Title: A Portable Large Volume Email Retrieval System

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Project Abbreviation: FINDMAIL

Supervisor: Associate Professor Hussein Suleman

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A Portable Large Volume Email Retrieval System

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CCS CONCEPTS
• Information systems → Information retrieval → Specialized information retrieval • Software and its engineering → Software libraries and repositories • Software and its engineering → Software Portability

KEYWORDS
Portable; Searchable; Email formats; Archives; Indexing; Parsing; User interface; Query System

ABSTRACT
Email is present in all facets of daily life. A remarkable amount of information resides in email archives. This paper describes an attempt to development of a portable email system that allows users to input large email archives in maildir or mbox format and accurately and efficiently browse and search over the archive offline. This approach to designing systems for preservation and offline access is useful in areas with limited Internet bandwidth such as in most African countries. Experimental results confirm that users were satisfied with the general design of the system and moreover, that this system is effective and efficient.

1. INTRODUCTION

In the working world, there is often a need to search and browse through very large collections of emails, to track down individuals or to verify decisions, etc. For convenience, many users will either delete or archive email after it has been handled. If they choose to archive their email, these archives can later become large and cumbersome to search through, especially after a long period of time has passed. This can be attributed to many factors, including poor personal information management and large amounts of high priority email. Whittaker et al. [15] termed this “email overload”.

With the problem of “email overload”, there is also the issue of archives becoming obsolete through software aging [8]. In order to combat obsolescence and improve longevity, various preservation strategies need to be considered.

A possible solution to address the email overload and obsolescence issues, is to use a portable offline searchable email archive which handles multiple email formats (such as mbox and maildir). The searchability feature would allow for specific emails to be retrieved from the large archive (managing email overload), whilst the portable and offline features would make the archive less likely to become obsolete in the short-term. This solution is the one proposed in this paper.

Taking the above into consideration, we created a Web application to facilitate portability and offline searchability, that allows for multiple email formats as inputs.

The project is divided into two logical sections which, when used in conjunction, solves the overall project. The two sections are as follows:

1. Pre-Processing:
This involves parsing and indexing of the inputted archives of various email formats. Parsing will extract and structure relevant information from the inputted archive, whilst indexing involves creating indices from the parser output.

2. Email Processing:
This involves the user interface and a query system that allows for fast and efficient
1.1. Project Significance

We hope this project will help individuals better manage their emails from large archives and provide them with fast and accurate search and browse functions, making it more likely for the information to be retrievable in later years. In addition, by releasing the resulting tool from this project as open source, the community will be able to freely use our work and expand and improve on our tools.

1.2. Project Aims

This project had the primary aim of developing a distributable repository which consists of the following features:

1. Allow for input of large email archives in multiple email formats: large maildir and mbox archives.
2. Portable: Is hardware independent, requires minimal software installation and only requires a standard Web browser.
3. Provide fast and accurate offline search and browse functions over the archive/collection.
4. Has user interface that represents emails in an easy to understand way, and is usable.
5. Implement a reliable preservation policy to ensure preservation against hardware and/or software obsolescence.

1.3. Project Structure

The rest of this paper present background work and how findmail system was designed. Various experimental results are then discussed to illustrate how findmail is effective and efficient. Finally, ethical considerations, conclusions and future work are presented.

2. BACKGROUND

2.1. Digital Collections:

For developed countries many preservation techniques can be implemented, however this is not the case for developing countries (such as in Africa) [12]. In developing countries, most preservation techniques cannot be implemented due to insufficient resources and poor/expensive cost of Internet bandwidth.

A particular way of preserving digital collections(including email archives) that works for developing countries is through using the principle of simplicity [8]. An illustration of this could be the use of XML plain text documents to store information and metadata, making it more likely for the information to be retrievable in later years. Focusing on simplicity also provides easier interconnection, extension and modification of the features of a specific system, allowing for the system to function on multiple platforms(portable). The concept of portability is important for email, as email users use multiple platforms to access their email, and the email itself can be stored in different formats.

Suleman et al. [13] developed CALJAX, a generic hybrid (online-offline) repository management and access system based on a strong AJAX foundation. It allows integration of content from a local source with content from a remote source, with the only requirement being a Web browser. XML plain text documents were used to store information, making it more likely for the information to be portable, preservable and accessible through a Web browser.

Expanding on the issue of poor Internet bandwidth, is the idea of having hybrid online-offline digital collections to counteract this issue. Online and offline collections present both advantages and disadvantages, thus a hybrid digital collection(online-offline repository) could interleve advantages from both, and potentially aid in preservation [13]. A hybrid system will however not be in the scope of this project, as there are many complications that come with creating such a system.

