Internet Radio Automation and Encoding Toolkit

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1 Overview

1.1 Required Hardware and Software

1.1.1 Operating System Requirements
This system has been developed and tested on **Linux Mint 18.3 with Mate**. Since the system makes use of window manager facilities, it may not work correctly on other versions of Linux with other window managers. Generally speaking, however, an Ubuntu derived Linux distribution with a GTK 3+ based window manager may work. If not, the display will not be correctly organized and buttons will overlap on another.

1.1.2 Window Manager
This software is configured to run with Linux Mint 18.3 with Mate. It has not been tested on other configurations.

For proper operation, it depends on certain window manager features. If these are not present, all or part may not operate.

The following is a list of some Mint 18.3 Mate window manager options. They may be set in:

```
Preferences | Look & Feel | Desktop Settings | Windows
```

when using the Mint Custom Menu Bar.

The following options do NOT work:

- Metacity
- Marco

If you use the above options, video will not encode correctly when you use **ffmpeg**.

The following options DO work:

- Marco + Compositing
- Marco + Compton
- Metacity + Compositing
- Metacity + Compton
- Compiz

Please adjust your settings accordingly.

1.1.3 Other Running Windows
The system makes use of **wmctrl** to control window visibility. This program makes use of
window names to control window behavior. You can see a list of currently running windows on your system by running the command:

```
wmctrl -l
```

When you run this software, it is advisable to close all other windows first as the names of some of these may conflict with or duplicate that names of windows that `wmctrl` is controlling.

### 1.1.4 Graphics Support

Generally speaking, performance will be improved if your Linux system has access to a supported graphics card. Generally speaking, NVIDIA based cards are well supported by Linux but driver installation may be required.

The video rendering software will make use of the graphics card GPU by means of VDPAU (Video Decode and Presentation API for UNIX) package. This option (libvdpau1) should be installed if you have active, compatible, video drivers.

### 1.1.5 Hardware Timing

The performance of some features will depend upon the speed of your hardware. Among these are:

1. Audio latency. Depending on the speed of your CPU and the number of processors, the audio may or may not be correctly aligned with video. This is due to the different processing for audio and video. There are settings in `stream.script` and VLC to compensate for this. Also note, the audio channels on some videos available on the Internet are not aligned correctly so compensation may not be advisable.

2. Camera initiation. When starting a camera in the system, a delay is taken while the camera initializes. If the camera does not fully initialize, subsequent control of the camera may not be successful. This may be remedied by increasing (or decreasing in the case of fast cameras) the delay in the code `Automation.c`.

3. Other windows. The system console incorporates windows that are created and maintained by other programs. As with cameras, there is a delay built in when these are started to give them time to fully initialize. These delays may need adjustment depending on your system.

### 1.2 Goals

Internet casting has been growing in popularity in recent years. While there are many commercial, and some open source, products available in the Windows ecosystem to support these activities, there are relatively few in Linux.
For actual casting, OBS (Open Broadcaster Software) is perhaps the best known. It runs on both Windows and Linux and has many sophisticated features to support casting and recording applications. Unfortunately, OBS requires considerable CPU resources, has complicated settings that do not always produce the best broadcast image for a given bit rate, and has more features than the typical user may need. Also, OBS is mainly a casting/recording tool. It lacks broadcast automation and playback facilities. These must be provided by other packages such as Mixxx, VLC, smPlayer, and so forth.

The attempt here is to develop an open source system that makes use of existing Linux resources, where available, that is compatible with OBS but has a simpler, less resource intensive profile, suitable for lower power machines, with support for:

1. high resolution full motion (24 fps) video
2. low streaming bit rates
3. built-in streaming encoder
4. broadcast and multi-media automation support.

The system makes use of existing software packages where ever possible. In some cases (pavumeter, pavucontrol, and guvcview), slightly modified versions of these standard packages are included in the distribution.

Existing software packages are started as independent processes. Since most of these take a period of time to initialize (for example guvcview can take several seconds to initialize a camera, depending on the camera), you will notice delays at times when first starting a service. These are due to builtin sleep commands that pause until the service has begun. The duration of these can be altered and, in some cases, depending on your hardware, may need to be increased.

1.3 Basic Design

The package consists of:

1. a control panel to schedule and automate the playing of local and Internet accessible media files;
2. an ffmpeg based encoder capable of sending a 24 frame per second (fps) full motion video to an RTMP (Real Time Messaging Protocol) media streaming server at a high level of compression;
3. PulseAudio loop-back configuration to merge and control audio send to the encoder.
4. Slide show, screen saver, camera, browser, and YouTube video controls.
1.4 Performance

In Linux, the most widely used audio and video casting system is OBS. OBS offers a number of features for both recording and casting but these can come at a price on lower power machines with limited graphics processing support, as is the case in Linux.

In OBS, multiple sources of video, audio, slides, video capture and so forth are organized into scenes. OBS captures the contents of these and allows the user arrange them into a window the contents of which are encoded and sent to the streaming server. Multiple scenes with differing layouts are possible. OBS supports a wide range of options for resolution frame rates, encoding and so forth.

