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Automating the Design of Citizen-Centric User Interfaces using Artificial Intelligence

Abstract

Designing citizen-centric interfaces remains one of the most challenging stages in the development of Indian e-Government systems. One of the primary reasons for this is the highly diverse nature of the citizens using the system. Recently, the Government of Assam (India) forged a partnership with the Department of Design at the Indian Institute of Technology (IIT) in Guwahati to implement a citizen-centric e-Government interface. This collaboration resulted in a citizen-centric usable and user-friendly interface. This project highlighted the importance of specialized skills for the design of usable interfaces. These skills are in short supply, and developing them in the workforce requires a concerted effort between Academia, Industry, and the Government. However, given the current shortage of user interface design specialists in the workforce, it is also worth considering alternate approaches to improving citizen- centric interfaces. In particular, it is interesting to consider whether augmenting the design process with artificial intelligence (AI) can make up for the shortfall in the supply of user design experts in the workforce. The field of AI has seen significant advances in speech recognition, computer vision, robotics, natural language processing, and many other areas, and the rate of progress is itself rapidly increasing. In this paper, authors provide a comprehensive review of the literature that examines the potential for AI to help in designing more effective and easy citizen-centric interfaces. Some of the questions that the authors hope to address at a high level include: can AI be used to identify the nature of the web end-users and adapt the interface in real time to facilitate better human-computer interactions? Furthermore, can it be used to direct the design decisions in the early stages of interface development? Can AI techniques help in ensuring that all the critical factors are embedded in the design of the interface?

To explore these and other similar questions in the context of citizen- centric e-Governance interfaces, the Government will need to collaborate with Academia and Industry to research and design AI-driven user interfaces that can adapt to the needs of a diverse citizenry. This paper investigates the applicability of AI research areas in the design of citizen-centric interfaces. The contribution of the insights from this paper will go towards the ongoing academic research work in the design of usable citizen centric interfaces.

Keywords: Artificial Intelligence, HCI, E-Government, Citizen centric interfaces

1 Introduction

The Indian e-Governance scenario has witnessed rapid growth in the electronic delivery of services in the recent times. From citizen services to digital payments, the use of E-Government systems for service delivery is fast gaining ground. The Digital India programme of the Government of India has services for the citizen as one of its pillars and there is an increased thrust by the Government on making services for the citizen online. Studies have however shown that many of the services fall short of being citizen-centric (Soufi & Naguire, 2007). Evaluation studies of E-Government systems that are predomintly citizen-centric indicate low adoption rates (Kumar et al., 2007; OECD 2015). While the low usage of the systems is attributed to several factors, authors focus on a key one, namely, the design of the citizen-centric interfaces. Authors draw on their experience from designing and developing citizen-centric standardised websites for the Government of Assam. Designing citizen-centric interfaces that meet the diverse requirements of the citizens became a key challenge during the development of the interface. This was because of the fact that the interaction requirements of websites cannot be generalized (Pyarelal & Das, 2017b). This project highlighted the importance of specialized skills for the design of usable interfaces.

This paper investigates alternate approaches to improving citizen-centric interfaces given the short supply of skills of user interface design specialists in the workforce. A key assumption is that usable citizen-centric interfaces can increase the adoption of E-Governmence systems.The field of AI has seen significant advances in speech recognition, computer vision, robotics, natural language processing, and many other areas, and the rate of progress is itself rapidly increasing (Grudin, 2009). The main purpose of the paper is to examine the potential of AI in designing more effective and easy interfaces for the citizen. Some of the closely related research questions that authors hope to address at a high level include: can AI be used to identify the nature of the web end-users and adapt the interface in real time to facilitate better human-computer interactions? Can it be used to direct the design decisions in the early stages of interface development? Can AI techniques help in ensuring that all the critical factors are embedded in the design of the interface?

Authors initially identified the areas of E-Government that have direct bearings on the above stated research questions:

- Usability and user-centred design
- Human Computer Interaction (HCI)
- Intelligent user interfaces

Following this, authors examine the literature on each of the above areas (Section 2). In Section 3, authors employ their experience from building standardized citizen websites for the Government of Assam to link the use of AI in the above three areas. This provides the background for Section 4, where authors propose the research areas where the possible applicability and potential of AI are identified. The insights from this paper will contribute to the ongoing academic research work in the design of usable citizen-centric interfaces.

