Python HW Link

High Level Overview

As Flight Simulators increasingly offer support for API interfaces (eg DCS, P3D), it now is feasible to move away from using Joystick interfaces (along with fun of dealing with USB issues) to a distributed system using Ethernet. Such as approach also simplifies output interfacing (e.g. indicators and gauges) as tasks and processes can be divided up across a number of devices and technologies.

This project builds on the Python/Raspberry Pi project used in the Huey Warning panel.

Definitions

Primary Flight Simulator – the PC running an instance of the flight simulator

Primary Node – the Raspberry Pi node that communicates to the Primary Flight Simulator

Distributed Node – either a Raspberry Pi or Arduino (with Ethernet shield) that communicates to the Primary node.

Principles

* Use UDP for all communications where possible. This removes any possible performance issues associated with Nagle and TCP slow start. It also means components are loosely coupled, enabling them to be restarted without impacted other modules.
* Accept inputs from push, toggle, rotary, and rotary encoders.
* Outputs – analog and digital, text. All outputs are normalised before being send to output card/block. Should consider the format used by DCS-BIOS
* Multiple Sim support. As outputs are normalised the and loosely coupled now simulator support can be added without negatively impacting existing sim support. The receive interface from the Sim listens on unique ports, allowing the code to be running at all times.
* A shallow native shim is used to link the simulator to this hardware modules. As an example, LUA is used with DCS, for P3D Sim Connect used.
* Remote shutdown of all Pi nodes is provided through the master, once this has been invoked the nodes will shut down the OS, requiring either a hardware reset, and a power cycle to resume. Ideally outputs will display a checkerboard to reflect a shutdown command has been received.
* Indicator test, a single command will be supported to light all indicators, and perhaps cycle gauges.
* Downstream nodes should accept a request to report input switch position. On receipt of such a request the node will send a report of switch positions, probably at a rate of 20 per second. Need to consider reporting toggle switches in off position and three position switches.
* Will initially develop using DCS, and the variable names currently used by the A10
* The IP addressing of the ‘internal’ network (i.e. between the primary Flight Simulator computer) as well as between nodes will use the 172.16.1.X network. This enabled multiple flight simulators to share a common 192.168.X.X network. If there is only a single simulator the 172.16.1.X network can exist as a secondary address on the Primary network interface, if multiple Simulators share a network, then the internal network should use a different network interface on the Primary Computer.
* Mapping of physical inputs to simulator functions is performed on the Primary Pi node. This keeps the distributed nodes independent of flight sim, and relatively simple, enabling the use Arduino nodes as needed without adding unneeded complexity.
* Each distributed node will have a Unique identifier, which largely is used to uniquely identify different input modules.
* Each distributed node will maintain a state machine for its interfaces, sending only deltas to the Primary Node
* Distributed nodes receiving non-string values receive data as A=V:A1=V1:A2=V2
* Packets from input nodes will have the format of DX:A=V:A1=V1, where X is the input node number. The Node number is only indicated in the front of the packet, not at the individual AV pair.
* If an AV pair is not known it will be silently discarded unless the Primary node is in learning mode – where it will ask the operator what task should be assigned to the unknown AV pair.
* Learning Mode is determined by an argument on the command line ‘learning’ or in the
* Debug Mode is determined by an argument on the command line ‘debug’

# Choice of platform for the hardware interface.

Whilst the Raspberry Pi offers the nicest development and troubleshooting environment, it lacks the high pincount found on an Arduino. The Arduino will require an Ethernet shield (and not all Ethernet shields are created equal, have run into issues with an IOT shield that had a poorly cooled chip which caused lock ups).

As the Arduino codes runs without an intermediate operating system, it offers the highest performance for IO related tasks such as driving stepper motors.

Have ran into issues with lockups in the 737 overhead display, possibly due to incorrectly terminated strings or invalid characters included in string. Strongly bounds checking will be performed on the Pi before strings are send to Arduino displays.