A problem that arises, however, is that, on Linux systems, where video graphic card support in minimal, the real time processing to handle this can be overwhelming to even high end machines. Even simple casts can require more CPU power than many systems provide, especially if high compression rates are needed. Full motion video is often difficult to attain.

The concept used here is simpler. A fixed area of the user’s display monitor is reserved as the casting area or canvas. Anything placed in this area (players, video sources, browsers, terminal windows, etc.) will be encoded and transmitted. Audio is obtained and controlled through the PulseAudio system (a JACK version will be available soon).

While this approach is not as flexible as OBS, it is far simpler and requires, in most cases, less than half the CPU time as OBS to cast the same content at the same frame rate but at a one quarter the bit rate.

In the default configuration, full motion, 24 fps video at a resolution of 640x360 can be encoded and transmitted at bit rates less than 850K per second with no graphical video hardware requirements. In a comparison test on the same media file, to achieve full motion video at the same resolution, OBS used in excess of 2,500K bits per second and twice the CPU time.

On an AMD FX 6100 processor overclocked to a maximum of 4 gHz\(^1\), a full motion (24 fps) video at 640 by 350 resolution encoding to the iVlog.tv streaming host site used the following:

1. Overall 1 minute Linux load factor: 1.0
2. Bit rate: varied but never more than 835 k bits/second
3. Encoder (ffmpeg): between 47% and 53% usage of one CPU core
4. MPV used about 20% of one CPU core.
5. Pulse Audio used about 12% of one CPU core.

\(^1\) The CPU was in *on demand* mode such that the actual CPU frequency varied from 1.4 gHz to 4.0 gHz.
The system is suitable for laptops and portable applications where OBS will not run. A very limited standalone version can be made to run on a Raspberry Pi. In this mode, the control panel is not used and the casting area is smaller. Consequently, the CPU load is reduced.

### 1.5 Workspace Switching

If you switch workspaces while casting, audio will continue to be streamed although the visible casting area will switch to the new workspace. See below in section 2.7 for details on the size of the areas being cast.

### 1.6 Implementation

The present implementation is on going and has only been tested on **Linux Mint with Mate 18.3** using the **Mint X** (or similar) theme. It may work with other versions of Linux. The implementation depends upon the underlying window manager for many services and these services may or may not be available in other Linux distributions.
2 The Automation Console

2.1 Overview
The system consists of a casting console that controls the audio and video presented to a casting area of the screen. The casting area of the screen (the red rectangle with the legend in Figure 1 Automation Console) is 640 wide by 350 high and located in approximately the center of your system screen. Visuals dragged into this area will appear in your transmission.

2.2 Casting Resolution
The are three builtin resolutions:

1. Low Mode: 640x350 corresponding to the gray area in Figure 1. Low Mode is selected by turning off the Panel and Full Screen buttons.

2. Panel Mode: 1324x750 corresponding to the entire area shown in Figure 1. Panel Mode is the default. It is indicated by the highlighted (red) Panel button.

3. Full Screen Mode: 1920x1080 corresponding to an entire screen. Full Screen Mode is enabled by clicking and highlighting (red) the Full Screen button. Clicking the Full Screen button turns off the Panel button if it was highlighted.

2.3 Video Players
Either the MPV or VLC audio/video player may be used. In these examples, the VLC player is shown. VLC comes with a builtin equalizer and a builtin compressor as well as some other features that may make it a better choice.

2.4 Browsers
Both Chromium (for YouTube videos) and Chrome (for general browsing) are used. You need to install both on your system. Before using either Chromium or Chrome in this system, you should close all existing Chrom or Chromium windows.

2.5 Basic Layout
Figure 1 shows the basic automation console. The casting area is the darker gray area in the upper right. Figure 2 shows the console with a video playing in the casting area using VLC.

---

2 Screens with at least 1920x1080 are required at the moment. To use another resolution requires a modification of the source code.

3 Choice of VLC or MPV is a compile-time option.
The active areas of the console are as follows:

1. The internal system volume meters (upper left) **L Mon** and **R Mon** (instances of *pavumeter*, a program commonly part of Linux distributions) showing the sound levels being presented to the encoder.

2. The sound levels for the microphone input channel (upper left) **L Mic** and **R Mic** (*pavumeter*).

Both the **Mic** and **Mon** meters windows are separate windows that float above the control console. However, if you drag the control console to another location, they will reposition themselves to their original, relative positions.

---

4 The versions of *pavumeter* and *pavucontrol* provided in the distribution have been modified slightly from the versions normally included in Linux in order to reduce the size of the associated visible windows.
3. The low resolution casting area is the rectangle in the upper right of the console - where videos, slide shows, the camera, and the screen saver will normally display. The area of the rectangle is 640 by 360. This is low resolution mode. Any image or video dragged to this area will be transmitted when the stream encoder is active in default mode.
In addition to low resolution mode (the gray area shown above) there are also panel and full screen modes which are discussed below.

