ScreenRepeat v3 – Technical Description

Background

It was noticed in our church (Formby Methodist Church) that some members of the congregation were finding it difficult or impossible to see the church screens. For hymns, large print copies together with a magnifying glass worked for some, however with increasing use of multi-media, especially videos, there was no way they could see such content.

The opportunity had been spotted several years ago of using tablets to help those with poor eyesight see what's on the church screens. Tablets have bright, clear and large-enough displays that are easier to read than large print sheets and can also show other visual aids that may be on the screens such as pictures, videos, bible readings and other texts.

The idea was recently revived and I have called it ScreenRepeat.

The aim was to find a simple, low cost method that would work with most types of tablet that people might have at home. Although in the end, the church funded a set of tablets solely for ScreenRepeat.

This document is a brief overview of the solution so that others can see if this is feasible for their specific needs and environment. I am happy to answer questions regarding our experiences with using this set up in practice.

Overview

ScreenRepeat consists of a server, a WiFi network and one or more tablets.

The server is the device driving the screens that are to be repeated on the tablets, and has the following:

- A web server hosting a simple html page containing an <img> element
- An application streaming a portion of the desktop, the second display, over TCP as a MJPEG (Motion JPEG).

The WiFi network is simple and unprotected, and isolated in that it is not connected to the Internet. It is connected via Ethernet to the server and the tablets connect to the WiFi.

The tablets have:

- A web browser pointed to the page on the web server;
- An application to lock the screen to prevent screen sleep and unintentional operation of the tablet while in use.

Detail

Server

We use a fairly low end Lenovo laptop that happens to be running EasyWorship on Windows 10. The church screens are connected as a single Secondary Display.

The web server is Mongoose, although others would probably work just as well.

The web page is set to refresh the <img> src attribute periodically (20 second interval) so that if the streaming is interrupted for some reason it will refresh automatically. Also, the image is set to stretch and fill the entire screen, resulting in slight aspect ratio distortion.

Streaming is done by VLC, set to serve the MJPEG image over a different port to the web server. The frame rate and resolution are adjustable to minimise the bandwidth needed while keeping the quality of the tablet display good enough.

WiFi

A good signal is key to this solution working well. It seems that the position is important – the higher the better. A good quality Access Point is probably worth investing in. We are using an old device that serves the purpose hopefully when installed at height.

Tablets

These are low cost Archos 101b Xenon devices with 10.1" screens at 16:9 (ish) aspect ratio to match the church screens.

The "Touch Lock" app is used to keep the screen on.

Design Decisions

Image Streaming vs VNC

The first two versions of ScreenRepeat used RealVNC and then TightVNC. RealVNC worked well, however it was dropped as they now charge and it's a subscription based setup. TightVNC worked well for a while. The problem with both of these solutions is they are unsuitable for showing video content as they bandwidth is too high and there is no control over the quality or resolution of the image – they are designed to be high quality for remote desktop work. ScreenRepeat v3 was intended to improve performance for video content.

TCP vs UDP

A lot of experimentation was done with using UDP instead of TCP: in theory it would be highly beneficial to use UDP as there is no error correction. It would be much more scalable so that many tablets could be connected with affecting performance, and in the event of a poor WiFi connection, only the performance of the affected tablet would be reduced. With TCP, I've noticed if one tablet has a poor signal it affects the others, presumably it is the overhead of error correction.

UDP was not used in the end due to the client end: no app could be found with adequately low latency that would receive over UDP.

There may be scope to write a custom app with low latency display of streamed video over UDP: beyond me.

Web Browser vs App

Initially an App was tried to display the video stream. There are many Android video apps that display network streams, even those for security cameras were tried, however they all have a high latency, in the order of seconds; even in the best case it was still over a second. This doesn't work well for following song words on the screen, where often the chorus follows on quickly from the end of a verse.

The solution found was to use a web browser, which doesn't have any fancy caching of the MJPEG image but just displays the images as they're received.

MJPEG

This was chosen as a consequence of using a web browser to receive the stream, it's simple and it works. It also uses low resources on the server.

Performance

The solution described has been used successfully for several weeks. The good aspects of performance are:

- The frame refresh rate is good enough for videos.
- The latency is generally sub 1 second which is fine for purpose.
- Five tablets/mobile phone devices have simultaneously been working without any issue.

Some things that I'm monitoring are:

- Occasionally the image on the tablets disappears until the periodic refresh discussed above is reached. I suspect the WiFi on the tablets is dropping out occasionally. This may be because the tablets are low cost, but is not too much of an issue.
- If one tablet has poor WiFi signal, apparently even if it's too close to the Access Point, it affects all others. Currently the AP is on a window sill at the back of the church, it is to be moved to its own high shelf, hopefully this will mean all tablets in church will be line of sight to the AP and so have good signal.

Contact

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