Modular transmit / receive station control

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based on
https://github.com/duggabe/gr-control
Design criteria

- “Plug and Play” design
- Four separate modules working together: control, transmit, receive, and relay driver
- USRP Source and Sink blocks must be in the same process (flowgraph)
- All transmit and receive modules must have the same interface to the control module
- To allow GUI presentation on the same display screen, the control module, transmitter, and receiver should be in the same computer
- No hardware modifications should be required
Using gr-control branches

- `main` (the default) is the development branch for software not yet put into the maint branches. It contains flowgraphs for GNU Radio 3.9+. It includes relay control using a Raspberry Pi computer.
- `maint-3.9` contains flowgraphs for GNU Radio 3.9 and uses a USRP device. The sample rate is set to 768kHz.
- `maint-3.8` contains flowgraphs for GNU Radio 3.8 and uses an ADALM-Pluto. The sample rate is set to 576kHz to minimize the processing load if used on a Raspberry Pi computer.
- Note that the `maint-3.8` and `maint-3.9` branches simulate the relay switching.
USRP sample rate = 768kHz
Options
Title: xmt_rcv_switch
Author: Barry Duggan
Description: Station Control Module
Output Language: Python
Generate Options: QT GUI

UHD: USRP Source
Device Arguments: re...e=1536
Sync: No Sync
Clock Rate (Hz): 30.72 MHz
Samp rate (Sps): 768k
Ch0: Center Freq (Hz): ...80>
Ch0: Gain Value: 1
Ch0: Gain Type: Normalized
Ch0: Antenna: TX/RX
Ch0: Bandwidth (Hz): 200k

UHD: USRP Sink
Device Address: sen...mes=128
Sync: No Sync
Clock Rate (Hz): 30.72 MHz
Samp rate (Sps): 768k
Ch0: Center Freq (Hz): ...10>
Ch0: Gain Value: 500m
Ch0: Gain Type: Normalized
Ch0: Antenna: TX/RX
Ch0: Bandwidth (Hz): 200k

ZMQ PUB Sink
Address: tcp://1....0.1:49201
Timeout (msec): 100
Pass Tags: No
Filter Key:

ZMQ PUB Message Sink
Address: tcp://1....94:49202
Timeout (msec): 100
Pass Tags: No
Filter Key:

ZMQ SUB Message Source
Address: tcp://1....37:49204
Timeout (msec): 100

ZMQ SUB Source
Address: tcp://1....137:49203
Timeout (msec): 100
Pass Tags: No
Filter Key:
Station Control Module

• Python transmit switching sequence
  • mute receiver
  • turn off rcv LED
  • turn on Antenna LED
  • send message to relay controller
  • wait for reply message
  • delay 10 ms
  • unmute transmitter
Raspberry Pi relay controller

- Python transmit sequence
  - wait for an input message
  - switch antenna from rcv to xmt
  - delay 100 ms
  - turn on power amp
  - delay 250 ms
  - send reply back to client
Raspberry Pi with relay board
xmt_rcv_switch display
xmt_rcv_switch display
Receiver modules

- Narrow Band FM
- Single Sideband
- Broadcast Wide Band FM stereo
SSB receiver
Transmitter modules

- Narrow Band FM
- Single Sideband
Narrow Band FM transmitter

Options
Title: NFM_xml
Author: Barry Duggan
Output Language: Python
Generate Options: QT GUI

Variable
Id: samp_rate
Value: 48k
Label: Sample rate
Default Value: 48k
Start: 0
Stop: 10
Step: 10

Variable
Id: usrp_rate
Value: 768k
Label: USRP rate
Default Value: 768k
Start: 0
Stop: 10
Step: 10

QT GUI Range
Id: audio lv
Label: Audio level
Default Value: 1.3
Start: 0
Stop: 10
Step: 10

QT GUI Chooser
Id: pl_freq
Label: PLL Tone
Num Options: List
Options: [0, 0, 67.0, 71.9...]
Default option: 0

Low-pass Filter Taps
Id: low_pass_filter_taps
Gain: 1.6
Sample Rate (Hz): 48k
Cutoff Freq (Hz): 4k
Transition Width (Hz): 1k
Window: Hamming
Beta: 6.76

Variable
Id: rs_ratio
Value: 1.04
Label: Rate
Default Value: 1.04

Note:
gc-cessb required

gr-cessb contains the modules
Magnitude Clipper and Peak Stretcher:
https://github.com/impeg/gr-cessb

Audio Source
Sample Rate: 48 kHz
Constant Source
Constant: 3

Multiply Const
Constant: 3

Audio gain

FFT Filter
Decimation: 1
Taps: low_pass_filter_taps
Num. Threads: 1

Float To Complex

Magnitude Clipper
Clipping Level: 1

Virtual Sink
Stream ID: clipper-out

QT GUI Time Sink
Number of Points: 32,768k
Sample Rate: 48k
Autoscale: No

Virtual Source
Stream ID: clipper-out

FFT Filter
Decimation: 1
Taps: low_pass_filter_taps
Num. Threads: 1

Virtual Sink
Stream ID: aud_out

Peak Stretcher
Constant: 1.3

Signal Source
Sample Rate: 48k
Waveform: Sine
Frequency: 0
Amplitude: 150m
Offset: 0
Initial Phase (Radians): 0

PL tone generator

Add

Band Pass Filter
Decimation: 1
Gain: 1
Sample Rate: 48k
Low Cutoff Freq: 200
High Cutoff Freq: 2k
Transition Width: 100
Window: Hamming
Beta: 6.76

Virtual Source
Stream ID: aud_out

NBFM Transmit
Audio Rate: 48k
Quadrature Rate: 48k
Gain: 1
Tau: 75m
Max Deviation: 5k
Preemphasis High Corner Freq: 1

Fractional Resampler
Phase Shift: 0
Resampling Ratio: 60.0962m

ZMQ PUB Sink
Address: tcp://1...0.149203
Timeout (msec): 100
Pass Tags: No
Filter Key: 

USRP sample rate = 768kHz
Narrow Band FM transmit
Modular transmit / receive station control

- **Summary**
  - Easy to add new modules
    - Radioteletype (RTTY) [https://github.com/duggabe/gr-RTTY-basics](https://github.com/duggabe/gr-RTTY-basics)
  - Easy to test variations