2.2. Email Archives:

Some existing software projects around email archives include Windows Mbox Viewer(MV), Mailbox [10] and Mailpile [6]. WMV [11] displays mbox files on the
user’s screen via a simple user interface. It runs offline but is a program specifically for Windows. It also does not provide search functionality over the archive. The other downsides are the fact that it does not cater for other email formats and is not portable across operating systems.

Mailrix and Mailpile include indexing and search functionality, but are not suitable either in terms of preservation, portability or offline use. Mailrix [10] is an email indexing and searching tool that works with maildir, MH or mbox formats. It works offline but is mainly for Linux systems. Since it involves installation and is not portable across non-Linux operating systems, it is unusable in this project.

Mailpile [6] is similar to Mailrix; it also indexes mbox and maildir formats, however Mailpile is an email client and personal Web mail server. It also has a much better user interface (in comparison to WMV) that is based on Gmail. It works on multiple browsers but does not have specific offline usability. It was made using Python, JS and HTML5, and is the closest work to the one we propose in this paper.

3. DESIGN OF FINDMAIL

Our approach was split into two main sections of pre-processing and email processing.

3.1. Pre-processing

3.1.1. Parser

Before indexing can occur, email archives (sources/inputs) of different formats, need to be streamed into the application. The parser extract relevant data (constituents) from the email archives and pass this data on to the indexer. The parser was created using the Python mailbox module [9].

3.1.2. Indexer

The indexer then generates indices for searching and browsing of the archive. In order to enable access via a Web browser, all indices were stored as XML files that can be parsed from within a Javascript environment. 

Pre-indexing is necessary to speed up access to result set. The indices for browsing are in sorted order of various fields such as from, date and subject. Pre-indexing for search generate inverted files that are used with an extended boolean search implementation in the access Web interface. The indexers was also created using Python.

3.2. Email Processing

3.2.1 User Interface(UI)

The access Web interface is a standard email web interface offering the user search and browse functions. It was developed using a user centered approach in order to understand users’ needs and preferences. It consists of mainly static HTML, CSS and Javascript to display the relevant result when a user invokes one of the services.

3.2.2 Query

The query system, using extended boolean implementation retrieves relevant emails from the email archive, by using the indices generated by the search indexer.

![Fig. 1. Overview of the FINDMAIL system](image)

In Fig.1, we show the popular email formats: maildir and mbox, being inputted to the parser. The parser then sends its output to the two indexers. The browser indexer will create indices to facilitate browsing of the email, whilst the search indexers will create indices for the search functionality. Both of these indexers will interact will the user interface to provide the services of browsing and searching to the user.

The design scheme helps to simply the preservation of the archive by making it easy for the archive to be migrated to other hardware environment or software platforms. This design scheme also highlights how simple repository storage and service architectures can be designed.
4. EXPERIMENTAL RESULTS

4.1. System Usability Testing:

The usability test was conducted on a near final version of the software. The test was conducted with a total of 20 users to assess attributes of the system that make it understandable, learnable, easy-to-use and attractive. The test lasted approximately 20 minutes. Ethical clearance was obtained from the Science Faculty Research Ethics Committee and the Department of Student Affairs. Before taking part in the usability test, participants were asked to sign a consent form informing them of the anonymity of their results. On completion of the task scenarios, users were asked to fill in a system usability score questionnaire to determine the usability of the system. On completion of the usability study, users were compensated for their time with a standard fee as specified by the Department. Tests were conducted in an uncontrolled environment of the Computer Science Senior laboratory. Participants accessed a Web page (standard email page) that presented a browse view of the collection, using a laboratory computer through Chrome browser.

Rather than observe users throughout the test process, users were allowed to conduct tasks and answer questions independently within the 20 minutes of the usability test session. The reason for this is that users who are observed will alter their behavior and may become nervous resulting in mistakes and errors affecting results [52]. However, if users experienced particular difficulties in completing a task or found the instructions to be ambiguous, the facilitator could be asked for help or clarification. Most users completed tasks successfully.

Responses were constrained to a Likert scale that ranges from ‘strongly disagree’ to ‘strongly agree’. The raw data and mode data from the usability test is provided in Appendix A. Figure 1 shows the cumulative distribution of the responses for each question. Users wanted clearly defined visuals and graphics. This was apparent when they struggled to identify chained mails, wanted a button near the search area, and failed to identify emails with attachments. Thus, more information should be added for ease of understanding. When looking at design, all the users were happy with the basic and minimalistic design. A majority of users (>52%) however, believed the system was not lacking in intuitivity. The system had maximal cognitive flow (little friction and confusion when the user was using the system). This was a good benchmark for the Project.

