Report Qualisys Motion Capture on ROS and Network Configuration

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1 Qualisys Motion Capture on ROS

1.1 Virtual Machine Installation

First, make sure that you have installed the Qualisys software on your PC and have activated the licence, then it is possible to follow this step to get the data given by the software on Windows directly on Linux/Ubuntu.

Once you have checked that the software is working correctly, make sure that the cameras are calibrated and that the program knows the position of the body to be tracked. We will now proceed with the installation of Ubuntu 20.04.6 on VM VirtualBox , followed by the installation of ROS on the virtual machine.

Step for Windows 10 (*Check if these steps are the same for Windows 11*):

- Install VM VirtualBox from link;
- Download iso file of ubuntu 20.04.6, from this link;
- Install Ubuntu20.04.6 on the VM, with manual installation. Follow this tutorial link

After the correct installation of Ubuntu20.04.6 on VM , open the installed SO and follow the procedure to install Ubuntu on it.

1.2 Ros Installation on Virtual Machine

To install Ros Noetic on Ubuntu20.04.6 LTS, follow the command list below.

Commands list

```
#Package Setup
sudo sh -c 'echo "deb http://packages.ros.org/ros/ubuntu $(lsb_release -sc) main"
> /etc/apt/sources.list.d/ros-latest.list'

#input ROS key
sudo apt install curl # if you haven't already installed curl
curl -s https://raw.githubusercontent.com/ros/rosdistro/master/ros.asc
| sudo apt-key add -

#Update
sudo apt update

#Install
sudo apt install ros-noetic-desktop-full

#Source environment
```

```
source /opt/ros/noetic/setup.bash
```

1.3 Qualisys Motion Capture SDK on ROS

Once the ros noetic installation is done,it possible to create a ros package.

```
#Create project directory
mkdir QROS2

#Move to project directory
cd QROS2

#Create source directoty within project directory copying the Qualisys source driver
mkdir src

cd src

#clone example project to source repository
git clone https://github.com/KTH-SML/motion_capture_system.git

#return to project folder
cd ..

#build driver
catkin_make

#source new build environment
source devel/setup.bash
```

2 Network Configuration

A ROS Network had to be used to interconnect all devices such as the Ground Control Station, the Rov, the haptic system and the motion capture system. Through the ROS environment, it was possible to communicate with any node in the network at any time. The requirements to set up such a network are:

- Complete two-way connectivity between all pairs of machines, on all ports.
- Each machine must publish itself with a name that all other machines can solve.

To establish full connectivity, it was necessary to create a local network, in which all devices are connected to an Ethernet switch. Each device is assigned a static IP to remain stable over time. Therefore, the devices in the network are configured as follows:

- Ground Control Station : IP 192.168.2.1
- Qualisys Motion Capture : IP 192.168.2.3
- BlueROV2 Fhatom X : IP 192.168.2.2

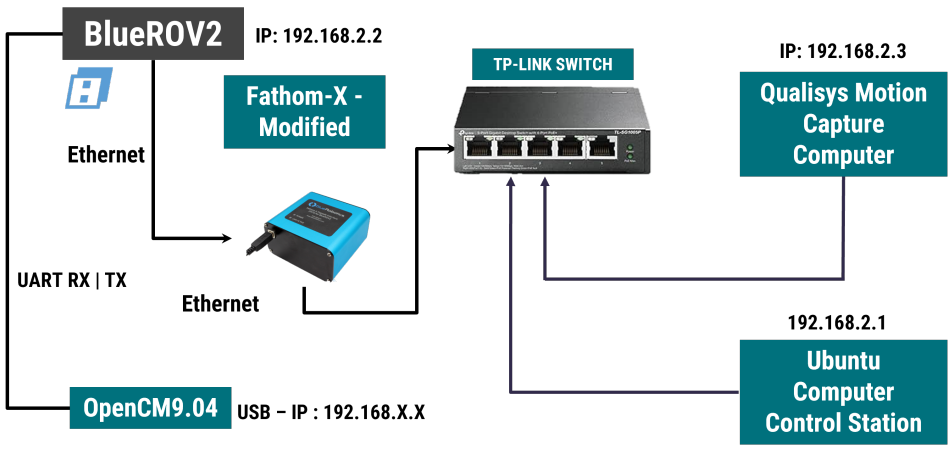

Figure 1: System Local Network

After configuring the Ros Network, we must define the Ros Master. For simplicity and efficiency, we use the Control Station as the master node, as it allows us to process data faster and have control over the entire network.

2.1 Static IP Configuration

As mentioned at the beginning of this section, each device connected to the network must have a static IP. Let us now set the ip for each device, knowing that the default ip of the BlueROV2 system is 192.168.2.2.

2.1.1 Motion Capture Computer - Operating System : Windows10

Set as Static IP of Windows 10 Computer : 192.168.2.4 , subnet: 255.255.255.0
Set as Static IP of Virtual Machine Ubuntu : 192.168.2.3, subnet: 255.255.255.0

2.1.2 Control Station Computer - Operating System : Ubuntu20.04

Set as Static IP of Ubuntu: 192.168.2.1,subnet: 255.255.255.0

2.1.3 Check interconnection between devices

http://wiki.ros.org/ROS/NetworkSetup
To check that the connection between devices is working, run on terminal of each devices this command:

```
ping 192.168.X.X
```

192.168.X.X is the static ip related to the other device in the net. If the data are transmitted and received the device is connected.
Check the connection in both devices.

```
# from ground control station
ping 192.168.2.3
# from qualisys computer
ping 192.169.2.1
```

