Editorial Preface

Sociotechnical Approach to Extreme Automation in Healthcare

Sabah Mohammed, Lakehead University, Ontario, Canada

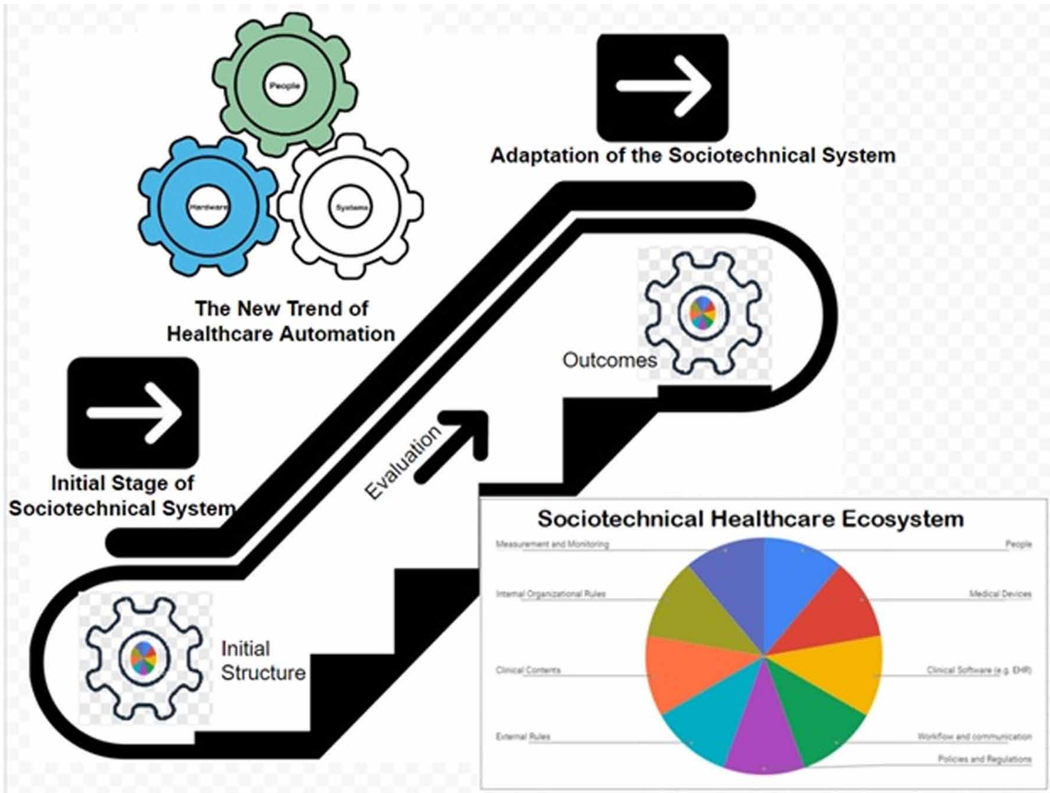
Jinan Fiaidhi, Lakehead University, Ontario, Canada

We are delighted to continue our efforts at IJEACH to create a new forum for exchange of information and publishing the excellent research work of scholars on all aspects of the emerging trends in the digitization and automation of healthcare. The healthcare automation in particular is very different from other industries because of the intensity of the personal interactions. Healthcare is all about people: patients and their families and friends, and the various healthcare professionals and caregivers. Many healthcare professionals, experts and organizations have turned to harnessing the natural properties of complex sociotechnical healthcare systems to learn concepts, theories, models, tools and methods, to redesign healthcare systems and processes and to improve patient safety and quality of care (Braithwite et al., 2009). We convene this IJEACH issue to address the general question of how to conceptualize sociotechnical system boundaries in healthcare automation. The new wave of healthcare automation systems involves increasingly complex social arrangements, and in turn, the social arrangements for patients' healthcare and clinicians' work more and more are parts of increasingly complex socio-technical systems. Moreover, the types and roles of interacting people to be taken into consideration are not restricted to healthcare professionals and patients. Healthcare networks now can include home-helpers, family caregivers, professional mediators, remote patient monitoring devices, telehealth services and variety of connections that can be reached via the Internet. The socio-technical considerations in healthcare, therefore, must include networks of people, technologies, medical devices and systems, information and data brokering, changing roles, the consideration of physical space, the influence of family and the role of local communities, as well as disease- or condition-centered online communities among many other considerations. Although sociotechnical approaches have been used to explain complexity in healthcare, little has been discussed on how to integrate the various components of the system and how to evaluate the success of its implementation over time (Yen et al., 2017). Figure 1 illustrates the new trend of healthcare automation.

