CST3140 – Coursework 2: Voice-based User Interface for Computer Science Students' Interactive Calendar

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1 INTRODUCTION

The computer science field of tertiary education faces high rates of academic failure, which is commonly due to students' struggle with grasping programming skills [1]. While the teaching approach offered by the university might contribute to students' incomprehension of the subject [2], the latter's lack of motivation and improper study plan cannot be ignored [3].

Implementing novel technologies in academic settings improves students' academic achievement, motivation and engagement [6]. In recent times, there have been significant technological advancements that include the creation of Voice User Interfaces (VUIs), which aim to close the gap between human-computer interaction and the physical world [7]. A VUI is a pioneering interface that gives systems commands via voice recognition [8].

The term Self-Regulated Learning (SRL) was coined after studies observed better academic achievement of students with the self-generated ability to control, manage, and plan their learning actions [4]. Computer science students who employed SRL displayed greater academic achievement [5].

Pairing a VUI with the SRL learning approach could be a great way to help computer science students mitigate their chances of failing. This paper, therefore, explores the design concept and development of an interactive calendar which allows students to set reminders and plan their studies in accordance with SLR, all the while benefitting from enhanced interaction speed, intuitiveness and accessibility which VUI systems such as chatbots offer [9].

This paper is structured as follows: The next section elaborates on the design concept of the voice-based interface for the interactive calendar. Section 3 focuses on the development of the VUI calendar prototype and explores the technology used, as well as the challenges faced. The evaluation method and its process are covered in section 4, while section 5 discusses the findings and results of the prototype's evaluation. Ultimately, section 6 concludes the paper.

2 DESIGN CONCEPT

According to Pintrich's General Framework for SRL, key aspects of self-regulatory activities include behavioural patterns such as time and effort planning and monitoring [10]. For university students, effective time management refers to successfully structuring their time to achieve certain goals [11]. Michigan State University carried out a research project to examine its student body's time management skills and academic performance when using a Learning Management System (LMS) calendar tool. While 85.4% of the survey participants used some kind of calendar to keep track of their academic activities, it was concluded that more incentives should be adopted to have them use the LMS offered by the university and in a more effective way [11].

Applying a VUI system to an LMS is a great way to promote the calendar tool to students. In this section, the design concept for such a system is expanded on. The learning management system used by Middlesex University is UniHub myLearning. This is a platform whereby students can access their university resources, view their deadlines and even communicate with the Middlesex community. The proposed VUI system integrates the UniHub LMS platform with an interactive voice-controlled calendar which encourages students to develop self-regulatory learning practices.

As shown by the wireframe in figure 1, the VUI system consists of a navigation bar similar to UniHub ❶, an interactive calendar ❷ which displays reminders added by the user ❸ and a chatbot logging voice interactions and communications between the user and the system ❹, which is activated by a tactile button ❺.

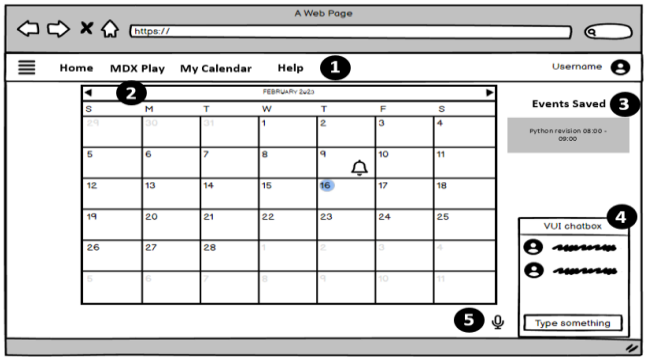

Figure 1: Prototype Design Wireframe

VUI research advises using visible indicators for system status and feedback to improve user experience [12]. Hence, this suggested VUI design includes an animated button which rotates when the system starts listening and stops when the system ends, as well as a chat log which provides instantaneous feedback through visual and audio outputs. This boosts users' confidence and satisfaction with

the system [13]. Additionally, since the system is a multimodal interface, it allows for manual user interaction through input fields which can be more reliable than using voice input only [14]. Provisions for errors and instructions on the use of the system are provided to users through the system's utterances and a display of a help panel, which can be accessed from the navigation bar.

Table 1 below showcases the different sections of the VUI system and trigger commands which the user may use to achieve the interactions provided by the system. In section 3, the different concise utterances of the system are explored, as well as the logic employed to recognise what the user wishes to accomplish from their voice input.

Section	Command Options	Interactions Provided
Calendar display	Date, Month, Saved reminders and events.	Navigating to today's date, the following month and the previous month.
Adding reminders and events	Creating new reminders/events.	Adding a title to the event, saving it onto the calendar and displaying it in the event section.
Accessing course resources	Accessing university material.	Redirecting to UniHub myLearning to access university resources.
Accessing recorded lectures	Accessing course material.	Redirecting to mdxPlay to access recorded lectures.

Table 1: Key features of the proposed prototype

Once the system identifies a command trigger from the user's voice input, the communication is logged in the chatbot, as illustrated by the sample conversation found in figure 2 below.

