nav6 Open Source IMU
Serial Port DTR Reset Issue
Description and Workarounds
1/20/2014

Overview

This document provides details regarding an issue discovered during testing of the integration of the current nav6 circuit board with the FIRST FRC CRio control system. Additionally, this document provides several workarounds.

Serial Port DTR Reset Background

The nav6 Open Source IMU was designed to be compatible with the popular Arduino UNO revision 3 circuit board. This compatibility includes the ability to upload new firmware to a target device (in this case, the nav6) via the Arduino Integrated Development Environment (IDE) over the serial port.

This firmware upload process begins when the IDE resets the target device, and then immediately begins sending the firmware. The target device, upon reset, runs a bootloader; the bootloader will wait for a short while, and if it begins receiving firmware, will write it to the flash memory on the target microcontroller. Once the firmware has been written, the bootloader begins executing the firmware in the flash memory. If the bootloader does not receive firmware within a short period, the bootloader begins executing the existing firmware in the flash memory.

The Arduino IDE resets the target by pulling the Data Terminal Ready (DTR) pin low for a short period of time, which causes the onboard microcontroller to reset. When the DTR pin again goes high, the microcontroller begins executing the bootloader.

Undesired Resets

The nav6 Open Source IMU is designed to automatically calibrate the onboard gyroscopes and accelerometers at startup; calibration takes approximately 20 seconds, during which time the nav6 should be held still. At the end of this 20 seconds, the nav6 calculates a yaw offset, and subtracts this from all subsequent yaw values that are reported. Thus, the reported yaw after calibration is complete should be zero degrees.

This approach works well for a FRC robotics match, since the nav6 will begin this process immediately when the robot power is turned on, and the wireless router boot time is longer than 20 seconds. By the time the match actually begins, the sensors are calibrated, and the yaw offset is applied, and the yaw value will be almost exactly 0.00 degrees.

However, the Serial Port support provided for the CRio will briefly set the DTR line to a low state when the Serial Port is opened - even if flow control is disabled. A method for disabling this behavior in software does not appear to exist currently.

The end result is that the nav6 begins initialization/calibration when the robot is powered on. Then, when the robot software begins initializing, the nav6 is reset a second time, and it begins calibrating again.
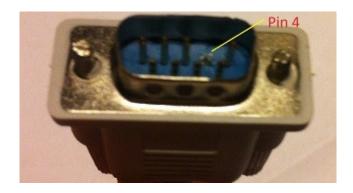
Workarounds

This second reset of the nav6 when the robot software opens the Serial Port is not a desirable situation; and there doesn't appear to be a way to work around this in software.

Fortunately, there are a several workarounds that can be followed to disable the nav6 from being reset via the Serial Port's DTR line.

Workaround 1: Remove the DTR pin in the serial cable where it connects to the nav6

This is a very simple approach that doesn't require any modifications to the nav6 circuit board. Pin 4 (DTR) should be removed, ensuring no electrical contact between the pin and the female DB9 connector on the nav6.
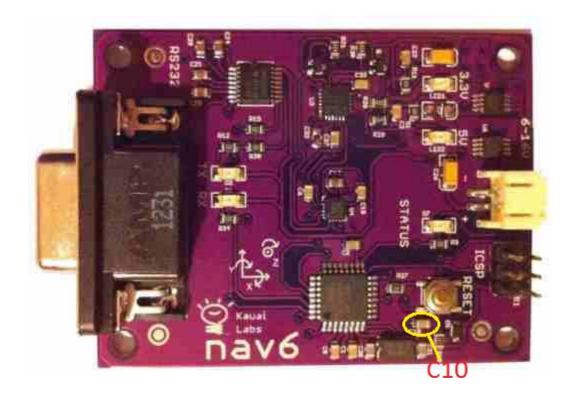

The pin is most easily removed with a sharp trimmer, such as a wire trimmer. Care should be taken to ensure that the remaining pins are aligned.

Workaround 2: Remove the inline capacitor (C10)

This is a more permanent workaround, and requires some skill with a soldering iron or a hot air gun. By removing the C10 capacitor, the signal from the DTR pin no longer has a path to the reset pin of the onboard ATMEGA328 processor.

With a soldering iron heated to about 650 degree Fahrenheit, and tinned with some solder to ensure optimal heat transfer, touch each end of the C10 capacitor and give it a careful nudge. After just a few attempts, the C10 capacitor should become unseated. Care should be taken not to accidentally unsolder any of the nearby components.

Workaround 3: Send the nav6 board back to Kauai Labs

If you'd prefer, we can modify the board here at Kauai Labs; simply mail the board to the following address, and include $6.95 to cover the return shipping cost, and we will remove the C10 capacitor for you, test the board and send it back to you.

Kauai Labs
2371E Niumalu Road
Lihue, Kauai, HI
96766

Side Effects

If the DTR reset capability is disabled, the Arduino IDE will not be able to automatically reset the bootloader when uploading firmware to the nav6.

In this case, when uploading firmware from the Arduino IDE to the nav6, immediately press the RESET button after initiating the firmware upload. This will reset the processor (just as if the DTR line was toggled) and as long as the reset occurs within a few seconds of initiating the upload, the bootloader will start and begin receiving/storing the firmware to the flash memory within the ATMEGA328 onboard the nav6.