However, the efforts to implement sociotechnical healthcare systems requires intensive understanding to new notion of interoperability between the various components of such complex system including people, medical devices, communication protocols and healthcare services. Enabling the interoperability between healthcare applications requires agreement in the format and meaning (syntax and semantics) of exchanged data including the ordering of message exchanges. However, today's researchers argue that these are not enough to achieve a complete, effective and meaningful collaboration – the use of data (pragmatics) is important as well. Pragmatic interoperability requires mutual understanding in the use of data between collaborating systems and people using these systems (Asuncion & Van Sinderen, 2010). Baxter and Sommerville (2011) provided a survey on important methods that can be used to achieve pragmatic interoperability in complex systems like healthcare. These methods include:

- Soft Systems Methodology (SSM)
- Cognitive Work Analysis (CWA)
- Sketching for designing workflow systems (Sketch)

Figure 1. The sociotechnical trend in healthcare automation



- Ethnographic workplace analysis (Ethnographic)
- Contextual design (Contextual)
- Cognitive systems engineering (CSE)
- Human-centered design (HCD)

Recently many notable researchers believe that a stronger focus on workflows and other pragmatic aspects of interoperability functions may be a key to overcoming the difficulties in implementing eHealth system interoperability and automation based on socio-technical processes, rather than as technical functions of certified devices (Weber & Kuziemsky, 2019; Liu et al., 2014; Ribeiro et al., 2019). Interestingly the notion of pragmatic interoperability has been used in many new major clinical and enterprise healthcare systems like the FHIR Electronic Healthcare Record (Moreira et al., 2019).

We are inviting more contribution on the automation of healthcare systems based on the sociotechnical and the use of pragmatic interoperability.

In this Issue

In this issue we are having ten papers that addresses sociotechnical healthcare applications. The first paper entitled "The dual tasking texting effect of cell phone technology on walking" by Asher Mendelsohn and Carlos Zerpa examines the effect of cell phone use on measures of force, acceleration and speed during the gait cycle. The results indicate that texting affects walking patterns by naturally slowing the gait speed and subsequently lowering acceleration and ground reaction force during the gait cycle. In contrast, reading a text message while walking revealed no significant difference from walking without using a cell phone. This outcome highlights the concept that more cognitively demanding tasks such texting while walking have a greater impact on gait mechanics and consequently, they increase the risk of falling and collisions. These results build on existing literature and allow for a deeper understanding of the effects of dual-tasking on gait and the potential danger it poses to pedestrians. The secondary purpose of this research is to examine the effectiveness of accelerometers at assessing gait patterns and their potential correlation to force platform measures. The results indicate that accelerometers provide another avenue to assess gait characteristics when performing a dual task such using a cell phone while walking. More specifically, accelerometers seem to provide similar outcomes as platforms in situations when the person walks without the use of a cell phone or when reading a cell phone text while walking. This outcome builds on existing literature and help validate the use of accelerometers as a cheap and versatile alternative instrumentation to the use of force platforms for gait analysis.

The second paper entitled "Long-Short Term Neural Network Analysis of Center of Pressure of Gait" by Arshia a Khan and Janna Madden describes the effects of vascular dementia are far reaching. The uniqueness of our approach is the application of computational analysis along with a focus on developing a personalized understanding of gait. Several research studies have identified gait as an important marker in early identification of vascular dementia. This study has developed a long short-term neural network to predict gait patterns that is associated with vascular dementia to help predict the onset of vascular dementia. The proposed tool advances the use of gait metrics for early prediction and recognition of subcortical vascular dementia and vascular cognitive impairment. In this research, and work to come, the challenge of differentiating vascular dementia from other forms of dementia and effects of aging remains a significant challenge. By continuing to explore data aggregation and metric evaluation in the realm of gait, we aim to contribute to this challenge of differentiating onset patterns from the trajectory of aging.