If there is no content to display (video, slide show, screen saver), the gray rectangle (or one of the other static displays selected by the radio buttons shown below the gray area) will normally be visible identifying the location of the casting area. You may select a replacement for the gray image image by clicking one of the radio buttons that appear beneath the casting area. Figure 3 shows this area with the Linux logo selected. You may add additional buttons by modifying the source code and the Glade file Automation.glade.

4. The master system audio control (lower left panel with tabs) showing, in Figure 2, the output level and volume control for the VLC player which is playing the video clip seen in the casting area.

Audio levels for all sources being sent to the encoder can be controlled from this window. When other sources are active, for example Skype or Chrome, the Skype or Chrome controls will appear here. The audio control panel is generated by a modified version of the standard Pulse Audio program pavucontrol\textsuperscript{5} which is provided in the

\textsuperscript{5} The versions of pavumeter and pavucontrol provided in the distribution have been modified slightly from the versions normally included in Linux in order to reduce the size of the associated visible windows.
distribution. This window floats above the panel and repositions accordingly if the main panel is moved.

2.6 Casting Panel Buttons and Boxes

2.6.1 File Select, Randomize, Text Entry and Play

File Select

There are two File Select buttons. Each opens a standard Linux GTK File Chooser window whose initial directory, the first time you use it, is:

$HOME/Desktop/Broadcast.

From there, you may navigate to other directories.

In the File Chooser, you may select a video or audio file to be played. The name of file selected will appear in the adjacent text box (shown with the shadow designation music file name).

Once you have selected a file, subsequent usage of the File Select button will cause the File Chooser to open in the same directory from which the selection was made however you may navigate to other directories if you wish.

Randomize

The Randomize buttons will select a random media file from the directory from which the last file was chosen by the corresponding adjacent File Select button and place the file name into the corresponding text box. The Randomize button does not initiate play. The media file will play when the corresponding Play button is clicked. Use of the Randomize button is meaningful only if a directory has been identified by prior use of a corresponding File Select button.

Music File Text Entry Box

The box may receive entries from the File Select button or the Randomize button. You may also past entries into this box. File references must be full system file references (path from root). You may also place URLs of videos if the videos are directly playable. That is, not YouTube URLs as these are not directly playable by VLC or MPV.

Play

The Play buttons cause the named file, or URL to play in a window in the gray area.

Video Fill
The Video Fill button at the bottom will cause the video player to expand to fill the entire panel in a manner similar to that shown for YouTube URLs (see below). Click the button a second time returns the video to the gray area.

2.6.2 YouTube Videos

YouTube URL, Text Entry Box and Play Button

The button labeled YouTube URL inserts the main YouTube URL into the first YouTube text entry box to its right. If you click the corresponding Play button, the top page of YouTube will appear in a small Chromium window in the casting area. You may search YouTube from here.

The YouTube text entry area is also where URLs pointing to YouTube videos may be pasted (but not typed).

The YouTube video whose URL is placed here will be played in a small Chromium window that will appear in the gray casting area when the adjacent Play button is clicked.

YouTube Button

The YouTube button in the center turns on or off the display of the Chromium window containing a YouTube video.

YouTube Fill Button

The YouTube Fill button on the bottom of the panel will cause the Chromium window displaying a YouTube entry to expand to fill the entire panel as shown in Figure 4. The button is highlighted (red) when active. Clicking the button again will cause the YouTube window to return to the gray area and the panel to be restored.
2.6.3 Full Directory Select and VLC

Full Directory Select Button

Clicking the Full Directory Select button will bring up a directory chooser box with which you can navigate and select a directory.

VLC

The VLC button causes the music/video contents of the selected directory to play in random order. Only the VLC players is used, not MPV.

2.6.4 Playlist Select, Shuffle and Play

Playlist Select

The Playlist Select button functions in a manner similar to File Select. It is used to select a standard system playlist file (.m3u) such as may be produced by VLC or smPlayer. The playlist file address will appear in the adjacent text box or you may paste the full path information of a playlist. Only playlists may be used, not regular media files. Regular media files will not play from this entry box.

Shuffle

If you click the Shuffle button, the contents of the playlist file will be played in random order.
Play

If you click the Play button, the contents of the playlist will be played in consecutive order.

2.6.5 File Search

Search Box

The uppermost search box (identified by a magnifying glass icon), searches through the music library for files whose names satisfy the search expression entered into the search box. The search begins when the user hits enter. The search expression may be any regular expression accepted by `grep`. Up to 20 files found will be displayed. If you click on one, it’s path information will be entered into the box labeled Search Results. The music library searched is:

```
$HOME/Desktop/Broadcast
```

Play

Clicking the adjacent Play button will cause the search results entry to play.

2.6.6 Program Search

The second search box searches through entries in the file `program.lst` from which the 12 program buttons are populated. The search expression is any expression accepted by `grep`. A results box will appear and the program buttons will rearrange such that the selected entry will become the upper rightmost button.

2.6.7 ffmpegV and ffmpegI

The `ffmpegV` and `ffmpegI` buttons toggle the stream encoder on or off. When the encoder is on, the stream bit rate will be shown in the area labeled (at this moment) `stream inactive`. This buttons invoke the bash script file `stream.script` which you must edit to insert your streaming host’s URL and your casting key. The encoder will not function until you do so. As currently configured, `ffmpegV` turns on the section of code in `stream.script` presently configured for iVlog while `ffmpegI` turns on the section presently configured for VaughnLive. You may change these to target other streaming servers.