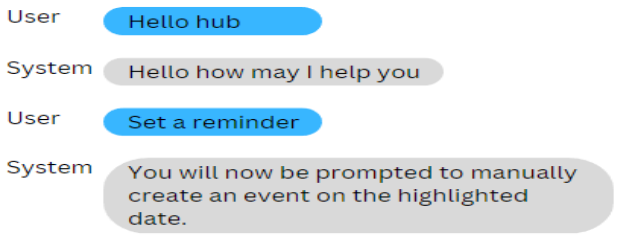

Figure 2: User conversation sample with system

3 PROTOTYPE DEVELOPMENT

The initial stage of development of this prototype consisted of building the front-end user interface. This was done using HTML tags and styling them using CSS. To build the back-end functionalities of the interactive calendar, JavaScript and Document Object Modeling were used. Once the web application was fully operational manually, Web Speech API was used to automate the system's functionality features using voice commands.

The API's speech recognition functionality takes in user input, while its speech synthesis function delivers the system's utterances as sound output. As shown by the snippet of code in figure 3, three arrays are created for the accepted words as commands, generic utterances, which the system would use to respond, and an alternative message which the system outputs when the user inputs a command out of scope, respectively.

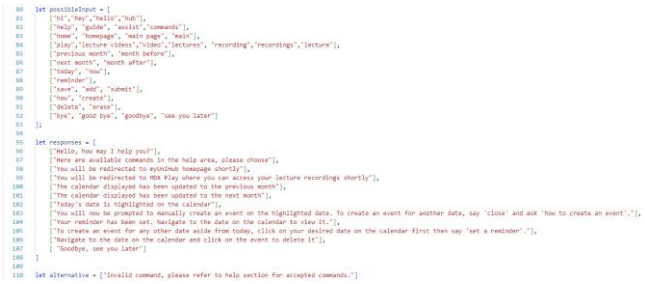

Figure 2: Array of user command and system responses

A looping function was written to compare whatever the string obtained by the API from the user's voice input matched with the accepted commands in the possibleInput array. The string.includes() function was used for this, and based on the array index returned, the appropriate system response was output. If no array index number is returned, the alternative array message is used.

Almost all manual functionality of the interactive calendar could be adapted to be performed using voice commands from the user. However, the challenge of creating a reminder using solely voice input was faced. Since creating a reminder requires input in the date format and using the Web Speech API returns the user input in the string format, the slot for the system to prompt the user to say the time and save it was too complex. To bypass this issue, the VUI system prompted the user to manually enter the time before proceeding with other voice commands. Moreover, to provide better user feedback and mitigate errors, placeholders were added on input fields to provide the user with appropriate feedback on operating the system. This is more clearly showcased in the video prototype attached in the appendix of this paper.

4 EVALUATION METHOD

Once the final prototype of the VUI system was completed, user evaluation was carried out to assess its reception amongst final-year computer science students at Middlesex University. Ethical clearance was sought before taking 5

consenting participants. The evaluation process was two-fold as data collection methods included 1. Direct observation of users trying out the system, and 2. Asking users to fill out a User Experience Questionnaire+ (UEQ+).

Direct observation allows for key patterns to be drawn when the user interacts with the system, while the UEQ+, which consists of 16 UX scales, provides user feedback on 3 main aspects of the system, namely the response behaviour, the response quality and its comprehensibility.

The evaluation process was carried out in person on the university campus. Once participants signed the consent form, they were briefly instructed on how to operate the system. They were advised not to think out loud when evaluating the system as this could interfere with the voice input and system response. The evaluator took notes of any frustration points and challenges faced by the user and jotted down positive aspects too. This process took around 15-20 minutes per participant, after which they filled out the UEQ+.

5 RESULTS AND DISCUSSION

During the direct observation, participants were given a set of tasks to perform, which they could all efficaciously do. This highlighted the system's success in its ease of use and intuitiveness since it prioritised recognition rather than recall by providing sufficient cues, thereby minimising the user's memory load. However, users were observed facing certain frustration points. Three out of five participants expressed annoyance as they had to repeat themselves a few times before the system understood, logged and responded to their commands. This may be attributed to recurrent issues faced by common VUI systems when analysing voice input from people having different accents and rates of speech [15]. Additionally, 60% of participants indicated that repetitively clicking on the trigger button for voice recognition was frustrating. This is due to the API's automatic 20-second timeout when no sound is detected in the surrounding. 80% of participants were unimpressed by the chatbot's ability to handle typos and its redundancy in showing the help panel whenever it encountered an error.

The results of the UEQ+ are denoted by the mean score obtained for the three previously mentioned aspects of the system, as seen in table 2 below.

Response behaviour	1.10
Response Quality	1.50
Comprehensibility	1.30

Table 2: Mean of the UEQ+ scores

The low mean score associated with the response behaviour of the VUI system suggests that the communication between the system and users felt rather artificial, while the one for comprehensibility is most likely due to users having to repeat themselves and the vague error-handling messages provided by the system. However, the 1.50 score obtained for response quality indicates the clarity, usefulness and suitability of the system's output.

