Db-Alpha Navigation experiment Tutorial

In order to perform the experiment it is necessary to have db-Alpha robot and the next components:

- RGBD camera (Realsense D435)
- MEMS-IMU (PhidgetSpatial Precision 3/3/3)
- Raspberry Pi (for wireless control)
- It is convenient to have plastic case for Raspberry Pi

Setting up Raspberry Pi:

For this project Raspberry Pi 4 with 4 GB RAM and 64 GB SD card is used.

Operating system installed on SD card is Ubuntu Server 20.04 LTS.
For installation follow this tutorial:
https://ubuntu.com/tutorials/how-to-install-ubuntu-on-your-raspberry-pi#1-overview

Additional software required to be installed:

- ROS
- librealsense
- realsense2_camera
- phidgets_imu
- opencv2

Connecting Raspberry Pi to the PC/laptop:

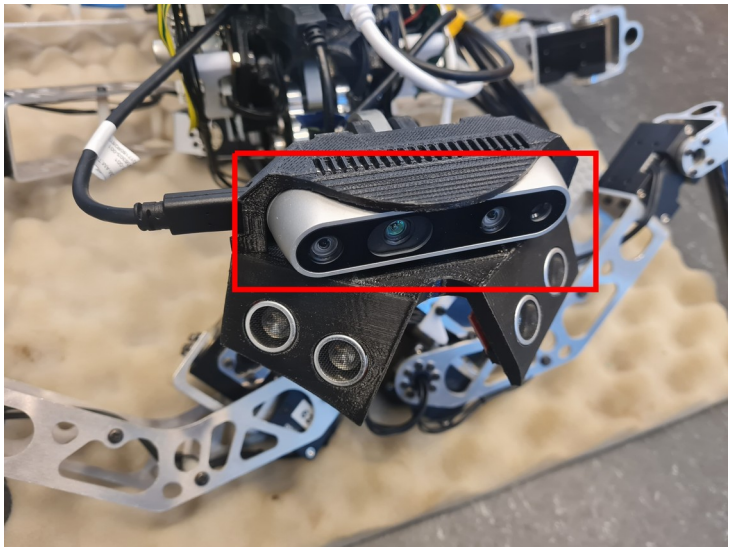
Connection is established via the WiFi or Ethernet.
In case of WiFi, hotspot can be set up from computer or mobile phone. To make Raspberry connect automatically to the selected hotspot, modify the file **network-config** file in the **system-boot** partition on SD card.

```
wifis:
  wlan0:
  dhcp4: true
  optional: true
  access-points:
    <wifi network name>:
      password: "<wifi password>"
```

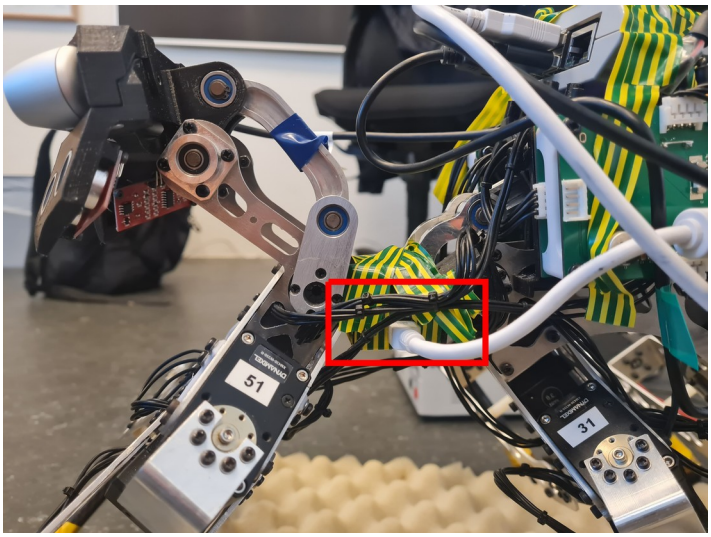
When connection established, Raspberry can be accessed from PC terminal by ssh.