2.6.8 OBS Button

The OBS button starts the OBS studio. You must configure OBS separately (see below). Once started, you must terminate OBS from the OBS window itself.
2.6.9 Panel Button
The Panel button tells the system that you will be casting the panel area (rather than full screen or the small gray area). Of Panel is not engaged, the Fill buttons at the bottom of the panel will not work if Panel (or Full Screen) is not in effect. They require panel mode or Full Screen mode. If you are already casting (with ffmpeg), the Panel button will not respond. It is locked.

2.6.10 Full Screen Button
The Full Screen button tells the encoder that you will be casting the entire screen (1920 x 1080). It will not respond if you are already casting. The Fill buttons at the bottom of the panel will not operate if you are not in Panel or Full Screen mode.

2.6.11 Low Resolution Mode
If both Panel and Full Screen are not highlighted, casting will be confined to the contents of the small gray area.

2.6.12 Program Buttons
The three columns of large buttons in the center of the control panel are the program buttons. Each button shows the name of a file read from the file program.lst. The file names are shown with path information omitted (the program.lst file must containing path information - see below).

Each file name that appears has been processed so that: (1) special characters removed, (2) the first character of each word following a blank capitalized, and (3) all other text reduced to lower case. The numbers in the parentheses following the file name are (1) the number of seconds of play time for the file and (2) how many times the file has been played during this session.

Left clicking on a button causes the named file to play.

Right clicking on a button causes the display of buttons to reorganize such that the button right-clicked moves into the first position (upper leftmost position).

2.6.13 Seq ProgramButton
The Seq Program button will begin to play the media files whose names appear in the program buttons. The files will be played in the order (sequential) in which they appear.
The first file to be played will be the one designated by the upper leftmost button. As each file is played, the buttons shift. The currently playing file is always in the upper left button. A media file may be moved to the first (upper left) button by right clicking on it. The files whose names appear in the buttons are loaded from `program.lst` which may be organized into a program play list.

2.6.14 Rand Program Button

The Rand Program will randomly select media from the `program.lst` file. The program buttons will be rearranged such that the currently playing media file is in the upper left button.

2.6.15 Stop Players Button

The Stop Players button halts program play and closes the player.

2.6.16 Pause Button

The Pause button will cause the currently playing sequential or random program to pause at the end of the current file and wait until the button is clicked again. This allows for announcements between files.

2.6.17 Origin Button

The Origin button returns the program buttons to the beginning of the `program.lst` file.

2.6.18 Next Button

The Next button, when in Seq Program or Rand Program mode, causes play of the current media file to end the current file and to advance to the next program file.

2.6.19 Prog < Button

This button shifts the program button page one page to the left.

2.6.20 Prog > Button

This button advances the program button page one page to the right.

2.6.21 Skype

The Skype button starts the Skype program (`skypeforlinux`) and places the Skype window in the upper right corner of the screen. The Skype window may be dragged to the casting area if desired. Audio from the Skype app is available to the encoder and can be controlled from the audio panel in the lower left of the console.
2.6.22 Saver Button

Saver displays the screen saver in the casting area. The default screen saver is the *morph3d* screen saver normally distributed with Linux. If *morph3d* is not present, this will not work unless another saver has been compiled into the code. The screensavers are assumed to be in `/usr/lib/xscreensaver/` and the section of `Automation.c` that controls the screen saver is at the symbols `SS_LIB` and `SS_NAME`.

2.6.23 Slides Button

Initiates the slide show in the casting area. The slide show is derived from the directory `$HOME/Desktop/Broadcast/Slides640`. The images should be edited to be no wider than 640 pixels.

2.6.24 Video Button

Causes any currently running player (Chrome app or MPV) to appear in the gray casting area or become invisible (toggle).

2.6.25 Cam0 Button

Toggles the camera on or off and places the video stream into the casting area (when not in Panel or Full Screen mode) or in the area below the gray casting area when in Full Screen or Panel mode.

The system assumes a camera resolution of 1280x720 (or similar ratio - this can usually be adjusted and set by `gucview`). The camera is assumed to be named `/dev/video0`.

This button invokes a modified version of `gucview` (provided in the distribution, see below). If you have a second camera, you may manually open it and drag its display to the casting area as desired. A new camera should be opened first by `gucview` independent of this program to create default settings.

Due to variations in hardware speeds, the delay factor for the camera may need to be adjusted. If the camera does not position itself correctly, this is a sign that the delay factor needs to be increased.

2.6.26 YouTube Button

Toggles the visibility of a YouTube window.

2.6.27 Hide All Button

Hides all casting area content.
2.6.28 Chrome Button

Toggles visibility of a Chrome browser

2.6.29 Casting Area Background Radio Buttons

The radio buttons beneath the casting area control the still card display in the casting area. Other options are test patterns, color bars, Linux logo, and a road scene.

