TUI4ZNote: Tangible User Interface for Note-taking in Zotero

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Tangible User Interfaces (TUIs) have emerged as a promising way to bridge the gap between the digital and physical worlds, allowing users to apply their real-world interaction skills to digital information. This quality makes TUIs appealing to a broad range of users, including academics, researchers, and those who use reference management tools like Zotero. TUI4ZNote is a novel Tangible User Interface tool designed to facilitate note-taking within Zotero. With TUI4ZNote, users can effortlessly collect and organize both handwritten and printed notes in their reference management system, making it easier to categorize and manage their research materials. This Tangible UI can be particularly helpful in streamlining the note-taking process, mitigating the issue of misplaced or lost handwritten notes. Ultimately, TUI4ZNote is a valuable tool for anyone seeking to write and cite papers or reports with greater efficiency and ease.

CCS CONCEPTS • Creativity Support tool • Tangible User Interface • Tangible User Interface for Note-taking

Additional Keywords and Phrases: Human-Computer Interaction, Note-Taking, OCR, User Interface

1 INTRODUCTION

Tangible User Interfaces (TUIs) have become a popular research area due to their potential to bridge the gap between the physical and digital worlds. TUIs allow users to interact with digital information using real-world interaction skills, making them an attractive option for various applications [1]. As researchers and academics often use reference management tools such as Zotero, the development of TUIs for note-taking within these tools could have significant benefits. TUI4ZNote is a novel Tangible User Interface tool that has been designed to facilitate note-taking within Zotero, allowing users to effortlessly collect and organize both handwritten and printed notes in their reference management system.

Previous research has shown that TUIs can enhance the user experience by improving the efficiency and effectiveness of interactions with digital information [2]. Additionally, TUIs have shown promise in various applications such as gaming, education, and healthcare [3]. The development of TUI4ZNote represents an exciting opportunity to integrate TUIs in reference management systems and streamline the note-taking process for researchers and academics.

Tesseract OCR, an open-source optical character recognition engine, has been gaining popularity for its accuracy and versatility in digitizing printed and handwritten text [4]. Tesseract OCR has been utilized in various applications, such as digitizing old books, recognizing license plates, and extracting text from images [5]. Additionally, Tesseract OCR can be

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integrated with microcontrollers like Arduino to enable the development of tangible user interfaces (TUIs) for note-taking and other applications.

We propose a novel tool named "TUI4ZNote", which is a Tangible User Interface Note-organizing tool to keep all the notes in a single archiving system. We first highlight three overarching design goals for TUI4ZNote, which are informed by the researchers [6-8] and my own experience of using reference management tools.

- The use of PyTesseract, an optical character recognition engine similar to Tesseract OCR, for document archiving and indexing in a record management system. This demonstrates the versatility and potential of OCR engines like Tesseract OCR and PyTesseract in various applications beyond note-taking, such as digitizing and managing important documents [7].
- The use of Arduino in this system enables the development of tangible user interfaces (TUIs) for text input and output, which could potentially enhance the user experience and ease of use [9].
- OCR engines like Tesseract have been evaluated for their accuracy and effectiveness in various studies [10].

This paper introduces a tool "TUI4ZNote" for anyone seeking to write and cite papers or reports with greater efficiency and ease. With TUI4ZNote, users can effortlessly collect and organize both handwritten and printed notes in their reference management system, making it easier to categorize and manage their research materials.

1.1 Aim/Purpose

TUI4ZNote is a novel TUI developed to utilize Tesseract OCR and Arduino to enable users to effortlessly collect and organize both handwritten and printed notes in their reference management system, making it easier to categorize and manage their research materials. TUI4Znote helps to mitigate the issue of misplaced or lost handwritten notes and streamlines the note-taking process, making it a valuable tool for anyone seeking to write and cite papers or reports with greater efficiency and ease.

1.2 Motivation

Researchers, academics, and professors often take notes during meetings, presentations, and literature reviews, but organizing and categorizing these notes can be a challenging task [11]. As someone who frequently takes notes using pen and paper, I have felt the need for a system that allows me to keep all my notes in one place. Our proposed Tangible User Interface (TUI) aims to provide a solution that brings these notes to life and offers easy accessibility [12].

Tangible User Interfaces have emerged as a new interface type that bridges the gap between the digital and physical worlds. They provide an opportunity to enhance users' interaction with digital information by leveraging their knowledge and skills of real-world interaction [13].

The remainder of this paper is structured as follows: Section 2 covers Related Work, Section 3 discusses Design Fiction, Section 4 describes the prototype design and implementation, Section 5 presents critiques of the proposed prototype, Section 6 outlines our contribution, Section 7 discusses future works and limitations, Section 8 concludes the paper, and Section 9 provides a list of references used.