Setting up the robot system:

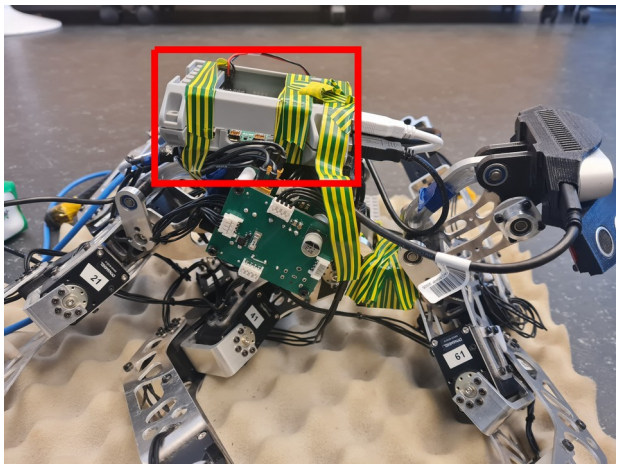
Realsense camera is placed on the robot head:

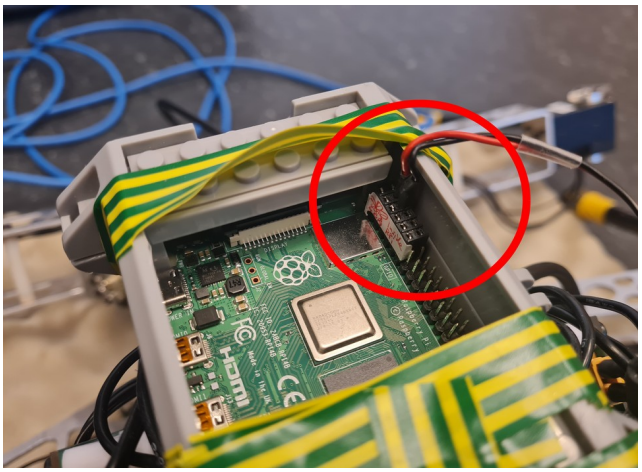


IMU sensor is placed on any stable position at the robot body (here is it placed under the “chest”):

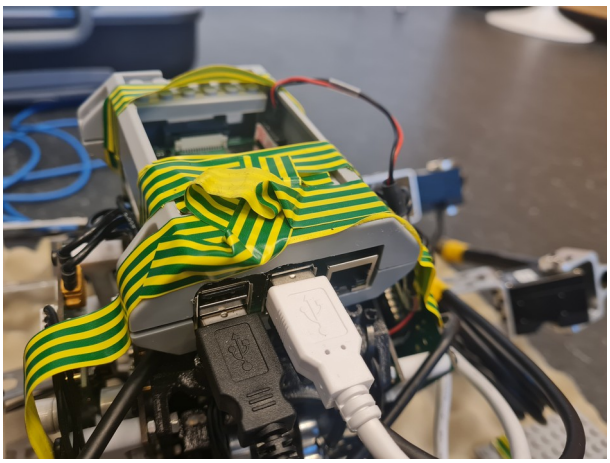


Raspberry Pi is placed on top of the back and power wires to the Raspberry are attached as follows(2nd pin – 5V power, 3rd pin – Ground):