2.7 Casting Modes

There are three casting modes corresponding to three resolutions. In each mode, if you switch to a different workspace, the area of the new workspace that corresponds to the casting area from the previous workspace is the area transmitted. There is no loss of audio due to switching workspaces as can be the case in OBS.

2.7.1 Low Resolution Mode

In low mode (where neither Panel nor Full Screen are selected), the mode in which the console initializes, only items placed in the shaded gray area on the upper right of the console will be transmitted when ffmpeg is running. The resolution of the cast will be 640 wide by 360 high. When ffmpeg is running, you must not move the console window.

The ffmpeg will lock onto the gray casting area coordinates. Any attempts to move the console while ffmpeg is running will fail.

In low resolution mode, typical bit rates at 24 frames per second are about 400 k bits per second.

2.7.2 Panel Resolution Mode

In panel cast mode, the entire panel will be transmitted when ffmpeg is on. The resolution of the cast is 1324 wide by 750 high. In panel mode, the console window will retreat to the upper left of the screen and attempts to move it will fail.

In panel mode, typical bit rates at 24 frames per second are around 800 k bits per second.

2.7.3 Full Screen Resolution Mode

In full screen mode, the entire desktop is transmitted when ffmpeg is on. The resolution of the cast is 1920 wide by 1080 high. If your screen is too small for these dimensions, do not use this mode or, recompile Automation.c with the dimensions of your screen. In this mode, you can move anything anywhere.
In full screen mode, bit rates at 24 fps are typically about 1200 k bits/second.

2.8 Program Buttons

The 12 visible program buttons contain entries taken from the file program.lst which is loaded when the system is started.

A left click on one of these buttons will cause the file referenced to play. A right click will cause the buttons to shift such that the button right-clicked will appear in the first position (upper leftmost).

The Prog< and Prog> buttons will advance (or retreat) to the next twelve entries.

If the Seq Program is clicked, the entries referenced in the program buttons will play one after another (sequentially) beginning with the entry in the upper left button (see note above about right-clicking a button).

2.9 Search Boxes

There are two search boxes. One searches for files in the music library and the other searches entries in program.lst. Figure 5 shows an example of a music library search. The program.lst file search is similar in appearance.
2.9.1 Music Library Search
All file names in or beneath $HOME/Desktop/Broadcast will searched. The search term may be any regular expression legal to grep. Typical search entries, however will consist of a single word. Case is ignored.

A list of files satisfying the search criteria will be displayed. The file selected will be entered in the box labeled music file search result. Clicking on the adjacent Play button will cause the file to be played.

2.9.2 Program Search
The other search box, labeled Search program entries, searches the entries in program.lst. Files matching the search expression are displayed. If a file is selected, the buttons are rearranged such that the selected file is in the first button position (upper most left). The search expression may be any regular expression accepted by grep.

2.10 Screen Saver Mode
It is not uncommon in casts, when there is no meaningful video available, for example, when an audio only file is playing, to show a still card, and animation or a pre-formatted slide show.

The screen saver mode used here consists of a display of animated patterns taken from the xscreensaver package which is part of many Linux distributions. The one shown in these examples is the noof saver. There are many others. Selection of which screensaver to use is presently a compiled option but selections buttons should be available soon.

The current default screen saver is morph3d. The full list of available screen savers is visible in the directory:

/usr/lib/xscreensaver

and a sample of these can be seen in:

System | Preferences | Look and Feel | Screensaver

You may change the installed screen saver by modifying the defined symbols

#define SS_LIB "/usr/lib/xscreensaver/morph3d &"
#define SS_NAME "morph3d"

in Automation.c and recompiling.

When selecting a screen saver, you should check the amount of video it generates and the amount of CPU time it uses. Dome other savers that might be of interest are deco,

---

6 grep is a standard Linux command line search program that accepts regular expressions.

7 See the symbols SS_LIB and SS_NAME in Automation.c
fuzzyflakes, gears, and glsnake.

Generally speaking, screen savers generate a great deal of video and thus may increase bandwidth. They should be used sparingly.

2.11 Slide Show Mode

The slide show is a display of images that part of the cast. The slide show presenter is Phototonic.

You should run and set Phototonic’s preferences before you use it here. Ideally, slide show should be set to random, time should be set to 10 seconds per slide, and not to display file name in the slide.

The slide show defaults to show images from the directory:

```
$HOME/Broadcast/Slides640/
```

Due to the way Phototonics works, an initial image is required. The default is:

```
image.jpg
```
So, you should ensure that the directory has an initial image named `image.jpg`.

![Figure 7 Slide Show Mode](image.jpg)

### 2.12 Skype View

In Skype view, the `skypeforlinux` program is executed and the window for Skype is placed on the right side of the display monitor. Skype audio is available to the audio control panel and video images may be cast if you move video portion of the Skype window into the casting frame. You must first install `skypeforlinux` if you wish to use this option.
2.13 YouTube View

When the **Play** button adjacent to a YouTube URL is clicked, a small Chromium window app is started and the URL from the panel is displayed. If this URL is a video, the video will play and the audio will become available to the audio control panel. If the main YouTube URL is inserted into the text box by the **YouTube** button and the **Play** button clicked, the YouTube front page will appear in the Chromium app window from which you can search and play videos.
The system can be used as a set of source windows for OBS where OBS can be used for recording or stream encoding. In this view, you have the option of only broadcasting the casting area or you may cast the main panel, the microphone and system volume levels, the audio control panel and the players which are each separate windows that may capture with OBS.