2 RELATED WORK

Utilizing Arduino for tangible human-computer interaction involves integrating tangible input with an Arduino and other software UI or output. One of the main advantages of using Arduino is its simplicity, low cost, and ease of use. Arduino also provides various resources for beginners, such as tutorials and community forums [14]. By connecting a reference management software (RMS) to a physical Arduino-based tangible device that users interact with, the usability

of this tangible user interface (TUI) can enable easy access to the collection and sub-collection list from the RMS. For instance, a low-cost, engaging game that integrates tangible activities has been developed to collect learning analytics data [15]. Additionally, researchers have explored using motion data capture to recognize characters in handwriting [16]. Another study focused on the hardware and software setup used to capture data and process it for recognition [17].

Tangible hardware-based interaction with software integrates various interaction techniques and technologies of tangible user interfaces (TUIs). A significant portion of tangible interfaces uses an Arduino-based physical system, such as buttons and displays, as a central component for interaction, which can input and output data from the Arduino or connected software [18]. This integration of tangible input and output with software has demonstrated the potential for enhancing user experience and facilitating more natural and immersive interactions between users and computers [19].

Some researchers have explored various approaches to handwriting recognition, including optical character recognition (OCR) [20]. The Tesseract-OCR model has been used in various applications for text recognition, such as digitizing books and recognizing license plates [21].

Several note-taking tools have been developed to help users organize and manage their notes more efficiently. One such tool is Microsoft OneNote, which allows users to create notes with text, images, and audio recordings, and organize them into notebooks and sections [22]. The proposed project aims to simplify the note-taking process for researchers by automating the file naming, categorization, and saving process, which can be a time-consuming task. In addition, the Arduino-based interface provides a tactile and intuitive way to select and save files, which can enhance the user experience.

3 DESIGN FICTION

To illustrate the power of TUI4ZNote, we present a series of design concepts written as short narratives, inspired by Kim et al. envision a future where machines and humans collaborate in the design process [23].

3.1 Narrative 1

Given the assumption that note-takers have control and freedom over TUI4ZNote to facilitate their Note-making process. If the users want to add their handwritten or collected printed notes after a meeting, literature review, or discussion with the research team, how do they accomplish this task? How can users use the tool in real-time to collect and categorize the process of their actions?

TUI4ZNote offers users to control and flexibility in facilitating their note-taking process. If a user wants to add handwritten or printed notes collected after a meeting, literature review, or discussion with the research team, TUI4ZNote can easily accomplish this task in real time. Users can quickly select the file name and save it in the system within mere seconds. In case they want to categorize or change their actions, they can scan the note again and select a different category, providing them with the freedom to do so. Furthermore, TUI4ZNote can scan hand-written or printed documents in real-time and extract and save the text in the reference management system.

3.2 Narrative 2

Given the assumption that note-takers have control and freedom over TUI4ZNote to facilitate their Note-making process. If the users want to use their collected notes in the reference management system, how do they accomplish this task? How can users use the reference management tool to facilitate their final writing process?

Once notes have been collected using TUI4ZNote, they can be easily modified, and copied from the reference management system. TUI4ZNote allows the user to select the file name and category of the notes, making it easier to find specific notes when needed. The notes can be accessed using our proposed TUI for the Zotero reference management

system, where they can be tagged and organized for future use. By using a reference management system, note-takers can streamline their writing process by easily inserting references and citations into their work.

4 PROTOTYPE DESIGNS AND IMPLEMENTATIONS

TUI4ZNote is a novel Tangible User Interface tool designed to facilitate note-taking within Zotero. With TUI4ZNote, users can effortlessly collect and organize both handwritten and printed notes in their reference management system, making it easier to categorize and manage their research materials.
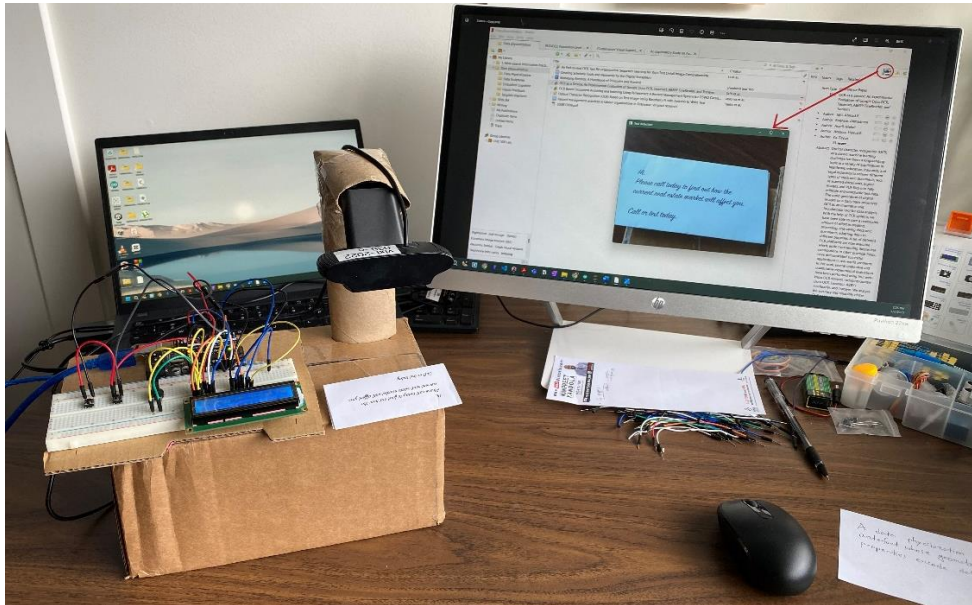