As we are not bound by the 128 input limit associated with either windows DirectX or the 32 input limit associated with FSUIPC, OverPro’s Arduino Joystick interface can be used with 256 inputs reducing the number of controllers needed for the pit. Hopefully a single controller for Port, Starboard and Forward zones can be used. OverPro’s code will be modified removing the usb interface, instead storing switch state and reporting deltas after completing a full scan of 256 inputs. Unsure if rotaries will be supported, no logical reason why not.

# Program tasks

The workload is divided into two programs – one dealing with inputs, the other with outputs. Both are fundamentally loops which briefly block awaiting receipt of a UDP packet either from the simulator/shim or from the input devices.

Command line parameters are used to get a debugging level as well as enable a configuration mode.

Configurations will be held in two separate files, the format of these files is yet to be determined, but JSON is mostly likely. The configuration files include:

1. IP Address code listens on (optional - if not explicitly configured 127.0.0.1)
2. Port Code listens on (optional – if not explicitly configured 7784 for input module and 7785 for output module. (still considering whether to leave export.lua sending direct to existing Arduino units)
3. Mapping of input to aircraft commands and aircraft outputs to physical displays/gauges.

# Protocols

Where possibly output values will be carried directly mapping to value to be displayed, and may be integer, float, or string. Indicators/Solenoids will be represented as a 0 or 1.

Data will be carried as AV pairs A1:V2, A2:V2. The data packet will be preceded with a D.

Operational tasks such as shutdown, reboot, refresh switch state will be preceded with a C (command), and a single operational task. Eg C9999.

Operational Task

|  |  |  |
| --- | --- | --- |
| Task Id | Task |  |
|  |  |  |
| CQ | Send all switch states |  |
|  |  |  |

Ikarus uses the following format

# If Sending Commands to DCS with Ikarus installed

# The values to be sent can be found

# C:\Program Files\Eagle Dynamics\DCS World\Mods\aircraft\Uh-1H\Input\UH-1H\joystick

# Structure is

# C - Command

# 15 - Cockpit Device Id

# 3003 - Unknown but seen in multiple places

# Switch Position

# Send to Port UDP\_PORT = 26027

# MESSAGE = "C15,3003,-1" - Turns Test Switch on - All warning lights

# MESSAGE = "C15,3003,0" - Turns Test Switch to centre

# MESSAGE = "C15,3003,1" - Turns Test Switch to Reset - clears caution on front panel

# Bright/Dim 15,3004

# Learnings from Different Modules

## USB Interfaces

There still is a need to use USB interfaces, such as for a High Resolution Analog interface (which already has noise reduction built in) or for Rotary Encoders. As the Leo Bodnar cards provide a solid rotary interface they will be used for inputs on radios and autopilots.

The follow vendor and product Ids are used for the Leo Bodnar cards:

|  |  |  |
| --- | --- | --- |
|  | Vendor Id | Product Id |
| BU0836 | 0x16c0 | 0x05b5 |
| BU0836X | 0x1dd2 | 0x1001 |
| BBI-32 | tba | tba |

The USB interfaces will still be normalised over the UDP interfaces, and should support requests to report the status of all Joystick interfaces, perhaps with a 10mS delay between the sending the status of each button input.

It appears that different Operating Systems provide different levels of accessiblity, epsecially around devices they are Human Interfaces (HIDs). The Mac won’t let you easily attach to the HID. This isn’t too much of an issue, but does mean testing needs to be done on the Pi itself.

### Raspberry Pi

The USB.Core library provides a low level interface for the Rapsberry Pi. It is able to scan the USB bus and report back what is attached.

The code scans the USB bus looking for a specific device, and then detaches the device from the Kernel driver. Once this is completes it then runs a set configuration, and then asks for a data block from the target device on a frequent interval.

A quick check is made to see if the value returned is different from the last interval, if it is then the list holding switch positions if refreshed

# Initiating Scripts on Pi Nodes

Instead of trying to start python directly from crontab, use shell script (usually my\_server) to

start things

To get the script to autostart

sudo crontab -e

And add line

@reboot sh /home/pi/Documents/Flightsim/Huey\ Caution\ Panel/my\_server 2>&1

Which results in the crontab file looking like

# Edit this file to introduce tasks to be run by cron.

..