The third paper by "The Effect of Breathing Pattern and Heel Strike Pattern on Peak Ground Reaction Force at Initial Contact during Walking" by Paolo Sanzo, Cassandra Felice and Carlos Zerpa explores if there was an interaction effect between the phase of respiration (inspiration or expiration) and foot strike pattern (heel, midfoot, or forefoot strike) on the peak GRF of walking at the time of initial contact and to determine if there was a correlation between the phase of respiration or foot strike pattern and peak GRF at the time of initial contact. Though walking and running are both forms of ambulation, the breathing physiology and motor mechanics are not the same. From a biomechanical perspective, walking begins when the foot strikes the ground with the heel or midfoot, whereas running often involves landing farther forward on the midfoot or forefoot as speed increases. Another main difference between walking and running are the muscle activation patterns utilized and propulsion energy required. In walking, the phases are usually very distinct and the legs are stiff with locked and extended knees; whereas running is continuous with a rebounding rhythm and unlocked and slightly flexed knees. Mechanically, running is a series of subsequent stance and flight phases characterized by a sinusoidal pattern of movement of the center of mass and can be described as a series of repeated bounds that uses the stretch-shortening cycle. Running is typically characterized by higher peak GRFs and shorter contact times, while walking is characterized by lower peak GRFs and longer contact times. These fundamental biomechanical differences may help to explain why the effect of breathing may be different when comparing walking to running in the current study. This study explored the interaction effect between the phase of respiration and foot strike pattern on measures of ground reaction forces while walking. The study also examined the correlation between the phase of respiration and peak forces. The research findings did not support the concept of breathing synchronization with higher ground reaction forces when exhalation occurred at heel strike during walking. The biomechanics of walking are very different than running and, therefore, the utility of breathing retraining may not be supported as has been proposed for running.

The fourth paper is entitled "Fall Prevention and Management App Prototype for the Elderly and their Caregivers: Design, Implementation and Evaluation" by Eseohen Imoukhome, Lori E. Weeks and Samina Abidi describes how smartphone have great potential in providing relevant and creditable fall management information to the elderly and their care-providers at the point of care. With falls being the leading cause of injury-related hospitalizations among seniors in Canada, it is imperative that this gap be bridged. This research shows that a mobile app based on validated health models can be used to educate and inform the elderly and their caregivers about fall management, and such an intervention could potentially bridge this observed knowledge gap. Our evaluation also showed that this app could serve as a source of empowerment for its users as they expressed that having the app on their personal smartphones will make them feel empowered and make them feel safer as the app will give them a better understanding of what to do when a fall occurs. This app is a prototype and is a standalone application, which means it is not integrated with patient health records or emergency services. Currently, the app has been designed for the android platform.

The fifth paper is entitled "An Electronic Medical Record System" by Muhammad Sarfraz, Anwar A. Al-Hussainan, Farah Mohammad and Hanouf Al-Azmi, proposes, designs and implements a new online system for electronic medical records (EMR) for assisting the current processes of Labs and Hospitals. Specific consideration is given to the records of blood donors. It provides an online automated alternate to the traditional manual processes adopted for various medical labs. The proposed system provides an easy way to communicate with the world. The paper presents Use Case diagrams that model the logics of the system. It also proposes schema for support databases in the system. The system is prototyped, and ready to be used. To achieve the targeted system, in addition to investigating the latest studies in this area, the needed data was collected through a questionnaire survey with the community. The system, as a special case, has been oriented for the communities of the state of Kuwait to improve its healthcare sector. However, this design can be easily ported to other countries platforms due to its generic formulation.

The sixth paper is entitled "Air Pollutants Concentration Prediction Based on Transfer Learning and Recurrent Neural Network" by Fong Iat Hang and Simon Fong where it creates two different type of transfer learning cases for LSTM RNNs that predict air pollutant concentrations. The first type of cases is that the source domain and the target domain use the same or similar air pollutants, but the location of the station is not the same; the second type of cases is that source domain and target domain use different air pollutants, but the locations of the stations are the same. The result of the experiments are that the above two types of cases, pre-trained neural network methods are all helpful for training neural networks, in other words, the LSTM RNNs initialized with pre-trained neural networks can get more accurate prediction capabilities. In addition, the number of epochs required to train LSTM RNNs can be reduced. Moreover, it is even possible to get better initial states for RNNs. However, when new observed data occurs, overfitting may occur. Therefore, the new observed data need to be used to update the RNN's weights and biases, in order to accommodate the new conditions that might be encountered. However, it should be noted that even if the pre-trained method is used in the process of training LSTM RNNs, over-fitting might occur.

The seventh paper entitled "Measuring Similarity Between Biomedical Data By Using Furia Ensembles Rule-Based Classification" by Simon Fong uses the FURIA method to compare two datasets based on attributes by using classification algorithms, for the attributes the data analyst need to select them by rules and the classification system uses an ensemble-based method for comparison of two datasets. The ensemble data mining learning methods are applied to rule generation, and a multi-criterion evaluation approach is used for selecting reliable rules over the results of the ensemble methods. The efficacy of the proposed methodology is illustrated via an example of two breast cancer datasets.