Figure 1: TUI4ZNote Overall Setup.

Figure 1 shows the overall setup for the TUI4ZNote. There is a Plugin in Zotero that is clickable to launch the interface of opening the camera module to Optical character recognition.

4.1 Design Choice & Rationale for TUI4ZNote Overall Setup

We chose this design as like this paper [25] presents an interesting and practical application of Arduino and OCR camera technology. We found it interesting and relevant to our own TUI4ZNote project as well.
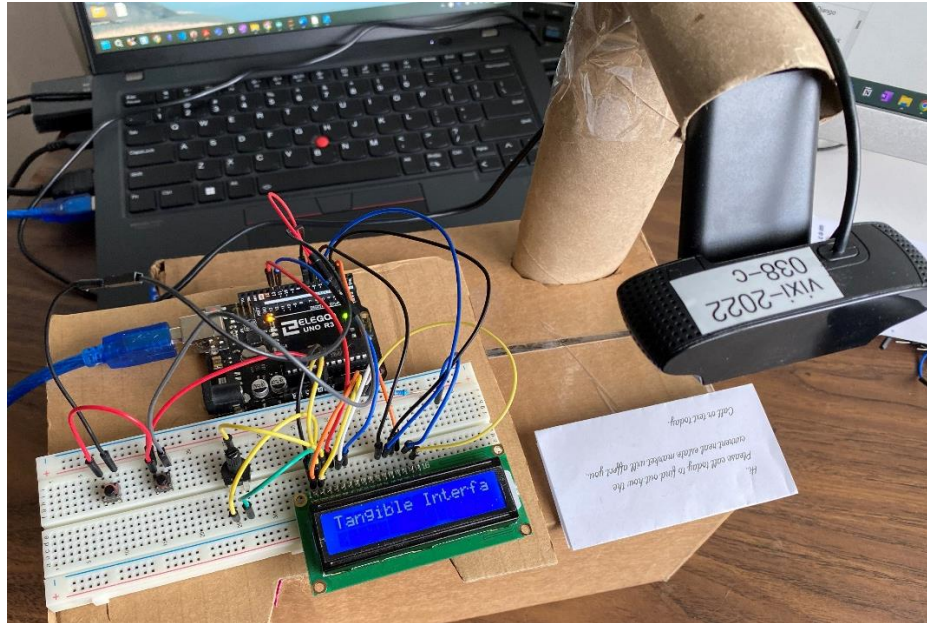
Figure 2: TUI4ZNote Arduino Connected with the OCR module.

Figure 2 shows the Arduino-based LCD module, buttons, and the camera connected to the actual system that uses an OCR camera to detect handwritten notes and save them as text files. The Arduino Code [26] includes the setup and loop functions. In the setup function, the LCD display and buttons are initialized. The loop function reads the state of the buttons and updates the LCD display accordingly. The buttons are used to select a topic and choose a file name to save the detected text. The code also includes debouncing delays to prevent false readings from the buttons.

