The TurtleBot 2e

Table of Contents

Introduction

Definition

The TurtleBot 2e is a new revision of the TurtleBot primarily defined by replacing the netbook with a single board computer(SBC) such as the 96 Boards CE computer, the DB410c. It will also feature the Orbbec Astra camera.

Benefits

The SBC's offer two main advantages over the existing netbooks. The first one is that functional SBC's are now available at the $75 price point, while the necessary netbooks remain in the $400 price range. The second advantage of the modern SBCs is that they require less power and can consequently be run off of the internal power supply from the Kobuki base. This significantly simplifies battery management for the user. There is only the one battery level to check, charge and discharge.

The switch to use the Orbbec Astra is an improvement since the previous two primary sensors, the Microsoft Kinect and the Asus Xtion are both out of production and becoming increasingly unavailable.

Challenges

There are disadvantages to switching to an SBC. Most evident externally is that the SBCs do not have an integrated keyboard or screen.

- The SBC does not have an integrated display or keyboard.
- Many fewer kernel drivers are available by default.
- The default installation is on Debian
    - This is new for the ROS community and as such untested.
- The DB410c needs a heatsink fabricated and a mounting method.

Contributing

The TurtleBot is an open community project. If you have improvements or suggestions for the TurtleBot2e please open pull requests against this document. If you would like to suggest anything that doesn't fit into this document directly please start a thread on the TurtleBot Forums

Hardware Instructions

To build a TurtleBot2e you will need the following parts.

Parts List

- TurtleBot2 Core Kit $1049.00 http://www.turtlebot.com/distributors/
  - Kobuki w/ charger
  - Plates
  - With astra mount
- Orbbec Astra https://orbbec3d.com/product-astra/ $149.99
- DragonBoard 401c https://www.96boards.org/products/ce/dragonboard410c/ $75
- DragonBoard Heatsink Kit https://www.element14.com/community/community/designcenter/single-board-computers/blog/2016/02/01/cooling-the-dragonboard-410c-and-ifc6410p ~$15
- DragonBoard 410c 12V TurtleBot power cord (12V barrel plug-> minifit) (Cable + minifit connector) $3 (requires molex crimper to assemble or soldering)
- HDMI Monitor (optional recommended) 7” freestanding https://www.adafruit.com/products/1033 $159.95
- USB Keyboard https://secure.logitech.com/en-us/product/wireless-touch-keyboard-k400r $30
- USB Hub (recommended with keyboard http://www.newegg.com/Product/Product.aspx?Item=9SIA2BP0T23948) $29.99

Build instructions

1. Drill out M6 clearance hole in bottom TurtleBot plate
2. Assemble TurtleBot2 Kit
3. Drill and tap an M6 hole in the bottom of the heatsink How to Tap
4. Assemble DragonBoard 410c heatsink assembly
   Directions to create DB410c Heatsink there is more info in this forum thread
5. Mount Astra The simplest mount is to drill out the center rear hole to 6mm clearance. And use the same 6mm bolt down to the chassis using the tripod mount. Point the camera forward and slightly upward.

   This will work for most simple use cases. Accurate mapping and navigation in larger spaces will need a more precise mounting similar to the Asus Xtion or Kinect. It should be elevated at the back and rigidly horizontal in the position called out by REP 119 We will be developing an official recommended way to mount the Astra onto the TurtleBot. Please check back in the future for more details.
6. Install Debian onto the DB410c
   Full details at https://www.96boards.org/db410c-getting-started/Installation/LinuxSD.md/ Also see https://builds.96boards.org/releases/dragonboard410c/linaro/debian/16.04/ for more details about the release.
   i. Download img and copy onto SD card.
   ii. Flip dip switch to boot from SD
   iii. Follow onscreen instructions
   iv. Remove media, flip the dip-switch back
7. Install DB410c to the TurtleBot Screw the M6 bolt into the heatsink.
8. Assemble the power cord.
   i. Use a Molex crimper to attach a minifit conector to the barrel connector ponytail.

The barrel connector is center positive, and the positive pin is away from the clip for the molex connector. How to assemble a molex connector

9. Connect power cord to the Kobuki 12v connector and DB410c board. Collect extra cable length between the Kobuki and the bottom plate.
10. Install USB hub under bottom plate and connect the USB cables
    i. The USB Hub upstream connector connects to the DB410c
    ii. Plug the Astra USB cable into the hub.
    iii. Plug connect the Kobuki USB port to the hub.
    iv. Collect excess USB cable between the Kobuki and the bottom plate.

Recommended Accessories

To make use of the TurtleBot2e it's important to have the ability to debug easily and quickly. To that end we recommend the following accessories be on hand to connect to and debug a TurtleBot2e because it does not have an integrated display.

It is not necessary to have one set of accessories per robot. It is recommended to have one set of

Keyboard + Mouse

https://secure.logitech.com/en-us/product/wireless-touch-keyboard-k400r

The portable Logitech K400 keyboard is very versitile and offers both keyboard and mouse capabilities when mobile. All drivers are built into the core kernel and the convenient off switch lets it go a long time between needing new batteries.

Monitor

https://www.adafruit.com/products/1033

This monitor is relatively portable however still has enough resolution to support full width text. If you are in a lab environment a desktop monitor with a moderately long HDMI cable will be much more convenient. The monitors by default need external power.

It is expected in the future to use a 7" touch screen display and embed it into a modified top mounting plate to provide an integrated display.

USB Hub

http://www.newegg.com/Product/Product.aspx?Item=9SIA2BP0T23948

Once you have a USB sensor, the Astra, and the Kobuki base the USB ports are full which does not leave space for anything else. There are cheaper USB hubs available however not all hubs are capable of streaming the data from depth cameras. Feel free to choose a different USB hub but make sure to test it before expecting to use it. In development we have tested several lower cost hubs with little to no success. The failures will usually cause unstable behavior of the usb drivers either in the kernel or user space.

Software Instructions

1. Install Debian Jessie Image Detailed instructions are available at: https://www.96boards.org/db410c-getting-started/Installation/LinuxSD.md/ This is recommended to occur before fully assembling the robot for easier access to the dip switches. (See above.)
2. Install ROS Kinetic http://wiki.ros.org/kinetic/Installation/Debian
3. Install turtlebot
    i. `sudo apt-get install ros-kinetic-turtlebot-apps`
4. In your environment set `TURTLEBOT_3D_SENSOR=astra`
5. You can now continue to the standard TurtleBot Tutorials.

Known Differences

There are a few known differences between the TurtleBot2e and the

- Joystick kernel drivers need to be compiled and installed if wanted (build instructions)
- Networking ARP issues(workaround, other discussion)