The eighth paper is entitled "Accessibility Monitoring for People with Disabilities: A Collaborative Virtual Community" by Ishita Saraswat Aymen Brahim, Nancy viva davis Halifax and Christo El Morr. In 2005, the Accessibility for Ontarians with Disabilities Act (AODA) (Accessibility Ontario, 2017;

Government of Ontario, 2005) came into effect, its purpose is to create accessibility standards that organizations from public, private, and non-profit sectors must follow to make an accessible province for all Ontarians. AODA sets a deadline for achieving accessibility for people with disabilities – January 1, 2025. The main requirements of AODA stipulates that all organizations with one or more employees develop an accessibility policy and be compliant with AODA by January 1, 2025. When designing the app, we kept in mind several important considerations. One of the main objectives was to build a user-friendly App to ensure that the users can report accessibility issues easily and accurately. This research have developed an AODA compliant app. There are two interfaces for the app, the front-end and the back-end; the back-end consists basically of the database system and the front-end can be accessed by two types of users, the App users and the App admin. The App users will be able to enter any accessibility issues in a geographic location and upload it to the database. They will also be able to view all the issues entered, both in list-view and in map-view. The admin, in addition to what a user can do, will also be able to delete the issues that have already been resolved. The current scenario suggests the App is adopted by one entity (e.g. York University, Ontario government); the admin will be linked to that organization (e.g. an activist organization, AODA compliance director, Accessibility Directorate of Ontario). The Accessibility Directorate of Ontario enforces AODA accessibility compliance requirements (Thomson, 2018), requires organizations submit accessibility compliance reports and hence can administer such App and use it as a complaint system to get access to AODA violations reports in order to take the right steps to enforce compliance. The App can function to not only develop a better understanding of access but also to articulate user experiences not captured by legislation as it intersects with those living with disability.

The ninth paper is entitled "A Speech Clinic System for Children with Communication Disorder" by Muhammad Sarfraz, Maha S. Almutairi and Zahraa A. Jasem his designs and implements a telehealth system for children with communication disorder (Speech Clinic System (SCS)). It provides an online automated alternate to the traditional manual treatment processes for children with communication disorder. The proposed SCS provides an easy way for parents to be in touch with the speech-language pathologist, check their child progress, make an appointment, follow guidelines and choose therapy exercises. The structure of the system has been designed to automate parts of the treatment process. To achieve the targeted system, in addition to investigating the latest studies in this area, the needed data was collected through interviews and searching about the treatment process of children with communication disorder. The system, as a special case, has been oriented for the Arabic speaking communities (especially state of Kuwait) to improve its healthcare sector. However, it can be easily oriented to fulfill the needs of other countries with some variation of language and other local requirements.

The tenth paper is entitled "Effects of Electronic Medical Record Downtime on Patient Safety, Downtime Mitigation, Downtime Plans by Joseph M Walsh, Elizabeth M Borycki and Andre W Kushniruk where authors focus on factors that become apparent in a mature EMR deployment based on downtimes: EMR downtime, contingency planning, and downtime mitigation. This paper explores how downtime may affect patient care, how organizations are creating contingency plans and what steps they're taking to mitigate the effects of the downtime either before, during or following a downtime event. Electronic Medical Record (EMR) systems have become the hub of patient care information for the modern clinical environment. EMR systems can consolidate information from various supporting systems such as Laboratory Information Systems (LIS), Clinician Provider Order Entry (CPOE) systems, as well as capture data from patient physiological monitors. These electronic data collection tools are improving the efficiency of healthcare as well as improving the quality of patient care, and patient safety. With the introduction of such technologies into a healthcare environment, downtime has emerged as a critical and patient life-threatening event if not planned for. Downtime in essence is the time during which a functional machine or system is not functioning properly or it is otherwise unavailable to users. Downtime events can take on many forms. The systems may be fully unavailable or only a portion of the system may be affected. Timing or scheduling of downtime events can also make an impact. Planned downtime is when the system is either partially or fully unavailable because of a scheduled activity. Unplanned downtime is a period where the outage was not expected. Semi-planned downtime is a period where the outage can be scheduled, but the controlling factors (i.e. factor that leads to the downtime) comes from an outside influence such as an imminent failure, or vendor request.

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