4.2 Design Choice & Rationale for OCR-based image detection

We found "A Tesseract-based Optical Character Recognition for a Text-to-Braille Code Conversion" by de Luna [27]. The author presents a system that uses Tesseract-based OCR to convert text into Braille code. This inspired us to integrate our proposed system to classify text to save it to the reference management archive.
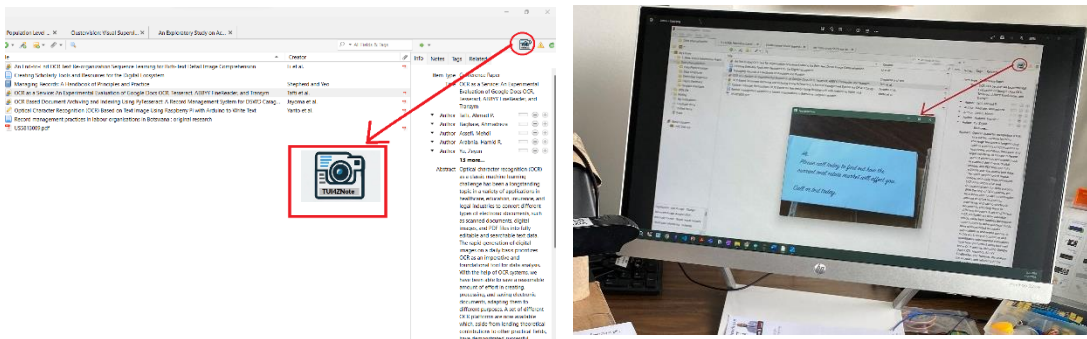

Figure 3: Proposed plug-in for (left) and Camera feed for OCR (right)

Figure 3 shows the design fiction of our proposed plug-in for Zotero in the left and the implemented OCR module scanning an image in right.

4.3 Code and Implementation for TUI4ZNote

TUI4ZNote uses Python IDE, Arduino with LCD Display and Buttons, and Tesseract OCR engine [28]. Every code we used for the development of TUI4ZNote is as follows: https://github.com/shakirul15-311/TUI4ZNote-Tangible-User-Interface-for-Note-taking-in-Zotero.

5 CRITIQUE

For the Implementation of TUI4ZNote, we used "The Creativity Support Index" formula and the questionnaire provided by Erin et al. [29].

Table 1: CSI Calculation for TUI4ZNote

Ratings	Factor Comparison Counts
Exploration: 18	Exploration: 3
Collaboration: 19	Collaboration: 3
Engagement: 20	Engagement: 1
Effort/Reward Tradeoff: 18	Effort/Reward Tradeoff: 3
Immersion: 14	Immersion: 1
Expressiveness: 19	Expressiveness: 4
CSI = (18*3+19*3+20*1+18*3+14*1+19*4)/3	
CSI = 91.66	

Table 1 shows the creativity support index calculation for the TUI4ZNote. There are ratings and Factor Comparison Counts. After the formula, we get a value of 91.66 which is a good support Index tool.

The main strength of our proposed TUI is that it is an Expressive tool. The users can truly express themselves when using this tool. Similarly, Collaboration with the tool is high as real-time categorization or collection process, as someone can Explore this in a team setting.

Some limitations are with immersion because this is a proposed prototype of a current system not all advanced features might be possible. A feature like categorization from Arduino and accessing other collections in the reference management tool.

6 CONTRIBUTIONS

TUI4ZNote helps the process of note-taking more convenient and streamlined for researchers. By automating the process of text recognition and file saving, researchers will be able to focus more on their work and less on taking notes. With the use of Tesseract-OCR and Arduino, this project has the potential to improve efficiency in note-taking. The ability to quickly select a file name from a predefined list using an Arduino LCD and buttons can save time and reduce errors.

The predefined list of topics can be customized based on the researcher's specific needs, making it easier to organize notes and find specific information later. This project can also make note-taking more accessible for individuals who have difficulty with manual note-taking, such as those with disabilities or physical limitations. This project can also have educational value by providing an example of how different technologies can be combined to create useful tools for researchers. It can inspire others to explore the potential of Arduino and Tesseract-OCR for other applications.

7 FUTURE WORK

The future is bright for the TUI4ZNote as it will work for researchers. This project can be expanded to integrate with other note-taking tools, such as Evernote or OneNote. This can enable researchers to seamlessly transfer their notes to other platforms.

In addition to this, we will look at automatic note categorization, mobile-integration can be adapted to on mobile devices, such as smartphones and tablets, which can make note-taking even more accessible for researchers on-the-go. Future work could explore ways to automatically categorize and organize notes based on their content, such as by date, project, or keyword.

8 CONCLUSION

Tangible User Interfaces (TUIs) have become increasingly popular as a way to bridge the gap between the digital and physical worlds, providing users with a more intuitive way to interact with digital information. TUI4ZNote is a Tangible User Interface tool that has been specifically designed to enhance the note-taking process within Zotero, a reference management system. By allowing users to easily collect and organize handwritten and printed notes within Zotero, TUI4ZNote streamlines the research process and makes it easier to manage and categorize research materials. This tool can be particularly beneficial for researchers, academics, and anyone who needs to write and cite papers or reports more efficiently. Ultimately, TUI4ZNote represents a significant step forward in the development of Tangible User Interfaces and has the potential to revolutionize the way that we interact with digital information.

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