UCT Virtual Student Advisor: ADVICE

Human Computer Interaction with a Virtual Student Advisor and Student Handbook Reader

Literature Review

Michael Brough
Department of Computer Science
University of Cape Town
South Africa
BRGMIC022@myuct.ac.za

ABSTRACT - A virtual student advisor is a tool designed to automate and perform the tasks of human student advisors working at a university. A virtual student advisor will be hosted online and have the capability to answer questions relating to student registration and will allow students to ask questions relating to their options for potential courses and degrees. The way in which the students will perceive and interact with the virtual student advisor will affect how successful the implementation of this tool will be. Therefore, research into the usability and design considerations for a tool like this should be conducted such that guidelines can be formally articulated to aid the design of the proposed virtual student advisor tool. The information about degrees and courses should also be easily accessible to the student advisor, therefore a tool to extract information from the student handbook will be designed and used in conjunction with the student advisor tool.

KEYWORDS

Chatbot, NLP, Human Computer Interaction, Virtual Student Advisor, Communication, Student Handbook, PDF File Reader, University of Cape Town.

I. INTRODUCTION AND MOTIVATION

The University of Cape Town has identified a concern that each year, student advisors are inundated with questions from students relating to their field of study and course registration. These questions come from both prospective students (i.e., have not registered at the University of Cape Town before) and returning students. Student advisor soften cannot provide personalised assistance and feedback to every student timeously during the registration process. It takes time for them to review the student's records and make recommendations based off the information they have. This presents an opportunity for the design and implementation of a tool to help all students through the registration process in a clear and efficient manner. The implementation of a virtual student advisor would alleviate some of the workload of human student advisors and save a significant amount of student time (due to the immediate correspondence of the virtual advisor) and would also introduce 24-hour assistance to students. Data privacy and confidentially are vital aspects of software design and should also be accounted for during this project.

This literature review will investigate the problems with the current student advisor system, existing work in the field of virtual assistants, design principles and guidelines for such virtual assistants, as well as security and privacy considerations. This review will also investigate best practices for designing a PDF reader for university handbooks and security considerations for these tools.

This part of the literature review for the ADVICE project is split into two sub-sections: Human Computer Interaction (HCI) and a PDF file reader to extract data from UCT student handbooks that the virtual advisor needs in order to provide adequate feedback to students. This review will include analysis of papers relevant to both sections and will be addressed individually using sub-headings (i.e., Human Computer Interaction, and Student Handbook Reader).

i. Human Computer Interaction

One of the most important goals in the field of HCI is the outline of normal and instinctive connections modalities. Specifically, numerous endeavors have been committed to the improvement of frameworks to communicate with the client in a characteristic language [1]. Today, people are familiar with Conversational Agents (CAs) such as Siri, Google Assistant, and Amazon's Alexa. The virtual student advisor will take the form of a conversational agent or otherwise known as a chatbot. Chatbots are an especially useful and successful framework by which humans and machine can interact with each other. Chatbots aim to mimic interpersonal communication and facilitate discussion with humans through their regular language (i.e., in this case, English).

How the end-user perceives the chat bot and how intuitive it is to use and interact with it are some of the most important aspects of this project. The functionality of the chat bot is irrelevant if the end-user does not know how to use it properly or simply does not enjoy interacting with it. The virtual advisor should be designed to optimize the user experience. Interacting with a conversational agent should feel like talking to another human [2]. There are generally three ways to suggest "humanness" among online chat agents: The use of human figures (visual cues), human-associated names or identity (identity cues), and the mimicking of human language (conversational cues). [3] These should be researched so that they can be integrated into the virtual student advisor interface and prototypes to increase usability and user-satisfaction.

ii. Student Handbook Reader

The goal of the student handbook reader is to design a program that can read and extract the text from UCT's Student Handbook and save information about courses such as course codes, time slots, pre-requisites, co-requisites, number of NQF credits, NQF level, and faculty of study. Apache PDFBox [4] is an open-source Java library that allows one to work with PDF documents. It offers

features such as creation of new PDF documents, manipulation and extraction of content from existing documents. This library can be used to design and implement a PDF reader to recognise the structure of the Student Handbook and successfully extract the information of each course and save it. The reader also needs to make this information available to the website, which is hosting the chatbot. This can be done in the form of a database exported from the reader program. The data that this PDF reader sends to and from the UCT server needs to be sent across a secure connection to avoid any data privacy issues. If the PDF reader is communicating with the chatbot, by extension, it is important that the reader is doing so over a secure connection in order to prevent attacks or data breaches of the information contained on the website.