2 Theoretical background: Interface design for citizen centric services for E-Government

2.1 Usability and User-centred design

The objective of E-Government systems for citizen-centric services is to improve the way Government services such as land and property registration, birth and death certificate services are provided to citizens. The rate of uptake of the E-Government services is currently very low, as a result of which, the end objectives of E-Government systems are not fully realised (Capgemini, et al., 2009). Two factors are directly attributed to this scenario: (i) lack of usability of the systems and (ii) lack of user-centricity in the interfaces of the systems (Olphert & Damodaran, 2007). Usability (also known as seamless interaction) is considered a key factor that influences the adoption of E-Government services by the citizens (Patel & Jacobson, 2008). Measurement of success factors of E-Government services have also shown usability as a critical element in the success of E-Government systems (Youngblood & Mackiewicz, 2012). According to (Clemmensen & Katre, 2012), usability affects the acceptance of the services by the citizens', usage and the day-to-day interaction with E-Government websites. The investigation of Verdegen and Verleye (2009) has shown that users' adoption and use of E-Government services relates to the usability in terms of navigability, flexibility and degree of access.

Authors draw on their experience in designing standardized websites for the Government of Assam. Three things became evident to the authors during the course of involvement: (i) the measure of usability is not easy to predict, especially when it comes to citizen centric systems; (ii) the usability aspects of interfaces are generalised without considering the diversity of users; and (3) the usability aspects are considered only at a peripheral level of the systems. The diversity of users accessing the E-Government systems makes user-centricity central to providing effective citizen services. Most E-Government services are however seen as falling short of being citizen centric (Soufi & Maguire, 2007). One of the reasons is the lack of an early understanding of users and their requirements. User-centered design (UCD) require involving users and addressing their needs throughout the design process of E-Government systems (Kotamraju & der Geest,2011). Another widely accepted principle of UCD is to take the needs of users as the central point of design (Marti & Bannon, 2009). Studies have shown including user-centred requirements in the design of E-Government systems added value (Damodaran,1996; Kujala, 2003). The user's needs to be at the core of user-centred design (Kotamraju & der Geest, 2011). The results from the initial survey that authors conducted on the existing Government of Assam websites showed that these interfaces were lacking in usability and usefulness (Pyarelal & Das, 2017a). Authors observed a substantial increase in the website usage when the users' needs were kept at the core of the design of the websites. For E-Government services to succeed, there is a need to sharpen understanding of factors involved in integrating user-centered design to E-Government (Kotamraju & der Geest, 2011)

Authors draw the following conclusions from the preceding discussions on usability and user-centered design of E-Government Systems:

(i) The user and their needs should dominate the design of citizen-centric interfaces
(ii) The diversity of needs of users to be considered, which is not easy when it comes to citizen-centric systems

In the next section, authors examine the potential of AI research to assist in building effective user interfaces.

2.2 Human Computer Interaction (HCI) in User Interface design

The end-to-end experience of the interaction that the citizen has with the system can be termed as the human-system or human-computer interaction (HCI). The Special Interest Group on Computer-Human-Computer Interaction of the Association of Computing Machinery (ACM SIGCHI) defines HCI as "a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them" (ACM SIGCHI, 1992). The inter-disciplinary nature of HCI combines computer science (application design and engineering of human interfaces), psychology (the application of theories of cognitive processes and the empirical analysis of user behaviour), sociology and anthropology (interactions between technology, work, and organization), and industrial design (interactive products) (Hewett et al).

Several research studies have linked the influence of HCI in the design process of user interfaces. The goal of the interface design process is seen as trasforming the user's conceptual model via the designer's model of the user experience to finally the programmer's model (Kossak et al, 2001). More specifically, HCI is seen to support the development of interactional techniques in the development of user interfaces. The involvement of the user and their cognitive and behaviourial factors are said to be the two dimensions of HCI in the design process. Involving the user is suggested by Preece et al (1994) as one of the approaches for achieving the goals of HCI, the second approach being an iterative design process.Taking into account the psychological and physical constaints of humans while designing user interfaces is recommended by Kossak et al (2001). Ongoing advances in HCI, cognitive science, psychology and neuro-science have greatly enhanced the ability of systems to effectively diagnose users' behavior and to provide appropriate assistance and adjustment (Jraidi et al, 2014).