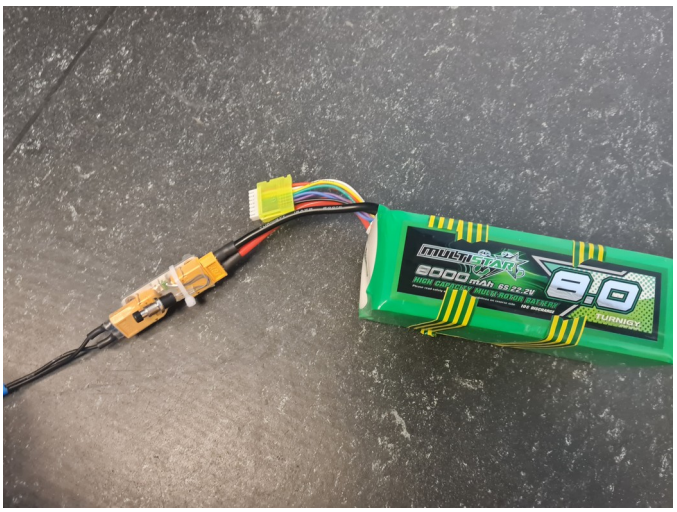


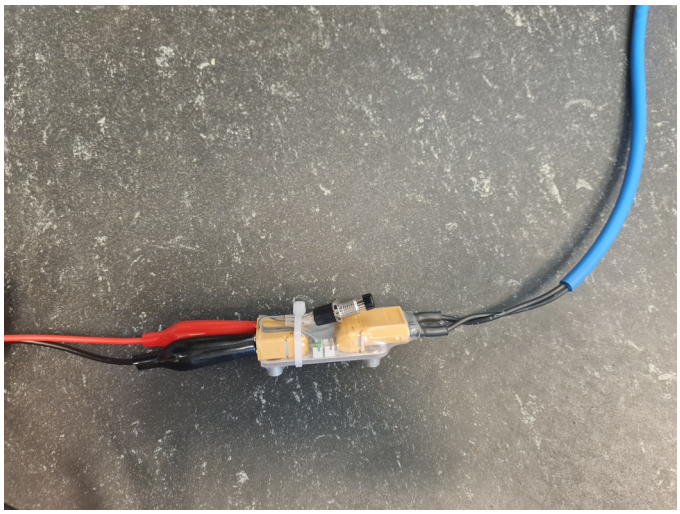


USB cables from the camera, IMU and robot controller are attached to USB slots of Pi:



Power cable is connected to the battery or the power supply (22V is required for robot to operate properly).
Chosen batteries are 6s 22.2V Li-Po.





Connection to the battery Connection to the power supply

NB! If Raspberry Pi does not manage to connect to wifi after start-up, disconnect the USB cables of devices from Pi, restart it, and reconnect again after start-up is finished.

Running the code:

The code has few parts responsible for different tasks in the navigation sequence.

First, connect to the Pi via ssh:

```
jevgeni@JevgeniPC:~$ ssh ubuntu@192.168.43.237
ubuntu@192.168.43.237's password:
```

(password on SDU robot's Pi is "jevproject")

Start motor controller and locomotion control code in separate terminals:

1. **$ roslaunch my_dynamixel_workbench_tutorial multiple_motor_test.launch**

2. **$ cd ~/catkin_ws/src/db_control/db_alpha_controller/bin**
   $ ./db_alpha_controller_real

Start-up the IMU:

$ **rosrun phidgets_imu phidgets_imu_node**

Start-up the camera ball detection algorithm:

$ rosrun camera_ball camera_ball2

Start the localization algorithm:

$ rosrun imu db_alpha_imu

Start navigation control server and client (in separate terminals):

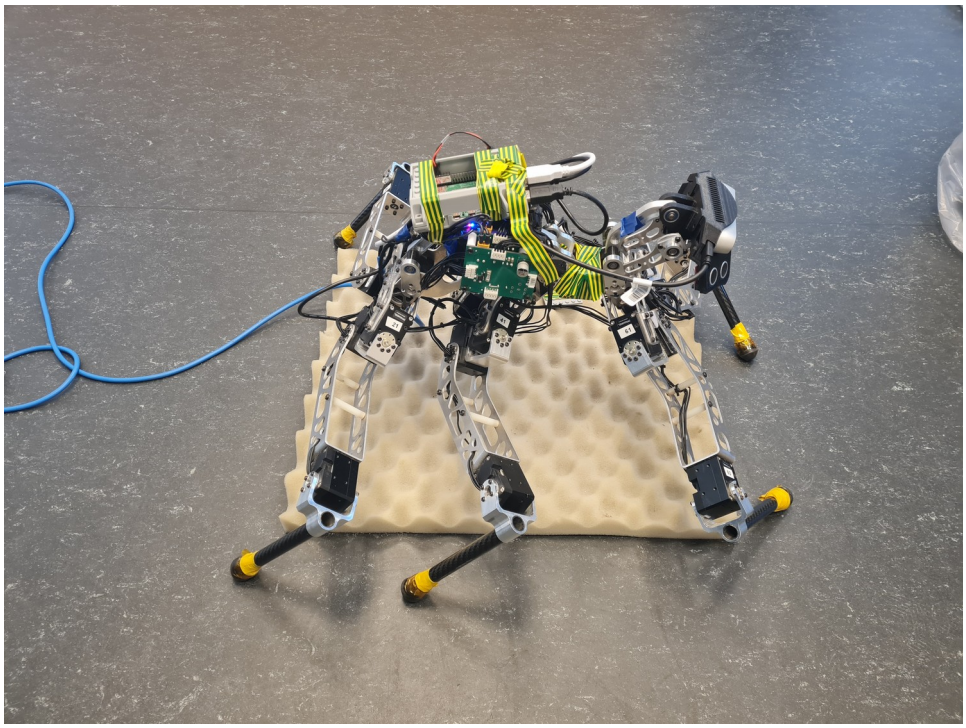
1. **rosrun db_navigation db_server**
2. **rosrun db_navigation db_server**