Other questions pertaining to the quality of the system's content were also included. An average score of 1.85 was obtained for the quality of the system's content. Hence, this suggests that participants found the VUI interactive calendar a promising solution to improve their academic performance in the field of computer science for revision and study planning.

6 CONCLUSION

This study explored the potential of a VUI system to encourage independent learning in students and evaluated its user experience through observation and the UEQ+. The VUI system, created using HTML, CSS, Javascript, and Web Speech API, was found to be a promising tool for enhancing academic performance through self-regulated learning.

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Harris Cohen, James P Giangola, and Jennifer Balogh. 2004. Voice user interface design. Addison-Wesley, Boston, Mass

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APPENDIX

Link to demonstration video: https://youtu.be/ZB-vW4WUqtY

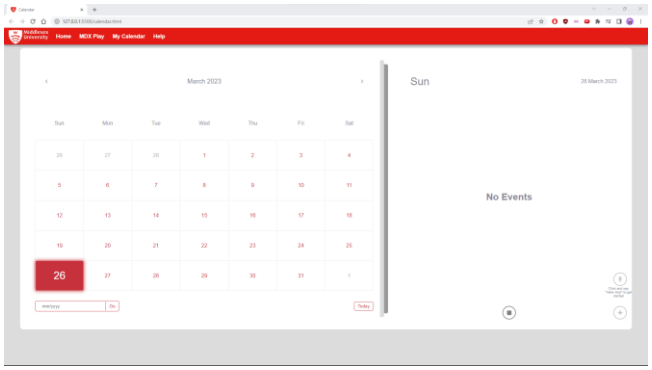

Figure 1: VUI system Dashboard

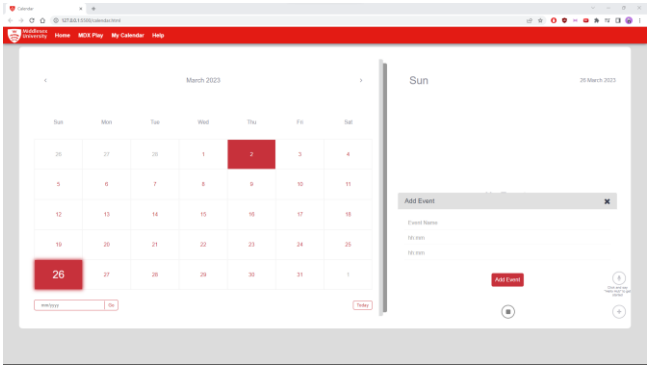

Figure 2: Creating a reminder

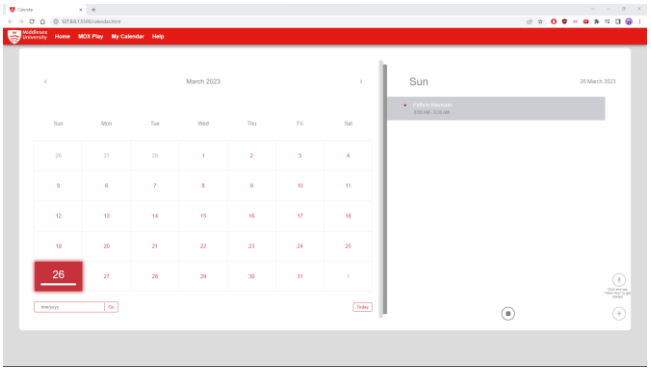

Figure 3: Calendar display of reminder

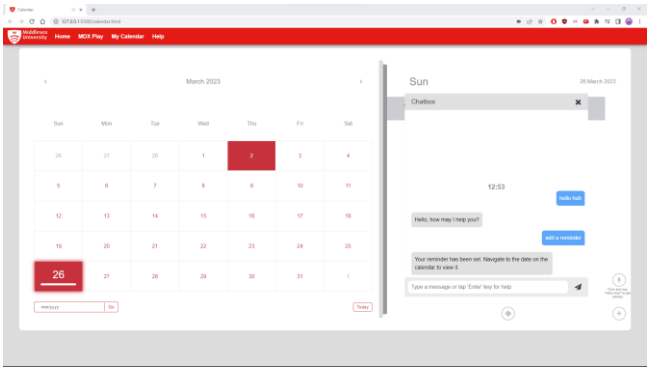

Figure 4: Chatbot log of system-user communication

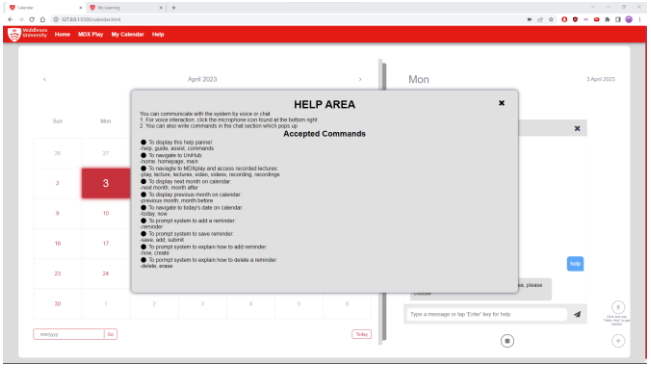

Figure 5: Help section