If you click the OBS on/off button, it will start OBS as shown in Figure 10 (or terminate OBS if it is running). The main console window will reposition to the upper left hand corner and OBS will appear in the location where you last positioned it.

Ideally, you will want to minimize the size of the OBS console and eliminate unneeded elements. In View | Docks you can determine whether scene transitions, scenes, controls, sources, etc appear in the OBS console. The fewer present, the smaller you may make the OBS console. Note: after you have resized the OBS console, you should exit and restart to see the full effect.

Tests indicate that the OBS encoder uses in excess of twice the CPU time and requires approximately four times the band width to produce a cast of similar quality to the built-in...
ffmpeg encoder.

2.14.1 OBS Settings

The OBS configuration shown in Figure 10 is based on an OBS screen capture source where that only broadcasts the casting area of the console.

When you click OBS the console will reposition to the upper left hand corner of your display.

Since the casting area of the console displays several independent windows, you may want to use the OBS screen capture source.

To do this, you need to set the screen capture transform (right click on screen capture and then click transform and then edit transform) to crop only to the casting area:

1. crop left is 700
2. crop right is 590
3. crop top is 28
4. crop bottom is 684

The cropped area corresponds to the casting area of the console.

Other OBS settings recommended for use with the casting console are:

Settings | Video | Output Resolution

set to:

640 by 360.

The output settings:

Settings | Output | Advanced

are:

Rate Control: CBR
Bitrate 2500
CPU: medium
Before using OBS, you must also set your streaming server’s URL and you casting key in the OBS settings.

### 2.15 Camera View

Camera view assumes a video camera of resolution 1280x720 or similar proportions. In camera view, you drag and resize one or more camera windows into the casting area. The contents of the casting window will be presented to the encoder. Other elements may be in the casting area at the same time.

The camera view uses a modified version of the program `guvcview` which is normally distributed with many versions of Linux. The modified source code and a compiled instance are in the Automation directory. The modifications involved the title bar which, by default, shows the frame rate. The modified version shows `/dev/video0` which makes the window easier to control.

If you need to adjust your cameras settings or initialize it for the first time (many cameras need to be initialized at least once), use the Linux distribution provided `guvcview`. The command line:

```
guvcview --gui=gtk3
```

may be needed to start the camera control panel.
Since cameras can take a few seconds to initialize, there are delays built into the camera initialization code. Pauses during camera initialization are normal.

![Figure 11 Camera View](image)

### 3 Encoder

The built-in encoder is ffmpeg. It is invoked from the bash script file `stream.script`. It is normally invoked by Automation-bin.

It may, however, be invoked directly. If invoked directly, you should provide three command line parameters:

```
stream.script vert-offset hor-offset widthxheight
```

where:

- `vert-offset` is the vertical offset of the upper left hand corner of the casting area from the top edge of the screen.
- `hor-offset` is the horizontal offset of the upper left hand corner of the casting area from the left hand side of the screen.
- `widthxheight` (example: 640x380) is the width and height of the casting area in pixels. Note there must be a letter x between the two numbers and no blanks are permitted. The numbers should be even.
If you wish to use the loop back audio, you need to invoke `loopback.script` prior to running `stream.script`. See `runAutomation.script` for details on how to kill the loop back after you have finished.

## Audio System

Placeholder - more to come.

## Standalone Mode

The encoder and audio system can be run in standalone mode without the use of the automation panel. In this mode, the user is responsible for initiating and moving media files into the casting area. This mode is useful on very limited machines such as Raspberry Pi where the casting area is a small area of the home display thus reducing CPU usage.

## Installation

### Linux Base

The system, as of this writing, has been tested on Linux Mint 18.3 with Mate and the default Mint X desktop theme. This code may work on other distribution and window managers but it has not been tested as of this time.

### Desktop Theme

GTK desktop themes influence the manner in which widgets (buttons, labels, lists, etc.) are displayed. The widgets in this project are tightly grouped to save screen space. If the default theme expands the padding or spacing of these, they may overlap or otherwise not display correctly. The theme Mint X is the default at present with Linux Mint 18.3 with MATE. Other themes should work as well but you should check their effects on not only this software but others as well.

You can set the theme by going to:

```
System | Preferences | Look and Feel | Appearance
```

In the pop-up box, select Customize, and under Controls, select Mint X or similar.

Usage of incompatible control themes may cause erratic layouts.

### Installation

1. The distribution comes with binary executables which are compatible with Linux Mint
Mate 18.3 and, probably, related Ubuntu based systems if auxiliary software is installed. The script file *install.script* consists of several *apt-get* commands that, if executed as root, install the needed code if it is not already present.

