ITAS 164
Initial Project Proposal
Crowd-Controlled Photo Frame Using E-Ink

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Introduction

For my initial project submission, I have decided on a network-connected digital photo frame that allows people to remotely upload images or short messages in real-time. There are multiple creative avenues for the approach to this project, while still remaining in-scope with the timeline and budget provided – these will be discussed below. In short, this project will allow people to upload photos from anywhere in the world utilizing a web interface, a small file share server, and a display with a Raspberry-Pi to handle all computing. This project will touch on a lot of ITAS fields we have already explored, such as server management, web form creation, and file sharing, while giving us a lot of new hands-on experiences working with Raspberry Pi and 3D-printing.

Needs Analysis

The concept of digital photo frames is not new – a lot of them exist on the consumer market at very affordable prices nowadays. The majority of them are small-scale and are typically curated towards a single household with standard Wi-Fi capabilities, or standard connections like SIM or USB file transfer. Typically, these include 3rd-party applications for submissions or physical on-site setup, and the majority of app-based photo frames utilize subscription models. Additionally, there are a lot of power needs for backlit digital displays, either requiring a consistent power supply or a frequent need to recharge, which can be frustrating for consumers who want an easy and aesthetically pleasing display without having to micro-manage everything themselves.

The purpose of this project specifically is to allow a group of people (ie. a classroom of students) to submit their own photos for display without the need for any third-party applications or physical connections, utilizing a simple web form and a minimal backend server to manage images and display them on a power-efficient, aesthetically pleasing display. The utilization of a web forum allows for a lot of modular options for this project: some ideas could include voting on photos to be displayed, weekly themes for students to submit, or live comments.

Finally, one major difference between this project and market products is the display. Instead of a backlit LCD display, I suggest using a colourized e-ink display similar to those used in e-readers. Not only do these add a unique aesthetic touch, but they are amazingly energy efficient, allowing this photo frame to be truly wireless without sacrificing convenience.

Technology & Resource Needs

As far as hardware, this project is relatively simple as far as sourcing third-party materials. The main starting point are the e-ink displays, which are actually Raspberry Pi (RPi) compatible by design. Our two potential options, both available quickly on Amazon, are as follows:

1. Waveshare 5.65in 7-Color Display, 600x448px ($100 CAD)
2. Waveshare 7.3in 6-Color Display, 800x480px ($136 CAD)

The RPi compatibilities for both display models, respectively, are:

1. Raspberry Pi 4B / 3B+ / 3B / 2B / Zero / Zero W / Zero WH
2. Raspberry Pi 5 / 4B / 3B / Zero / Zero W / Zero 2W / Pico / Pico W / Pico WH

Depending on the model needed, our average RPi budget is anywhere between approximately $20-$70 CAD. Adding on a simple rechargeable battery which is compatible with the display (such as this one) hovers around $15-$20. Assuming the most expensive setup with the largest screen and one of the most expensive RPi modules (the 4B at $62 – I think the 5 is overkill for specs needed) the maximum cost for this project is estimated at approximately $220.

Of course, the assumption here is that these are the only two main costs, and that the 3D-printing (for the frame) and server hosting costs are absorbed by access to ITAS equipment on campus. Thus, the project falls very neatly within the budget limitations – if we have access to an RPi already via ITAS, then the only true market cost of this project will come from the e-ink display. Essentially, there are a lot of hardware options available to adjust the budget as needed.

As far as group size, I would suggest a group of 3 people. Though the product itself is physically small, the spread of potential tasks in this project spans a wide range of technologies: server building, coding, web hosting, 3D printing, RPi deployment, etc. I expect that a group of 3 would be the best number for this project, but it is possible for it to be tackled with a 2-person team as well.

Stakeholder Analysis

Generally, there are two main use-cases that I have in mind for this project:

1. A collective of students who can submit photos to a classroom frame; or
2. A household with family members or friends far away, where messages or pictures can be sent to them for display in their own homes

Based on the above, this project has a wide range of use-cases which can span a dynamic group of stakeholders. The primary application idea is for use in a classroom setting, whereas the students are the users who are able to submit their own photos to the client, who ‘owns’ the frame. The sponsors of this project would include the faculty of ITAS and VIU as an organization.