The value of HCI in designing user interfaces is conclusive from the above studies. Recognising the importance of HCI, recommendations have been made to have a more sustained research on HCI to make the next generation of user inter-faces dramatically more useful, usable, and universal. The areas are to develop improved design methods and metrics, improved tools for building usable, consistent, and reliable user interfaces, software architectures for the next generation of user interfaces, and improved methods of delivering online assistance (Katre & Clemmensen, 2008).

2.3 Artificial Intelligence (AI) in Human Computer Interaction (HCI)

HCI is the business of designing user interfaces that people can work well with and combines the diverse areas of research, design, and application (Sonntag, 2012). The author, Lieberman, 2009 opined that the activities in HCI and AI are intertwined and that both share a common goal in making user interfaces more effective and easier for people to use. The fields of artificial intelligence (AI) and human-computer interaction (HCI) are influencing each other like never before (Green, 2015) and are seen as converging (Grudin, 2009). While HCI focused more on empirical approaches to usability and human factor, AI techniques focused more on developing algorithms for improving the human intelligence (Gurdin, 2009).

With the paradigm shift in technologies, authors examine the AI based technologies that are fundamentally changing the HCI in user interface design. AI's interactive Natural Language Processing (NLP) technology is behind making the interfaces smarter. Voice recognition platforms have given a different dimension to interfaces. NLP has helped Google's search engine become much smarter at pulling up results. AI-enhanced speech recognition is powering speech-based and gesture-based systems.

Human conversations utilise many input and output modalities (Sonntag, 2012). AI techniques can be used to model this complex interaction behavior of human (Russell & Norvig, 2003). Conversational AI techniques are transforming HCI from uni-modal channels of communication to multi-modal channels to convey information. Multi-modal dialogue systems allow inputs and outputs in more than just one modality and go beyond the capabilities of text-based Internet search engines or speech dialogue systems (Sonntag, 2012). With multi-modal interfaces, the fulcrum of human-computer interaction has shifted much closer to the human (Oviatt & Cohen, 2015). The concept of collaborative multimodality introduced in (Sonntag, 2012) states that the user and the system must have a collaborative goal. It serves as the missing link between HCI and intuitive human centered designs in the form of natural language interfaces or intelligent environments (Sonntag, 2012).

AI software, preceived by users as the 'agent' has major implications for user experience design (Lieberman, 2012). AI-powered chat-bots, for example Amazon's Alexa, Apple's Siri and the Google Assistant are examples of AI capabilities incorporated into the design of user interfaces.

3 Citizen-centric websites for Govt. of Assam (India)

Involvement of authors in the standardization of citizen-centric Government websites led to conduct of initial research to undertstand the reasons for the low adoption rate of the websites: what are the deeper problems in the system that is preventing its wider usage; how the citizens interact with the system and their experience in terms of usability, usefulness and the level of satisfaction; are the interaction patterns of the service delivery to the users adequate.The initial survey resulted on some key findings : (i) the interfaces lacked usability and usefulness, (ii) websites were developed without considering the user and user needs. The project case has been described in Pyarelal & Das (2017a).

The Govt. of Assam sought the assistance of experts from IIT Guwahati for the design of the websites. One of the authors of this paper participated as an expert in the project. With the guidance of experts from the Department of Design, IIT Guwahati on Website usability, User experience, Visual aspects of the website developed resulted in greatly transforming the citizen interface. Authors' involvement in the project resulted in the following findings: (i) Designing an interface that met all the diverse requirements of the citizens was a key challenge in the development of the Website of Citizen Centric Interface, and (ii) This was mainly because of the fact that the interaction requirements of websites cannot be generalized.

The diverse and unique nature of the target users calls for knowledge of the principles of human-computer interaction (HCI) and a high-level understanding of all aspects of human-computer interfaces, from the design stage to the execution. The availability of these desired skill sets in industry today is minimal. Considering the thrust that the Indian Government is

giving to e-Governance, it is necessary that this expertise be generated in industry. In Pyarelal & Das (2017a) authors highlighted the role and importance of specialized skills required for designing citizen centric interfaces for Indian E-Government Systems. To achieve this, authors proposed evolving a specialised discipline, the curriculum of which will include topics such as: designing the architecture for user interaction points, design methods for consistent, intuitive, and usable interfaces, design of usability evaluation models based on the target age groups and levels of computer literacy, and prototyping techniques for the design life cycle.