2. Unzip the distribution onto your Desktop directory. Do not attempt to install it elsewhere. It will not work.

3. Create (as root) the directory */usr/local/share/pavucontrol*

4. Copy the file in the distro named *pavucontrol.glade* to the above.

5. Make it world readable (*chmod a+r pavucontrol.glade*)

6. Be sure the directory path to it is world accessible (x permission for directories but this should be the default)

7. Install the programs (from synaptic) *mpv, vlc*, and *chromium*

8. Create a directory on your Desktop named Broadcast

9. Put some video or audio files into this directory (or subdirectories of same).

10. Make your PATH contain the current directory. Add the following, at the end, to .bashrc

    ```bash
    PATH=$PATH:$HOME/bin:.:/bin:/sbin:
    ```

Close & reopen your terminal window for the above to take effect.

11. See Section 7.3 for information on what directories are required and their contents.

### 7 Running the Console

#### 7.1 Setting Up Program.lst

Replace the contents of the file *program.lst* with your music file names. This is the file that will be used to load the buttons with music. The file must consist of full file references, one per line, for the music you want to have appear in the buttons.

For example:

/home/you/Desktop/Broadcast/RockMusic1/processed.full/VenturaHighway.mp4

The above should be an absolute file address on your system where you is your user id. You can get a list of absolute addresses for a directory of media files on your system by the following:

---

8 .bashrc is in your home directory.
1. Open a **caja** file explorer window to show the file names in *compact* format (see the edit preferences option).

2. In the window displaying the files in compact format, type ^a (control-a) followed by ^c (control-c). This means *all*, and *copy*.

3. Open the text editor (**xed**) from Applications | Accessories

4. In the text editor window, type ^v (paste). The edit window will now contain the file names. Remove any references to non-media files.

5. Save this as **program.lst** in the **Automation** directory. The files in this list, in the order they appear, will be shown in the playlist buttons of the control console.

   If you successfully built **program.lst**, you will now see the file names listed in the buttons. Click on one and it should begin to play. If there is no **program.lst** file, the buttons will be empty.

### 7.2 Server URL and Casting Key

To begin a cast, first modify the **SERVER** and **KEY** variables in **stream.script** to point to *ivlog* or *vaughnlive* or what ever other service you intend to use that supports the *rtmp* protocol. This information should be available from the streaming server host site.

### 7.3 Directories

The system has been configured to assume that certain files will be located in fixed locations. In future versions, some of these will be relaxed but, for the moment, these locations are required.

1. The system assumes that the environment variable **$HOME** contains the location of your home directory (this is normally the case in most Linux distributions).

2. The system assumes that **$HOME/Desktop/Broadcast** is the directory in which your media files are located. The directory may contain sub-directories. Symbolic links are permitted but the search function does not follow them at present.

3. The system assumes that **$HOME/Desktop/Automation** is the address of the directory containing the systems software.

4. The system assumes that **$HOME/Desktop/Automation/fifo** is the location of one of the system pipes used for internal communication. This file will be automatically created and deleted. If, however, it does not get deleted automatically, you will get an error message if you try to copy it (or the containing directory). If the console is not running, you may safely delete this file.
5. The system assumes that $HOME/Desktop/Automation/stream is the location of one of the system pipes used for internal communication. This file will be automatically created and deleted. If, however, it does not get deleted automatically, you will get an error message if you try to copy it (or the containing directory). If the console is not running, you may safely delete this file.

6. The slide show default directory is $HOME/Broadcast/Slides640/. The slide show requires an initial image file by the name of image.jpg to be located in this directory.

7.4 Running the Console

You initiate the system with the command9:

   ./runAutomation.script

This will cause the main console to initiate and start the floating windows.

As the system initiates, several small windows will open, and, ultimately, reposition themselves on the screen. This can take a few seconds as there are delays built into the startup procedure to allow these windows to initialize. On some slower systems, it is possible (but not likely) that the builtin delays may not be sufficient. If this is the case, they should be increased in the main code module (Automation.c).

You will also see messages in the terminal window that initiated the system. Some will be minor error messages and this is normally not a problem. If it crashes, however, there were problems.

Once the console has finished initialization, you may initiate casting by clicking the Stream on/off toggle button. This will cause the script file stream.script to execute and attempt to make contact with the server.

When the stream is running, do not move the main window as the streaming encoder has locked onto the casting rectangle. If the casting window is moved, the encoder will no longer see its contents.

When contact is established, the Stream Inactive text above the ffmpeg on/off toggle buttons will begin to display the encoder's bit rate (the rate at which it is sending data to the server).

You may begin playing media files at any time.

You may terminate the console (and all floating windows) by clicking the X box in the upper right corner of the main window.