Key Tasks

Here is a general, rough breakdown of the main tasks for this project:

1. **Weeks 1-2**: brainstorming, hardware decisions based on project needs
2. **Weeks 3-5**: backend and frontend development for file server and web form
3. **Weeks 6-8**: configuration of RPi and python scripting
4. **Weeks 7-9**: frame design for 3D printing, and final assembly
5. **Weeks 9-11**: user testing, feedback, revision, or any other modular additions to the project as needed, ie. more time for scripting modifications or web adding extra form features
6. **Weeks 12-13**: final presentation preparation

For milestones, the first milestone would include the completed hardware draft after **week 2**, where all hardware and software requirements are finalized and purchases are made. The second milestone would be a successful implementation of the server features, where photos can be successfully submitted to server via the web form, ideally around **week 5** of the project. The final milestone would be the roughly-completed project around **week 9**, where everything has been assembled and can be tested as a whole product by external users.

Division of Labour & Resources

For a general idea of plan labour division, I feel project tasks would be best tackled in roughly three areas. These areas can be divided evenly, using a 3-member team (A, B, and C) as an example, as shown below:

1. **Hardware**
    a. Purchasing and setup of all needed cables and hardware modules
    b. Configuration of hardware, RPi OS, and any drivers needed for compatibility
    c. 3D frame design and printing
2. **Backend**
    a. Setup of backend file server to receive and store images
    b. Python scripting for RPi deployment
    c. Backend web form functionality, additional coding needed for extra features such as voting, reactions, theme integrations, etc.
3. **Frontend**
    a. Creating user-facing web form for image submissions
    b. Implementing additional features into the UI of the web interface (voting, reactions, themes, etc.)
    c. Physical measurements, assembly, and power need (battery) details for final product

Potential Limitations & Risks

Though this project has a fairly well-defined timeline and scope, there are still some points of failure. Hardware sourcing may be relatively simple due to the physical simplicity of this project, however one concern may be that we are unable to source the display in time. There are very limited manufacturers of e-ink screens in this scope who can deliver in a reasonable time, and we are almost exclusively limited to purchasing one from Waveshare. If this is not doable, this project will need to be fundamentally re-structured.

Aligning with hardware, any 3D printing issues may also delay the project – however this is strictly aesthetic and has no particular effect on the actual functionality of the product, so it can be considered minimal risk.

Additionally, aligning expectations with the limitations of e-ink is important. While this may not necessarily be considered a true limitation, by design e-ink does not operate like standard backlit screens and typically has a refresh rate of around 30 seconds, depending on the chosen display.

Finally, any timeline issues will of course cause delays and need to be addressed. Following the timeline listed further above, there should theoretically be enough extra time allotted in weeks 9-11 to absorb any potential delays in labour or materials for this project. Though, if the team is reduced to only 2 members, this will significantly affect the timeline and limit any of that flexibility.

Successful Product Draft

At its most basic potential state, a successful completion of this project would have the following capabilities:

1. A stable, reliable method for any user to upload images over the internet to the frame
2. Similar to the above point, a properly-implemented network between the RPi, file server, and web form working together is mandatory
3. A fully automated display (ie. slideshow, schedule) without the need to manually adjust, switch, or cycle through submitted photos

Adding further functionality to make the project much more unique and interesting, at least one or more of these other features (or any other similar ideas) should be implemented:

a. Moderation: a method where an administrator can approve or reject images before they are displayed
b. Themes: a weekly theme “challenge” to encourage submissions based on a certain type (ie. pets, quotes, comedy, etc.)
c. Gamification: add reaction emotes, a ‘like’ feature, user leaderboards, live commenting
d. Text integration: an option to add text instead, conveying a message or a quote to the screen

References Used

Hardware:

- Waveshare 5.65in 7-Color Display, 600x448px
- Waveshare 7.3in 6-Color Display, 800x480px
- Raspberry Pi Boards, PiShop.ca
- 3.7v Rechargeable Battery

Tutorial / Demonstration:

- ESP32-based digital photo frame with 7-color E-Paper/E-Ink (Youtube Video)
- DIY GitHub Example: ESP32 E-Paper Digital Frame Project

Documentation:

- Raspberry Pi Foundation: Using Your Raspberry Pi