II. The Current Student Advisor System

At present, students at the University of Cape Town are informed that they need to register for their courses and if they need any information, they need to consult the Student Handbook or contact a Student Advisor (SA) for assistance. SAs are often busy with other duties like lecturing or researching so students should contact them to see them during consultation hours. Once they agree to meet at a specific time, they will then discuss which courses they want to do and which they should register for. This system, however, can never accommodate every single student who needs help with registration before the registration deadline. Students often do not have enough information or do not know where to find the correct information, therefore mistakes are made during the registration process, making it far longer and more tedious than it should be.

The problems with the current process rest with both SAs and students alike. SAs are often very busy with other commitments, so they tend to rush their advisory duties in order to return to other work. [5] Student advisors and students alike need to be interested in the courses and connect on a deeper level than just the coursework [5]. Students should also express interest in bettering their education and themselves, which is not always the case. Students often want to register for a degree or courses based on what they have heard and do not know any specific details about their degree of choice.

Although the UCT website contains all relevant information for students to research their degrees and courses, as well as how to register correctly, many students either do not know where to find the information or struggle to find it. This suggests that the UCT website may not be an effective medium for communicating registration and course information to students. A similar study conducted by Margolin et al [6] on three different community college websites highlighted that most usability problems encountered by end-users were either related to either finding information (41% of problems) or understanding the information presented (52%). Only 11% of the problems encountered were due to technical issues. This is not a standalone study. Peker et al [8, 9] also noted that the university websites under review also had multiple usability and accessibility issues. A study of UCT's website could also reveal a similar truth. There is so much information on the website that it becomes unintuitive to find something specific, especially for prospective students who have never used UCT's website before or unaware of the existence a student handbook.

The design and implementation of a virtual student advisor can potentially remedy the usability problems of the UCT website as it will give the end-users (i.e., new and returning students) a framework to communicate exactly what they are looking for using natural language. This is far more intuitive than navigating a website in search of specific information. A contextual inquiry into the design considerations of this tool needs to be conducted in order to eliminate the usability and accessibility shortcomings during the registration process at UCT.

III. Related Work

This section explores the existing work done in this field that is related to both design considerations for improving human-computer interaction with chat bots and conversational agents and practices and software packages for extracting specific data from pdf documents.

i. Human-Computer Interaction with Chat Bots

The first conversational agent, ELIZA, was created in 1966 [1] and has served as the basis for most chatbots and conversational agents created since. ELIZA served as a framework whereby people could interface with machines using natural language instead of computer code. Nowadays, people are familiar with the conversational agents that come pre-installed on most mobile devices such as Apple's Siri, Google's Assistant, and Amazon's Alexa. These use inputs such as the user's voice, vision (images), and contextual information to assist the user by answering questions in natural language, making recommendations, and performing actions. [7] These are widely successful in the field of technology and have been adapted for many of the languages used around the world. A study conducted by Gurantz et al [10] implemented a virtual student advisor in a high school setting to assist with university enrolment and found that it increased the enrolment numbers in colleges and resulted in higher graduation rates overall.

Historically, online support agents in commerce and marketing would be manned by real people who would give interactive advice and support to customers in a way that static delivery of information (e.g., frequently asked questions) could not. Advances in technology, however, have led to the development of unmanned chatbots which accurately mimic human speech patterns and give the user the impression that they are speaking to a real person. The paper written by Go and Sundar [3] addresses the "humanness" of a chat bot and why it is important for them to mimic human conversation. They mention that there are three main aspects of what makes conversational agents human-like: The use of human figures (visual cues), human-associated names or identity (identity cues), and the mimicking of human language (conversational cues). These factors can be leveraged in the design process of the virtual student advisor to increase the feeling of social presence while using the tool, thus leading to more favourable attitudes towards the assistant and greater behavioural intentions to return to the website. [3]

There is evidence that a tool like this will be useful to prospective UCT students but there has been little work on a University Virtual Student advisor that encompasses the scope of what this project aims to achieve. A relevant study related to this project however was that of a virtual advisor website that linked students to SAs over the internet [11] but the advisor was not automated.