---

9 Note: the ./ is not required if you included the current directory in PATH as shown above.
7.5 Installation & Compilation

7.5.1 Required Software

The system makes use of a number of freely available, open-source software packages, many of which may already be installed and no further action is required. The system also assumes that the standard Linux Mint screen saver collection (\texttt{/usr/lib/xscreensaver}) is installed. The system uses the \textit{morph3d} screen saver (this is a setting in \texttt{Automation.c})

The following items are required:

1. ffmpeg
2. libgtk-3-dev
3. mpv video player
4. pavucontrol (a modified version provided with distro)
5. pavumeter (a modified version provided with distro)
6. PulseAudio (included in Mint 18.3)
7. gcc/g++ compiler and libraries
8. guvcview (a modified version provided with distro)
9. JACK Audio (optional if you want to use JACK instead of Pulse)
10. libpulse-dev
11. libgtkmm-3.0-dev
12. libgtk-3-0
13. libcanberra-gtk3-dev
14. libcanberra-dev
15. gtkmm
16. wmctrl
17. pulseaudio-utils
18. at-spi2-core
19. glade
20. Phototonic
21. chromium-browser
22. VLC

23. google-chrome-stable

These are available in the Synaptic package manager or you may automate the instalation with the install.script file.

### 7.5.2 Installation Script

The process of installing missing items from the above is automated in the script file install.script. This file consists of a sequence of instances of `apt-get` that will install any items from the above that are missing. You need to run it as root.

```bash
sudo ./install.script
```

This script will generate a large number of messages (this is normal) and may take some time to run. You must have a functional Internet connection to use it.

You should now follow the instructions given in section 6.3 on page 32 above.

### 7.5.3 Compiling the Code

Once you have installed the required software, you should now be able to compile the system with the command:

```bash
./compileAutomation.script
```

### 7.5.4 Modified Open Source Code

Included with the distribution are compiled versions of pavumeter, pavucontrol and guvcview. These modifications to the standard versions make the windows that they generate smaller and easier to control.

To recompile the modified code (probably not necessary), descend into the appropriate sub-directory of Automation, directory and then, as root execute:

```bash
bootstrap.sh
make
make install
```

The executable will be in the src sub-directory (for pavumeter and pavucontrol) or guvcview (for guvcview). Copy the executables to the main Automation directory. The configure procedure for these may identify additional software requirements.

For pavumeter and pavucontrol, follow the procedure outlined in section 6.3 on page 32 above.

On some systems, it may be necessary to run pavucontrol (Volume Control) once in order to initialize the pulse settings in your ~/.config/pulse should no settings be present.
8 Glade File

The layout of the buttons and boxes is controlled by the file *Automation.glade*. Within limits, adjustments to the appearance of the console may be made by altering this file, saving the result, and, in some cases, recompiling the code (usually not needed). The Glade tool displays *Automation.glade* as shown in Figure 12.

![Automation.glade](image)

Figure 12 Automation.glade

9 Options

For the most part, options are set in *Automation.c* as variables and defined symbols.

Options are also set in *stream.script* and *loopback.script*

10 Script Files

The distribution comes with several BASH script files. These all have a `.script` file extension. They are used to install, compile and run the programs. These all need to be user executable (should be the default). To make a file executable, in the Automation directory, type:

```
chmod u+x *.script
```
10.1 install.script
This file installs Linux system software needed for the other programs. It consists of several apt-get install lines. It needs to be run as root. At the end, it compiles and runs the distribution.

10.2 compileAutomation.script
This script compiles the system code. The system does not use the configure / make / make install sequence.

10.3 loopback.script
This file sets up the Pulse Audio loopback to capture the audio for streaming. If you are using OBS for streaming, it is not necessary to execute this file. The audio sources can be configured directly in OBS.

If you are using the built-in streaming facility, you need to execute this file. The main execution script, runAutomation.script, automatically executes this file when it starts up.

While audio normally consists of two sources: input microphone/line-in, and the output of players (such as VLC), the builtin encoder, ffmpeg is set to take audio from only one source. This is handled by routing both audio inputs to a single internal sink which becomes the single source for ffmpeg.

The script sets up an internal audio sink and routes the audio from both the computer’s microphone input, and output from any players (MPV, VLC, Chrome, etc.) to this sink. The output of this sink is used as the input to the streaming encoder software. Otherwise, the encoder would only receive audio from the microphone or the players but not both.

If your system has multiple audio sources, such as a web cam or the audio channel on a video card HDMI port, you should disable these as they can become confused with the main audio card. You can disable an audio device by right clicking on the speaker icon which should be on your panel and clicking on sound preferences then selecting the Hardware tab. The devices will remain disabled until you turn them back on again.

10.4 stream.script
The file stream.script contains the encoder commands. It is automatically executed by runAutomation.script.

If you use OBS to encode your stream, you should not execute this file.

If you use this file to encode your stream, you first will need to edit it to include the URL of the
host server to which you are casting and your casting key (provided by the casting host).

10.5 runAutomation.script
The file runAutomation.script executes loopback.script and runs the automation system. The automation system will invoke stream.script only if you click the stream on/off button.

11 FAQ

11.1 No Sound
Check that one or more of the volume controls has not been set to silent. If you, for example, set the output of mpv or vlc to silent, it will remain at silent until you change it - even if you reboot!

11.2 No Sound, Yet Again
Check that sound cards not being used are turned off (see above) and reboot. The file loopback.script attempts to determine which card is your main audio card and sometimes gets confused.
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