2.2 ROS Network Configuration

Ros Master:

```
export ROS_IP=ip_of_this_machine
export ROS_MASTER_URI=http://ip_of_this_machine:11311
```

Ros Node:

```
export ROS_IP=ip_of_this_machine
export ROS_MASTER_URI=http://ip_of_master:11311
```

2.3 Setting & Testing Connection

Set all the connections and test it. Start close all and reopen VM VirtualBox, go to settings and then to network. Enable 2 adaptator and check if at the same computer are attached the two ethenet cable. One for the qualisys camera systema and one connected to the switcher with usb adaptator.
Then start the virtual machine, and open the terminal. After that check the Ethernet connection, there will be two:

- enp0s3 is the eth connection with qualisys camera
- enp9s8 is the usb connection

On Qualisys Software start the real time recording of data. Before check to have done correctly the calibration process, and to have create a Rigid Body to track.
Now we can check the connection through all the device, run this command on both device and check if the connection has been created:

```
ping 192.168.2.1 # check connection to QGC Computer
ping 192.168.2.4 # check connection to Windows Computer
ping 192.168.2.3 # check connection to Virtual Machine Computer
ping 192.168.2.2 # check connection to BlueROV2 FathomX
```

There could be some problem of connection when is trying to ping from ubuntu computer to windows computer. In this case take a look at the firewall of windows, it must be inactive.

After checking the network connection, let set the ros network. Follow these commands:

```
# set the ros network on ubuntu vm :
export ROS_IP=192.168.2.3
export ROS_MASTER_URI=http://192.168.2.1:11311
# set the ros network on qgc :
export ROS_IP=192.168.2.1
export ROS_MASTER_URI=http://192.168.2.1:11311

# Start ros on QGC
source ~/catkin_ws/devel/setup.bash
roscore
# Start Qualisys on VM:
source ~/QROS2/devel/setup.bash
roslaunch mocap_qualisys qualisys.launch server_address:=192.168.254.1 udp_port:=-1
#open new window terminal
source ~/QROS2/devel/setup.bash
#check if there are topics
rostopic list
rostopic echo <name-of-topic>


# Check rostopic list and echo on the QGC Computer in a new terminal.
source ~/catkin_ws/devel/setup.bash
rostopic list
rostopic echo <name-of-topic>
```

2.3.1 Useful commands ROS

```
#tools
rostopic #shows rostopic commands
```

```
rostopic list #shows all published nodes

rostopic info #shows info about node

rostopic echo #shows data from node

#new window to pull data from any location
#navigate to directory folder
cd QROS

#source build environment
source devel/setup.bash
#show what is using each node
rostopic info /qualisys/name_of_tracking_obj/pose #example

#plot data
export DISPLAY=$(ip route list default | awk '{print $3}'):0 #opens new window
export LIBGL_ALWAYS_INDIRECT=1 #creates plot

rqt_plot /qualisys/name_of_tracking_obj/pose/pose/position/z #plot that looks at ground
```

2.4 OpenCM9.04 Access via Ground Control Computer

In order to access the opencm card using the Ethernet connection of the bluerov system, third party software installed on the RPi3 was used. The software is called VirtualHere, and it allows us to virtualise the serial connection between the RPi3 and a USB device, giving us the IP address to access that device. So we can control it without it being physically connected.

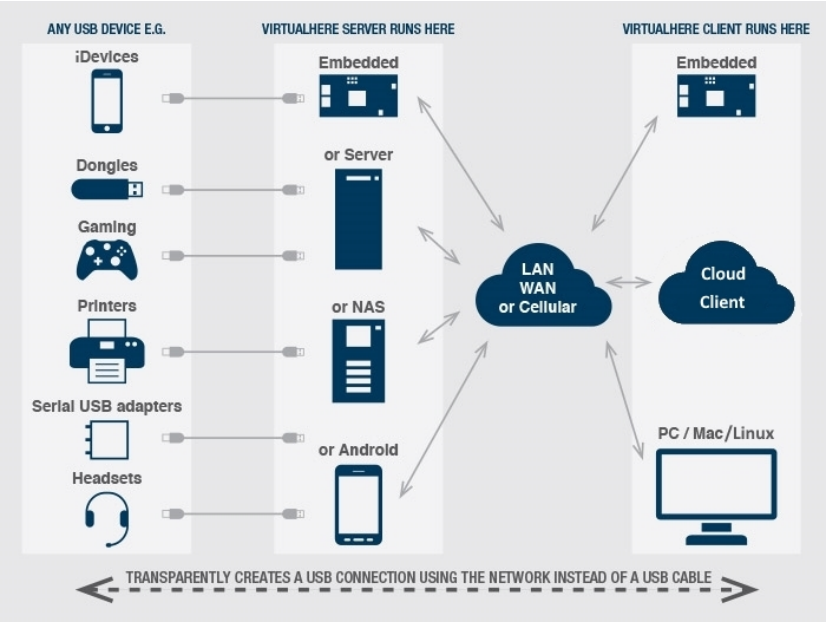

Figure 2: VirtualHere Diagram

RPi3
Download https://www.virtualhere.com/sites/default/files/usbserver/vhusbdarm and install it on RPi3, and write a bash script in order to run it every time the opertating sistem start.
Ground Control Computer : Ubuntu20.04

Download https://www.virtualhere.com/sites/default/files/usbclient/vhuit64 and install it on ubuntu using these command:

```
# Go to the folder containing the file
sudo chmod +x ./vhuit64
# Run it
sudo ./vhuit64
```