Generally the raw data, as well as the mode responses, do not appear to indicate any particular usability issues.

The overall feedback was positive, with all criticism being constructive and leading to consistent improvements and updates to the design of the user interface.

![Fig. 2. Cumulative distribution of the system usability score.](image)

4.2 Performance Testing:

Experiments were conducted to measure the time it takes to download and display the entire content of a Web page for both the search and browse functions over collections of various sizes. The data collection used were simple text files filled with test data. This allowed tight control over the number of files, as the exact number of files could be generated for each test. The test was conducted on collections containing various number of files (2000, 4000, 6000, 8000, 10000, 12000) and all the files contained the same email items, as the load time is affected by the number of http connections needed to download items, item size and types.

The browsing test was conducted by loading 3 pages and the load times were recorded and averaged. The results of the time taken to generate a browse view is presented in Figure 3. This time is linear but does not increase much with increases in collection size. Similar results were obtained for the search function.
All performance testing was done on Mac Book Pro 5.2. There are a few caveats that we were aware of for this kind of performance measurement as listed below:

1. The available system memory and CPU.
2. The browser used affected the Javascript execution and rendering speed.

Table 1: Precision and recall for random query terms present in collection.

<table>
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<th>Query/Term</th>
<th>Precision</th>
<th>Recall</th>
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<td>1</td>
</tr>
<tr>
<td>projects</td>
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4.4 Portability Testing:

The developed systems’ look and feel with respect to the UI and functional features are similar on multiple OS and multiple browsers. It can be run on Windows 10, mac OS, Linux and any standard Web browser versions without any change in the behavior, thus can be ported from one environment to another.

5. ETHICAL, PROFESSIONAL AND LEGAL ISSUES

Ethical issues were identified in the testing, software implementation and data handling stages of the project. Each will be discussed in further detail below.

5.1. Testing:

We applied to the Faculty of Science Research Ethics Committee for ethical clearance, in order to test the usability of the system on students. All user testing was conducted through a simple survey and usability testing, which did not raise any ethical issues.

5.2. Software:

This project is declared open source. This is to encourage further development and improvement to our software.

5.3. Data:

We sourced data from our own personal Gmail inboxes (Shivaan Motilal has a 680 MB inbox unzipped,
Breyden Monyemoratho has a 670 MB inbox unzipped) and compiled from the Enron email dataset containing approximately 1.5 million emails (423MB, tarred and zipped) [2], which did not raise any ethical issues.

6. CONCLUSIONS AND FUTURE WORK

Experiments have confirmed that the developed proof of concept is intuitive, portable and effective for browsing and searching over email archives. Findmail has demonstrated that it is possible to leverage a simpler architecture and Web technology to enable fast and accurate browsing and searching over email archives in developing countries with limited Internet bandwidth.

This simple approach can be extended further in the following ways:

1. Leveraging the feature of AJAX framework to enable integration of content from a local source with content from a remote source, thus allowing the user full access to the most current content.
2. Integrating the current solution with tools and services that facilitate preservation, such as logging and integrity checking.
3. For greater efficiency, splitting browsing and search indices into shards. Thus the speed of both operations will be constant irrespective of the size of the collection.
4. Some (advertising) email messages contain unsightly links that are bundled together with the message body. There is no easy way to ascertain if these links will be useful to the user or not, however the display of these links can be improved on.
5. The display of chained email to the user can be improved on. Chained messages are currently separated into parts but not displayed as such to the user.
6. Using Dublin Core as the metadata scheme to ensure conformance to international standards and a universal understanding of the metadata.

7. ACKNOWLEDGEMENTS

I would like to thank my project partner Motilal Shivaan and project supervisor, Associate Professor Hussein Suleman for his commitment and help throughout the course of this project. Finally, my sincere thanks and appreciation are extended to University of Cape Town’s Computer Science department for funding our participant remuneration and supplying experimental space.

8. REFERENCES


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- What are the research questions?
- Need a detailed separate experimental design section
- Need actual data to support conclusions
- More detail for experiments
- Make sure to only write on your part of the project
APPENDIX A: The raw data and mode data from the usability test:

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Additional notes:
- Participants generally found the interface intuitive and easy to use.
- Minor issues were noted regarding the clarity of some instructions.
- Overall, the test was deemed successful, with all participants completing the tasks within the allotted time.