It simply displayed 14 frequently asked questions, and if further assistance were required, it would connect them to an advisor when one was available. Carolis et al [12], however, took a more personalised approach to a tool like this designed for mobile devices. They employed the use of a simple animated character with a human likeness which attempted to closely emulate human conversation patterns via text, but they could not fully implement the system due to the constraints of the tools and technology that they used.

This project also intends to add a voice element to the virtual assistant whereby students can give commands or ask questions with their voice. This implies that the virtual advisor should, in turn, respond with a voice of its own. Qiu and Benbasat [13] posit that a simple text-to-speech (TTS) reading of information can contribute to the two major components of flow: cognitive enjoyment and focused attention. [13] They also concluded that the inclusion of a 3D avatar to represent an online service agent has a significant effect on the users' perception in telepresence. This aligns with Go and Sundar's [3] attribution of visual cues that mimic human interaction better the user experience.

ii. PDF Student Handbook Reader

There are multiple options for designing a program to read and extract data from PDF documents. One such library is Apache PDFBox for Java. [4] This tool provides objects and methods in the Java programming language to easily read and manipulate PDF files (UCT Student Handbooks are publicly available as PDF). The Java programming language is ideal for designing this tool as the extracted data needs to be added to a database. Each entry in the database would be the equivalent of a custom class in Java with multiple attributes per attribute in the table.

The course information found in the student handbook is formatted in a table format. (An example can be seen from figure 1 below).

Major in Applied Biology (for students registered before 2019 only)
[BIO01]

First Year Core Courses

Code	Course	NQF Credits	NQF Level
BIO1000F	Cell Biology	18	5
BIO1004F/S	Biological Diversity	18	5
CEM1000W	Chemistry 1000	36	5
Either			
MAM1004F	Mathematics 1004	18	5
or			
MAM1000W	Mathematics 1000	36	5
STA1007S	Introductory Statistics for Scientists	18	5

Second Year Core Courses

Code	Course	NQF Credits	NQF Level
BIO2010F	Principles of Ecology & Evolution	24	6
Two of:			
BIO2011S	Life on Land: Animals	24	6
BIO2012S	Life on Land: Plants	24	6
BIO2013F	Life in the Sea	24	6
Recommended:			
STA2007F/H/S	Study Design & Data Analysis for Scientists	24	6

Third Year Core Courses

Code	Course	NQF Credits	NQF Level
BIO3013F	Global Change Ecology	36	7
BIO3014S	Conservation: Genes, Populations & Biodiversity	36	7

Figure 1: A Screenshot of the Major in Applied Biology Course in the Faculty of Science Handbook.

Yildiz, Kaiser and Miksch [15] formulated a method to extract information from tables in PDF documents using table decomposition and other methods on over 150 tables across several pdf documents. Strategies and methods from this paper can be adapted for implementation in the UCT Student Handbook Reader.

In order to successfully convert data extracted from the student handbooks to tables in a database, NoSQL is an adequate tool for the task. NoSQL is a database that provides a mechanism for storing and retrieving data modelled in ways other than the table relations used in relational databases. [16] NoSQL will also be useful as the data will be in JSON format which is needed for the functionality of the website. To use NoSQL effectively in a Java program, one must implement it using the NosDB library [17] which will also format the data in a JSON format such that it can be used by the web server hosting the Virtual Student Advisor.

IV. SECURITY AND PRIVACY

The proposed system will handle students' personal information; therefore, security and privacy are of utmost importance to ensure their data is protected as well as maintaining compliance with modern standards and guidelines.

When conducting research regarding human-computer interaction, there are many guidelines and principles that one must follow to ensure participating party's identifying information is kept confidential. Kelman [18] writes about the correct procedures to handle the privacy of participants. He details that any persons conducting research must minimise threats to participants' privacy, make the participants aware of all details, and gain their consent, and keep in mind any threats posed by the research (ethical considerations). Identifying information such as names, identity numbers, and pictures or videos of their likeness should not be recorded in order to protect their identity unless deemed necessary for the results of the research.