Authors also proposed a E-Government design model to address the challenges of user-centricity in the interface design.

1. Plan	2. Prepare	3. Implement	4. Evaluate
1.1 Identify the users	2.1 Involve users	3.1 Produce design	4.1 Evaluate against the need
1.2 Specify the user needs	2.2 Apply design principles	3.2 Test Design with all stakeholders	4.2 Iterate
1.3 Detail the context of use	2.3 Design Prototypes		4.3 Factor and reproduce design
1.4 Finalize the scoping			

Table 1. Representation of a Model with four stages for HCD for Indian E-Government Systems.

Each stage in the design cycle model include areas where the activities are to be done manually. Authors had also highlighted the lack of specialised skills in the design for which specialised skill sets are to be developed through industry, academia and government consortiums. In the next section, authors propose the areas where HCI in interfaces can be improved with AI techniques, given the short supply of skill sets in building effective citizen facing interfaces.

4 AI in Citizen facing Interface Design

Authors of this paper examine the use of the AI in the context of designing citizen interfaces to improve its usability. Three specific areas which emerged from authors' experience and through literature review are considered for potential application of AI: (i) *Understanding the users and keeping the user' needs in the forefront* while designing the interfaces are considered as success factors for effective citizen interfaces (Pyarelal & Das, 2017b) . The users of E-Government systems and their needs are varied. In the project of standardization of Government webistes, the earlier websites had not considered the user and their needs. During the deisgn of the new standardised websites, users were identified first. The needs of each category of user were then identified. The new standardized websites have specific roles for citizen, business and government users. The content displayed is based on the user needs compiled manually. With the knowledge about users gathered over a period of time based on the user' interactions, NLP-powered analytics tools can be used to run queries against datasets built over a period of time. With knowledge engineering AI techiques, adaptive UI personalised interfaces where the content is adapted based on the needs of the user can be generated with the help of data collected. (ii) *Diverse nature of the citizens* was identified as one of the key issues in the design of citizen-centric interfaces of Indian E-Government systems. The citizens vary in age, literacy and in their skills in using computers. Hence, their

pattern and mode of usage also varies. Learning the usage patterns can remove uncertainity (Horvitz,1997) and with AI, predictive patterns can display the most relevant data. The user interface based on the capability of the user can be generated. AI can be used to search the patterns, make new insights, extract knowledge from the data and make predictions while interacting with citizens. (iii) *Improved Search techniques* with interactive virtual assistant that uses AI to answer citizen queries. Speech-recognition and multi-modal systems can increase the responsiveness of the interfaces.AI techniques can bring intelligence into citizen-centric interfaces.

This section is by no means exhaustive in the span of application of AI technology in citizen centric interfaces. AI needs to be selectively applied in areas where maximum value for citizens are achieved starting with simple automation.

Conclusions

Since long there have been notable discussion by Shneiderman and Maes on whether or not AI be a primary metaphor in human computer interfaces (as cited in Winograd, 2006, p. 1256). There have been many critics of AI. Winograd, 2006 argues that human thinking is a complex interaction that cannot be totally replaced by AI citing McCarthy's view of AI as a kind of 'superbrain'. In fact, several research studies point to the fact that the use of sophsticated machinery does not often yield the desired results. Instead, in many cases simple techniques deliver more value (Horvitz, 1997). However, Winograd, 2006 suggests that 'there are clearly places where AI can be applied and places where other styles of interaction are more appropriate'. Horvitz, 1997 makes a strong case for research on user models and reasoning machinery for building intelligent user interfaces. Promising strides can be made in UI design by integrating simple automation in the funtionality of user interfaces (Horvitz, 1997).

In the current span of research in the field of AI, it is seen that there is no concerted effort in research studies in the field of E-Government. Industry research in AI is focussed on their specific needs, while the academic research studies covers a broad spectrum. Keeping the skill base and capital required for undertaking research in the specific areas of AI for E-Government Interface Design, Government will need to collaborate with Academia and Industry to research and build AI machinery that can adapt to the needs of a diverse citizenry. Authors recommend that AI be made a strong research component with specific goals for improving the usability of citizen-centric interfaces of E-Government systems.

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