

Mounting the WAM in Vertical Orientation

These instructions describe the modifications necessary to use Libbarrett with a 7-DOF WAM mounted in the vertical orientation, opposed to the standard horizontal mounting configuration. The 4-DOF WAM configuration can easily be deduced from the below instructions.

Four configuration/calibration file changes:

Update world_to_base transform:

This transform describes the relationship between the 'world' frame and our base 'J1' frame.

This transform is located in the file:

/etc/barrett/wam7w.conf

In the standard configuration, this coordinate frame is in the same orientation, requiring a simple identity matrix describing the world_to_base transform.

```
1 0 0 0
0 1 0 0
0 0 1 0
0 0 0 1
```

When rotating the entire robot to a new orientation, we must recompute this transform. In the case of mounting the WAM vertically, this is 90 degree rotation about the Y-axis.

Calculating the necessary changes is done using a rotation matrix.

http://en.wikipedia.org/wiki/Rotation_matrix

We find that our new world_to_base transform for the WAM now looks like:

```
0 0 1 0
0 1 0 0
-1 0 0 0
0 0 0 1
```

Make this change in your configuration file **/etc/barrett/wam7w.conf**

From

```
world_to_base = ((1, 0, 0, 0),
                 (0, 1, 0, 0),
                 (0, 0, 1, 0),
                 (0, 0, 0, 1));
```

To

```
world_to_base = ((0, 0, 1, 0),
                 (0, 1, 0, 0),
                 (-1, 0, 0, 0),
                 (0, 0, 0, 1));
```

Next, update our calibration.conf file:

We must change the calibration poses used by bt-wam-zeroal and bt-wam-gravitycal to reflect our new mounting position in **/etc/barrett/calibration.conf**

Change the zeroal poses to all zeros:

From

```
zeroal:
{
wam7w:
(
  (1, ( 0.0, -1.57,  0.0, 1.57,  0.0,  0.0,  0.0 ), "the J1 scribe marks are aligned"),
  (3, ( 0.0, -1.57,  0.0, 1.57,  0.0,  0.0,  0.0 ), "the plastic elbow covers are vertical"),
  (2, ( 0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0 ), "the inner link is vertical"),
  (4, ( 0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0 ), "the J4 scribe marks are aligned"),
  (6, ( 0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0 ), "the tool-plate is horizontal"),
  (5, ( 0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0 ), "the J5 scribe marks are aligned"),
  (7, ( 0.0, -1.57,  0.0, 1.57,  0.0,  1.57,  0.0 ), "the J7 scribe marks are aligned")
);
};
```

To

zerocal:

```
{
wam7w:
(
  (1, ( 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0 ), "the J1 scribe marks are aligned"),
  (3, ( 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0 ), "the plastic elbow covers are vertical"),
  (2, ( 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0 ), "the inner link is vertical"),
  (4, ( 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0 ), "the J4 scribe marks are aligned"),
  (6, ( 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0 ), "the tool-plate is horizontal"),
  (5, ( 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0 ), "the J5 scribe marks are aligned"),
  (7, ( 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0 ), "the J7 scribe marks are aligned")
);
};
```

Also, change the gravitycal poses in **/etc/barrett/calibration.conf**

From:

gravitycal:

```
{
wam7w:
(
  ( 0.0, -1.5708, 0.0, 1.5708, 0.0, 0.0, 0.0 ),
  ( 0.7854, -1.5708, 1.5708, 1.5708, -1.5708, 0.0, 0.0 ),
  (-0.7854, -1.5708, -1.5708, 1.5708, -1.5708, 0.0, 0.0 ),
  (-0.7854, 1.5708, 1.5708, 1.5708, 0.0, 1.5, 0.0 ),
  ( 0.0, 0.7854, 0.0, 2.3562, 0.0, -0.7854, 0.0 ),
  ( 0.7854, 1.5708, -1.5708, 1.5708, 0.0, 1.5, 0.0 ),
  ( 0.0, 0.0, 0.7854, 1.5708, 0.7854, 0.7854, 0.7854 ),
  ( 0.0, 1.5708, -1.5708, -0.3927, 0.7854, -1.0781, -0.7854 ),
  (-0.7854, 0.7854, -0.7854, -0.7854, 0.7854, -0.7854, 0.7854 )
);
};
```

To:

gravitycal:

{

wam7w:

(

```
[ 0.0, -1.5708, 0.0, 1.5708, 0.0, 0.0, 0.0 ],
[ 0.7854, -1.5708, 1.5708, 1.5708, -1.5708, 0.0, 0.0 ],
[ -0.7854, -1.5708, -1.5708, 1.5708, -1.5708, 0.0, 0.0 ],
[ -0.7854, 1.5708, 1.5708, 1.5708, 0.0, 1.4, 0.0 ],
[ 0.0, 0.7854, 0.0, 2.3562, 0.0, -0.7854, 0.0 ],
[ 0.7854, 1.5708, -1.5708, 1.5708, 0.0, 1.4, 0.0 ],
[ 0.0, 0.0, 0.7854, 1.5708, 0.7854, 0.7854, 0.7854 ],
[ 0.0, 1.5708, -1.5708, -0.3927, 0.7854, -1.0781, -0.7854 ],
[ -0.7854, 0.7854, -0.7854, -0.7854, 0.7854, -0.7854, 0.7854 ],
```

```
[ 0.0, 0.0, 1.5708, 1.5708, -1.5708, 0.0, 0.0 ],
[ 0.0, 0.0, -1.5708, 1.5708, -1.5708, 0.0, 0.0 ],
[ 0.0, 0.0, -1.5708, 1.5708, 0.0, 1.4, 0.0 ],
[ 0.0, 0.0, 1.5708, 2.3562, 0.0, -1.4, 0.0 ],
[ 0.0, 0.0, 2.3562, 1.5708, -1.5708, 1.4, 0.7854 ],
[ 0.0, 0.0, -2.3562, 1.5708, 0.0, -0.7854, -0.7854 ],
[ -1.5708, 0.0, -1.5708, 1.5708, 0.0, 0.7854, 2.8 ],
[ -0.151, -0.707, -1.422, 1.947, -2.124, -0.558, -2.851 ]
```

);

};

Lastly, We need to update the default home position.

We do this by editing the file `/etc/barrett/calibration_data/wam7w/zerocal.conf`

Delete the contents and replace them with our approximate new home position.

```
Home = ( 0.0, 1.57, 0.0, 0.0, 0.0, 0.0, 0.0 );
```

That's it!

You will lastly have run zero calibration and gravity calibration

```
$ bt-wam-zerocal
```

Moving all joints to their zero position. This will adjust to any offsets to the home position you have newly created.

Now run gravity calibration

```
$ bt-wam-gravitycal
```

It should now go through the 17 poses to learn the gravity compensation torques.

After completing both of these routines, all of your Libbarrett software should work exactly the same. Test this by running through the examples in `~/libbarrett_examples`