This research will not require participants to share their names or other identifying information, therefore, it will not be recorded in order to uphold their right to privacy. This type of qualitative research must also adhere to South Africa's COVID-19 restrictions and will therefore be done virtually. Roberts [19] describes methods to perform virtual qualitative research. They describe that in order to establish rapport, videoconferencing software or other software such as text messengers and audio calls were used, but this allows for technical difficulties such as connectivity problems to affect sessions. They did note however that sometimes these issues could strengthen the bond between participant and researcher as they worked together to solve the issue(s). In the cases of conducting research virtually, one must also ensure privacy is emphasised. The "waiting room" functionality during Zoom interviews can be used to keep uninvited persons from joining. Virtual backgrounds could also be used to hide participant's backgrounds for an added layer of privacy. [19]

A large amount of student and university information will be stored on this platform. This means that we will need to abide by all the necessary privacy and security regulations. The right to privacy is recognized as a fundamental human right in the Bill of Rights of the Constitution of the Republic of South Africa and is protected in terms of the Constitution and the common law. South Africa has also recently adopted data protection legislature [20]

and the Protection of Personal Information (POPI) Act which this project will also have to be compliant with.

Since the student handbook reader will be connecting to the website to send it information, security precautions should also be taken on this connection. If the handbook reader insecurely connects to the server, attackers could use this to access the information stored on the database. Connections to the server should be done securely by only making use of HTTPS communication between the program and the server, ensuring that the data cannot be accessed or intercepted by potential attackers.

V. DISCUSSION

The literature examined thus far suggests that there are existing systems that perform some of the tasks that this project aims to achieve, but there is no system that successfully performs all of them. This presents an opportunity for this project to fill a "gap" in this field of computer science.

The HCI aspect of this project involves the investigation into how humans perceive natural language processing bots and which design principles lead to the best user experience possible. The bot should try to mimic interpersonal communication as closely as possible leading to a positive user experience. A contextual inquiry into which humanising techniques are most effective for our target audience should be conducted to discover what should be considered when designing high-fidelity prototypes and the final Virtual Student Advisor tool.

The research identified in this review contained little to no information about design constraints and guidelines for Africa. Africa, unlike North America and Europe where majority of this research was done, has its own set of challenges and considerations that need to be considered for this project to be successful. Examples of some of these constraints are internet accessibility and computer literacy rates in South Africa.

These constraints will also impact the ability to conduct thorough qualitative research in a virtual setting. Internet access is not standardised in South Africa [20] and the price of mobile data is not affordable for many people living in low-income areas. We do not want to discriminate against those who do not have access to these tools and need to take into consideration their situation and accommodate for their needs as much as the others. Interviews may have to be limited to audio-only (for those with limited connectivity) and the virtual student advisor will need to employ data compression techniques in order to reduce data consumption.

A potential avenue for further development and research is accommodating for multiple-language support. South Africa has a plethora of spoken languages, the most popular being English, Afrikaans, Xhosa, and Zulu. The project could be designed with this in mind and enable for easy way to switch between languages in the website's options. Adding support for all these languages is out of scope for this project but is a consideration for further development.

The existing literature that does pertain to virtual student advisors are typically focused on a specific field of study, such as in the paper by Coates et al [11] where the focus was specifically on medical students. This project will tackle multiple faculties: namely Commerce, Humanities, Science and potentially accommodate for the students enrolling in these faculties coming from Engineering and the Built Environment.

The virtual student advisor will be handling a large volume of requests and student data, potentially containing private information, therefore security and privacy need to be accounted for in all parts of the project. The project should be designed and implemented with security from the beginning to ensure that each step of the process is secure.

When conducting the contextual inquiry, privacy should also be of utmost importance. Personal and identifying information of participants will not be recorded to protect their right to privacy and comply to South Africa's rules and regulations regarding data protection and privacy laws.

VI. CONCLUSIONS

This project aims specifically for implementation at the University of Cape Town, but further work on this could extend this tool to other tertiary institutes around the country. The Student Handbook Reader will be designed to read only the student handbooks published by UCT in the last 7 years, but further development of this tool could see added functionality for other tertiary institutions too. These would store other institute's course information which would be deemed equal to the ones at UCT to calculate the transfer of credits when students are applying to switch between institutions. We must however be cautious of adding too much functionality to the system in order to maintain user experience design principles.