..

#

@reboot sh /home/pi/Documents/Flightsim/Huey\ Caution\ Panel/my\_server 2>&1

Originally a separate shutdown script was operated, need to work out why it was commented out, possibly as the script below only ever reaches remoteshut.py after the receiver code exits, which is never…

### BEGIN INIT INFO

# Provides: my\_server

# Required-Start: $remote\_fs $syslog $network

# Required-Stop: $remote\_fs $syslog $network

# Default-Start: 2 3 4 5

# Default-Stop: 0 1 6

# Short-Description: Simple Web Server

# Description: Simple Web Server

### END INIT INFO

#! /bin/sh

# /etc/init.d/my\_server

export HOME

echo "Starting My Server"

cd /home/pi/Documents/Flightsim/Huey\ Caution\ Panel

sudo /usr/bin/python receiver\_004.py 2>&1 &

#sudo /usr/bin/python remoteshut.py 2>&1 &

exit 0

# Receive UDP Port utilisation

A number of these values are referenced from soic\_conv\_ExportStart.lua from DCS

|  |  |  |
| --- | --- | --- |
| Port | IP Address | Description |
|  |  |  |
| 26027 | 127.0.0.1 | DCS\_Emulator\_Rx |
|  | 127.0.0.1 | New DCS Emulator |
| 7777 | 127.0.0.1 | SOIC on Primary Sim PC[[1]](#footnote-2) |
| 7784 |  | Input Codes listens on |
|  |  |  |
|  |  |  |
| 7788 | 127.0.0.1 | Arduino Sendor Emulator. Sends to DCS\_Emulator RX |
|  |  |  |
|  |  |  |
|  |  |  |
| 13135 | 192.168.1.105 | Fuel Hands on A10 |
| 13135 | 192.168.1.106 | Fuel Display (OLED on A10) |
| 13135 | 192.168.1.107 | Compass and Clock Analog hands |
| 13135 | 192.168.1.108 | Clock Digits |
| 13135 | 192.168.1.109 | General Stepper |

### Adding RS232 Interface

Ref - https://www.instructables.com/id/Read-and-write-from-serial-port-with-Raspberry-Pi/

Using Max 3232 based interface which supports 3.3 to 5V

Pin Used (remebering pin numbers does include both sides of header – so these pins are adjacent.

4 (5V),

6 (GND)

8 (TX),

10 (RX)

Can use sudo raspi-config → Interfacing Options → Serial to enable/disable console through serial interface. In the disti used in Dec 2018 it is disabled by default – enabled to validate the TX led flashes during the reload process.

### Notes from the Huey readme

Git Commands

Clone Repo

git clone <https://github.com/bnepethomas/bne-arduino-flight-simulator-interfaces.git>

git config --global user.email "your email”

git config user.name "your name"

Watch for untracked files

$ git add .

$ git commit .

$ git push

Testinputdata.csv

input\_config.py

input\_assignments.json

temp\_input\_assignments.json

## PI Addressing

The Pi Ethernet interface has been configured with a secondary interface. This doesn’t seem possible using dhcpd.conf - so using /etc/network/interfaces. Using the Wireless interface to assign a default route and DNS server.

Currently unable to SSH to 144 but can 145 (wired). Also if a ping is made to wired interface - the reply originates with Mac address of wireless

auto lo  
iface lo inet loopback  
  
auto eth0  
allow-hotplug eth0  
iface eth0 inet static  
 address 192.168.1.145  
 netmask 255.255.255.0  
  
  
auto eth0:1  
iface eth0:1 inet static  
 address 192.168.3.100  
 netmask 255.255.255.0  
  
  
auto wlan0  
allow-hotplug wlan0  
iface wlan0 inet dhcp  
wpa-conf /etc/wpa\_supplicant/wpa\_supplicant.conf

1. The SOIC port points to another Shim which maintains a TCP connection to the SOIC processes, converting the UDP payload into a TCP stream. Currently error handling does not address a restart of SOIC processes. [↑](#footnote-ref-2)