If you choose the manual control, robot can be controlled via the keyboard in **$ ./db_alpha_controller_real** terminal:

- w = go forward
- s = go backward
- a = turn left
- d = turn right
- q = sharp turn left (on the spot)

- e = sharp turn right (on the spot)
- b = break

NB! Be careful when terminating **multiple_motor_test.launch** node – it will cause robot to fall on the ground. To prevent damage while terminating node hold the robot or put something soft under it as on the picture:



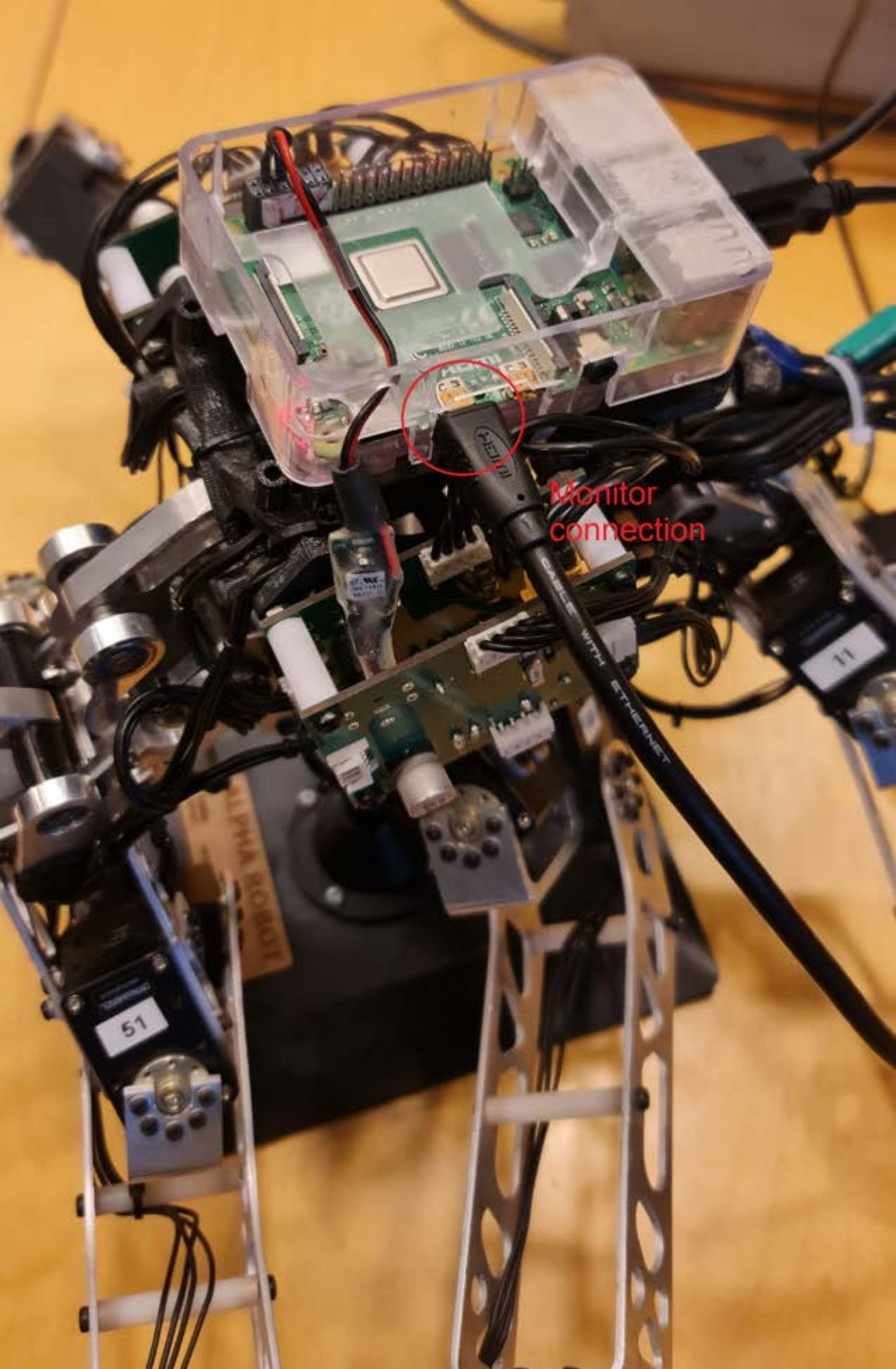
Modifying the code:

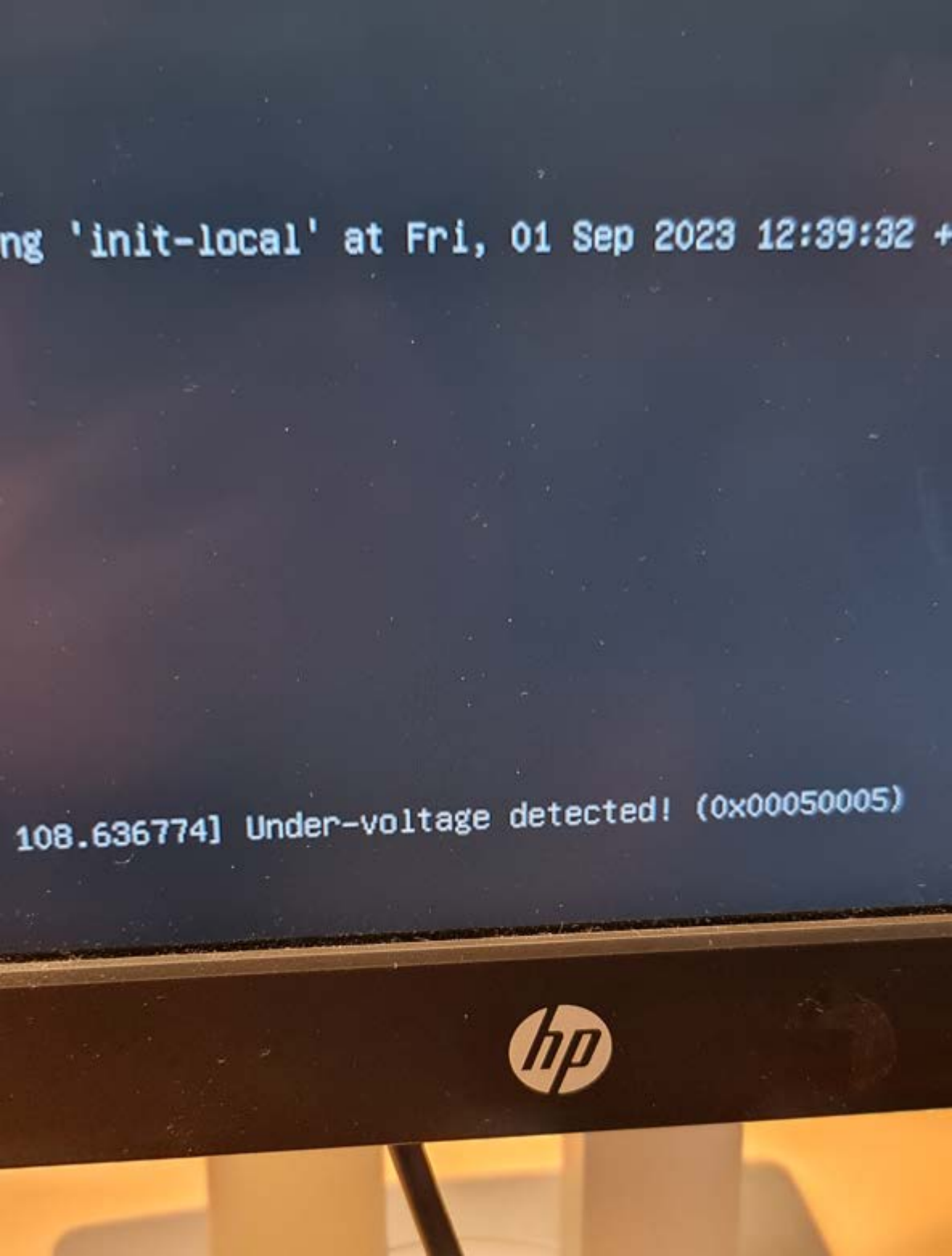
1. **Locomotion control:**
   Go to the folder
   /home/ubuntu/catkin_ws/src/db_control/db_alpha_controller/control/real and modify the file called **neutronController.cpp**
   Usually modified for switching between manual and navigation code control)

2. **Camera ball detection:**
   In the folder **/home/ubuntu/catkin_ws/src/camera_ball/src** modify the **BGR_sample.cpp**

3. **Localization code:**
   In the folder **/home/ubuntu/catkin_ws/src/imu/src** modify the **db_alpha_imu.cpp**

4. **Navigation server:**
   In the folder **/home/ubuntu/catkin_ws/src/db_navigation/src** modify the **db_client.cpp** or **db_server.cpp**
   Server is responsible for switching behaviors between foraging-goal-homing.