Although work has been conducted on the effectiveness of chatbots and conversational agents in online commerce, there has yet to be any noteworthy work done for a university virtual student advisor at this level of detail. The virtual assistant, unlike previous research, will emulate human speech patterns and mimic interpersonal communication to improve the user experience. This implies that work on this project is novel and that this project will contribute to the fields of Human Computer Interaction and natural language processing in the context of conversational agents.

REFERENCES

[1] Joseph Weizenbaum. ELIZA - A computer program for the study of natural language communication between man and machine. *Commun.* ACM 9, 1 (1966), 36-45.

[2] Ewa Luger and Abigail Sellen. 2016. "Like Having a Really Bad PA": The Gulf Between User Expectation and Experience of Conversational Agents. In Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16). ACM, New York, NY,USA, 5286–5297.

[3] Eun Go and Shyam Sundar. 2019. Humanizing chatbots: The effects of visual, identity and conversational cues on humanness perceptions. *Computers in Human Behavior 97*, 304-316.

[4] Apache PDFBox | A Java PDF Library. 2021. *Pdfbox.apache.org*. https://pdfbox.apache.org/.

[5] Mollie Krupp. 2014. The Student-Advisor Disconnect. Women in Higher Education. 23. 18-18.

[6] Jonathan Margolin, Shazia Raffiullah Miller and James E. Rosenbaum. 2013. The Community College Website as Virtual Advisor: A Usability Study.

[7] Johann Hauswald, Michael A. Laurenzano and Yunqi Zhang et al. 2015. Sirius: An Open End-to-End Voice and Vision Personal Assistant and Its Implications for Future Warehouse Scale Computers. *ACM SIGPLAN Notices 50*, 4, 223-238.

[8] Serhat Peker, Seyma Kucukozer-Cavdar and Kursat Cagiltay. 2016. Exploring the relationship between web presence and web usability for universities. *Program 50*, 2, 157-174.

[9] Majid Ishfaq and Vijaya Y. Lakshimi. Analysis of University Websites – A Study. Research and Reflections on Education, 18(02B), 11-20.

[10] Oded Gurantz, Matea Pender, Zachary Mabel, Cassandra Larson and Eric Bettinger. 2020. Virtual advising for high-achieving high school students. *Economics of Education Review 75*, 101974.

[11] Wendy Coates, Felix Ankel, Adrienne Birnbaum et al. 2004. The Virtual Advisor Program: Linking Students to Mentors via the World Wide Web. *Academic Emergency Medicine 11*, 3, 253-255.

[12] Carolis, Berardina and Pizzutilo, Sebastiano and Cozzolongo, Giovanni and Drozda, Pawel and Muci, Francesca. (2006). *Supporting Students with a Personal Advisor.*. Educational Technology and Society. 9. 27-41.

[13] Lingyun Qiu and Izak Benbasat. 2005. An investigation into the effects of Text-To-Speech voice and 3D avatars on the perception of presence and flow of live help in electronic commerce. *ACM Transactions on Computer-Human Interaction 12*, 4, 329-355.

[14] Pooja Lodhi, Omji Mishra, Shikha Jain and Vasvi Bajaj. 2018. StuA: An Intelligent Student Assistant. *International Journal of Interactive Multimedia and Artificial Intelligence 5*, 2, 17.

[15] Burcu Yildiz, Katharina Kaiser and Silvia Miksch. 2005. Pdf2table: A method to extract table information from pdf files. IICAI 1773-1785

[16] Nasution, Mahyuddin. (2021). *NoSQL Concepts and Characteristics*.

[17] Introduction to Java API with NoSQL Database - NosDB. 2021. *Alachisoft*. https://www.alachisoft.com/resources/articles/client-java-api-nosql.html.

[18] Herbert Kelman. 1977. Privacy and Research with Human Beings. *Journal of Social Issues 33*, 3, 169-195.

[19] J. Kessa Roberts, Alexandra E. Pavlakis, and Meredith P. Richards. 2021. It's More Complicated Than It Seems: Virtual Qualitative Research in the COVID-19 Era. *International Journal of Qualitative Methods* 20 (2021), 160940692110029.

[20] Juma, Calestous and Moyer, E.. (2008). *Broadband Internet for Africa*. Science (New York, N.Y.). 320. 1261. 10.1126/science.1161105.

[21] Moriarty, Kathleen. (2020). *Looking Forward*. 10.1108/978-1-83909-928-120201008.