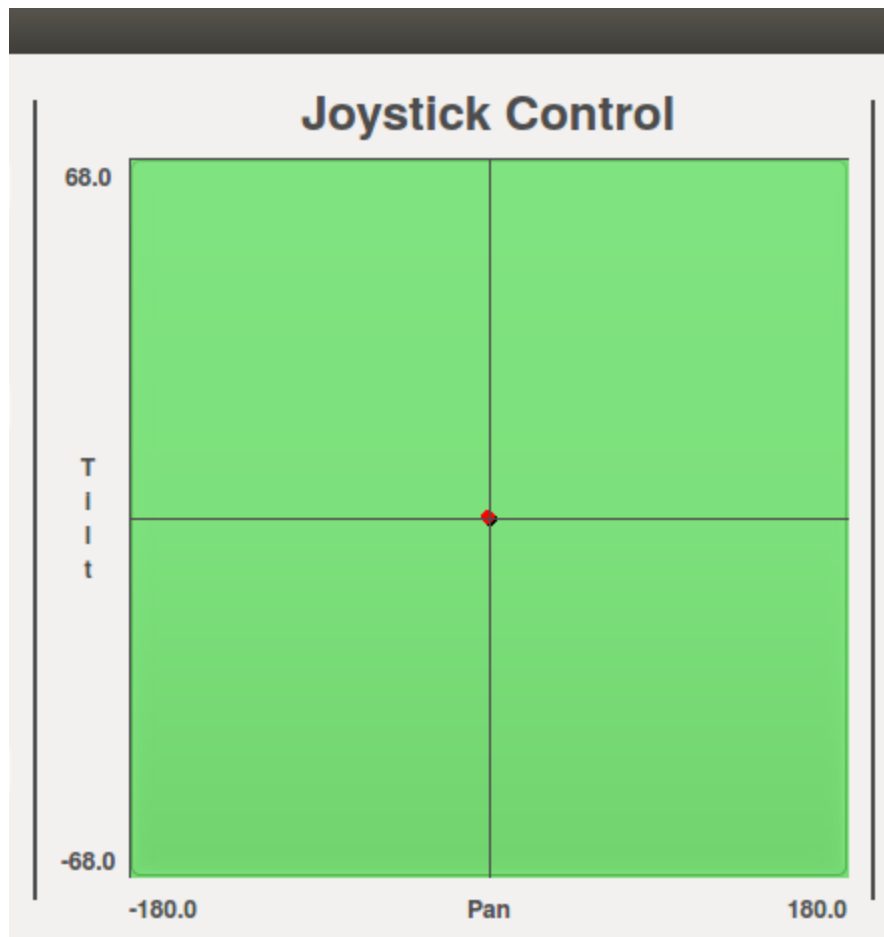


Figure 3: Combined Joint Control Interface (a.k.a Joystick Control)

Sequence Control

As mentioned above, this feature (Figure 4) allows a user to create a sequence of 'pan' and 'tilt' positions that the Turret should follow at specific times. The table fields are as follows:

- **Pan [deg]** - desired 'pan' joint angle in degrees
- **Tilt [deg]** - desired 'tilt' joint angle in degrees
- **Velocity Type** - drop down menu allowing a user to choose between **Time [ms/move]** and **Speed [deg/s]** for the specified row

- **Velocity** - value corresponding to the **Velocity Type**; for example, if the **Velocity Type** is set to **Time [ms/move]**, this field could be set to 1000 so that it takes 1000 milliseconds for the move to complete
- **Delay [ms]** - the amount of time in milliseconds after the joints have arrived at their respective goal positions that the program should wait before executing the next row; for example, if the **Velocity Type** is set to **Time [ms/move]**, the **Velocity** is set to 1000, and the **Delay** is set to 767, then it will take 1767 milliseconds for the whole row to complete

There are also a few buttons that can be used to customize this feature. They are:

- **Insert Row** - to add another row to the table, first click the row in the table underneath which you would like the new row to appear; then click this button
- **Delete Row** - to delete a specific row, first click the row, then click this button
- **Play Row** - to execute a specific row, first click the row, then click this button; the joints will also move at the **Velocity** specified in the row, but the **Delay** field will be ignored
- **Save** - Saves the data in the table as a CSV file to a user-specified location and with a user-specified name
- **Load** - Loads data from a user-specified CSV file into the table
- **Play All** - starting with the first row, the program will command the Turret to the specified 'pan' and 'tilt' positions at the designated velocity and wait **Delay** milliseconds before moving to the next row; this will continue until all rows have been executed
- **Stop** - if the **Play All** button was pressed, then pressing this button will stop the program from executing the remaining rows in the table; note that the current row will still finish executing
- **Loop** - if checked, then after the program executes the final row in the table, it will wait **Delay** milliseconds as specified in the final row, and restart the sequence from the beginning; if unchecked, the program will become idle after executing the final row

Preset Positions

	Pan [deg]	Tilt [deg]	Velocity Type	Velocity	Delay [ms]
1			Time [ms/move] ▾		
2			Time [ms/move] ▾		

Welcome to the Interbotix Turret Controller! ☒ Loop

Figure 4: Sequence Control Interface

External Joystick Control

Please refer to the image and table below to understand how to control the Turret with a PS4 controller. Although the image shows a PS3 controller, the same button mappings apply.

PS3 & PS4 Button Mapping



Button	Action
START/OPTIONS	move the turret to its center position
R2	rotate the 'pan' joint clockwise
L2	rotate the 'pan' joint counterclockwise
D-pad Up	increase motor angular velocity in steps
D-pad Down	decrease motor angular velocity in steps
D-pad Left	'Coarse' control - sets motor angular velocity to a user-preset 'fast' speed
D-pad right	'Fine' control - set motor angular velocity to a user-preset 'slow' speed
Right stick Left/Right	pan the Turret CCW/CW
R3	reverses the Right stick Left/Right control and R2/L2 buttons
Left stick Up/Down	tilt the Turret forward/backward
L3	reverses the Left stick Up/Down control