Monitor
connection
51
11


ng 'init-local' at Fri, 01 Sep 2023 12:39:32 +
108.636774] Under-voltage detected! (0x00050005)

```
] Started Monitoring of LVM2 mirrors, snapshots etc. using dmeventd or progress polling.
] Reached target Local File Systems (Pre).
] Started udev Coldplug all Devices.
] Started Dispatch Password Requests to Console Directory Watch.
] Reached target Local Encrypted Volumes.
] Found device /sys/subsystem/net/devices/eth0.
] Found device /dev/ttyS0.
6.276536] brcmfmac: brcmf_fw_alloc_request: using brcm/brcmfmac43455-sdio for chip BCM4345/6
7.065597] brcmfmac: brcmf_fw_alloc_request: using brcm/brcmfmac43455-sdio for chip BCM4345/6
7.137266] brcmfmac: brcmf_c_preinit_dcmds: Firmware: BCM4345/6 wl0: Mar  2 2020 23:30:41 version 7.45.202 (r724630 CY) FWID 01-72f6ece2
  ] Started Flush Journal to Persistent Storage.
  ] Listening on Load/Save RF Kill Switch Status /dev/rfkill Watch.
    Starting Load/Save RF Kill Switch Status...
17.916808] Under-voltage detected! (0x00050005)
OK ] Found device /dev/disk/by-label/system-boot.
    Starting File System Check on /dev/disk/by-label/system-boot...
OK ] Started File System Check Daemon to report status.
OK ] Started Load/Save RF Kill Switch Status.
OK ] Started File System Check on /dev/disk/by-label/system-boot.
    Mounting /boot/firmware...
OK ] Mounted /boot/firmware.
OK ] Reached target Local File Systems.
    Starting Tell Plymouth To Write Out Runtime Data...
    Starting Create Volatile Files and Directories...
    Starting Enable support for additional executable binary formats...
    Starting AppArmor initialization...
    Starting ebtables ruleset management...
    Starting Set console font and keymap...
    Starting Initial cloud-init job (pre-networking)...
[  OK  ] Started Tell Plymouth To Write Out Runtime Data.
[  OK  ] Started Create Volatile Files and Directories.
[  OK  ] Started Set console font and keymap.
    Mounting Arbitrary Executable File Formats File System...
    Starting Network Time Synchronization...
    Starting Update UTMP about System Boot/Shutdown...
[  OK  ] Started ebtables ruleset management.
[  OK  ] Mounted Arbitrary Executable File Formats File System.
[  OK  ] Started Enable support for additional executable binary formats.
[  OK  ] Started Update UTMP about System Boot/Shutdown.
[  OK  ] Started Network Time Synchronization.
[  OK  ] Reached target System Time Synchronized.
[  OK  ] Started AppArmor initialization.
    Starting Load AppArmor profiles managed internally by snapd...
[  OK  ] Started Load AppArmor profiles managed internally by snapd.
[   25.786103] cloud-init[1676]: Cloud-init v. 20.2-45-g5f7825e2-0ubuntu1~18.04.1 running 'init-local' at Fri, 01 Sep 2023 12:39:32 +0000. Up 25.23 seconds.
[  OK  ] Started Initial cloud-init job (pre-networking).
[  OK  ] Reached target Network (Pre).
    Starting Network Service...
[  OK  ] Started ifup for eth0.
[  OK  ] Started ifup for wlan0.
    Starting Raise network interfaces...
[  OK  ] Started Network Service.
    Starting Network Name Resolution...
    Starting Wait for Network to be Configured...
[  OK  ] Started Wait for Network to be Configured.
[   26.169736] brcmfmac: brcmf_cfg80211_set_power_mgmt: power save enabled
[  OK  ] Started Network Name Resolution.
[  OK  ] Reached target Host and Network Name Lookups.
[   44.124745] Under-voltage detected! (0x00050005)
[ ***  ] A start job is running for Raise network interfaces (1min 34s / 5min 12s)[  108.636774] Under-voltage detected! (0x00050005)
[ ***  ] A start job is running for Raise network interfaces (3min 40s / 5min 12s)_
```