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Voice Tech in HealthCare

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Introduction

Technology is transforming industries across the globe, and these developments are taking place at such a rate that it is impossible for humans to adapt to them, and healthcare is no exception. We have witnessed a radical transformation in the healthcare journey, and it all comes down to something that we use daily, something that we all have with us right now, something that we are born with, i.e. our voices. We no longer have to adapt to the way a computer works. In fact, the computers are adapting to us, and now we are seeing the adoption of voice assistants' smart speakers like **Amazon Alexa, Google Assistant, Apple Siri**, and many more.

Voice, coupled with the power of **Machine Learning** & **Natural Language Processing**, has become so compelling nowadays that it becomes an interesting area of research, and we see massive adoption of this technology. In fact, devices like this are being adopted at a rate faster than any consumer technology in history. Such technologies can change the way things have been accomplished for quite a long time in the healthcare industry, including how patients participate in out-of-patient care and how doctors know and communicate with clinical gadgets.

In the presence of a voice-enabled device, the patient can ask questions to the voice assistants regarding their heart conditions, sending a report to the caretaker, scheduling an appointment, and symptom checker in the home healthcare system (Dojchinovski, Ilievski, & Gusev, 2019)[1].

What is Voice Tech in Healthcare all about?

Considering the utilization of sophisticated algorithms, chatbots with precision in order to achieve the desired results have shown the potential to engage voice assistants in a delicate field of research. With these devices, we are going to have artificial intelligent health care teams living in our homes. Imagine a voice assistant being able to help a doctor make a diagnosis, or your Alexa having the option to check in with you at home following recent hospital discharge to give you medical advice (T'19, 2019)[2]. In fact, the number of new startups and organizations in the healthcare Voice User Interface space is growing substantially.

[1] (n.d.). Interactive home healthcare system with integrated voice .... Retrieved April 18, 2020, from http://docs.mipro-proceedings.com/dc/21_dc_5503.pdf

[2] (n.d.). Voice Technology in Healthcare | Center For Digital Strategies. Retrieved April 20, 2020, from https://digitalstrategies.tuck.dartmouth.edu/publication/voice-technology-in-healthcare/

Research Areas

We, as a group, researched the role of Voice tech in the following scenarios in the Healthcare industry, and to ease the maintenance of the information, we created a **Trello Board** (*https://trello.com/b/6epBfMT8/voice-tech-in-healthcare*) and collected the research in a structured manner for the appropriate flow.

1) Covid-19 Pandemic

2) Elderly Patients

3) Disabled Patients

4) Vocal Biomarkers / Chronic Diseases

COVID-19 Pandemic

With the recent outbreak of COVID-19 across the globe, the usage of technology in healthcare has assumed a different meaning. Voicetech, in particular, promises to be the game-changer in this scenario as the world moves to low-touch methods in all industries.

Since the Coronavirus is highly infectious and demands social distancing and minimum contact to reduce its spread, the top healthcare institutions may employ robots for information collection and even treatment, in a few cases. In several countries, the healthcare facilities have been overwhelmed due to a sudden spike in the number of patients needing immediate attention. In such cases, robots may again be used for making calls to gather information on the suspect and confirmed cases. Artificial Intelligence is expected to power 95% of all interactions by 2025[3] and may also be used for quick dissipation of information.

Using voice-controlled devices such as doors and windows, can be critical at shared places, especially hospitals with some confirmed cases and multiple suspected cases. Newly developed mobile Apps are helping patients get a good sense of whether they are infected or not using Voicetech applications before they run the risk of going to a hospital amid lockdown.

Voicetech Use cases in COVID-19 Pandemic

As discussed above, in the current pandemic, the following developments are taking place around the usage of Voicetech for providing healthcare solutions:

[3] (n.d.). AI will power 95% of customer interactions by 2025 – Finance .... Retrieved April 20, 2020, from https://www.financedigest.com/ai-will-power-95-of-customer-interactions-by-2025.html

1. Voicetech Startups like ***VocalisHealth[4],*** have built the Coronavirus Speech Test by using Voice analysis on Big Data.
2. Using Voicetech to tackle lockdown created loneliness that causes several physical and mental health issues.
3. Autonomous robots and voice robots may be used as cleaners and for information collection in hospitals.
4. Using Voice Recognition for making payments for health services due to lockdown.
5. Voice control of smart home devices can minimize the risk of contracting coronavirus from touching shared surfaces.

Elderly Patients

Caregiving demands for the elderly have been evolving from a few decades as the life expectancy of the population is also growing with the innovations and technological assistance in healthcare. The percentage of people aged above 60 years is going to be doubled from 11% to 22% from the year 2000 to 2050. We need to be prepared for the changing requirements associated with the changing demographics[5].

While discussing specific assistive devices for elderly home treatment, let us define the older people's practical, physical, and emotional needs. All those tasks that require independent living, such as sanitation, health, dietary needs, and timely medicine, include functional needs. Cognitive tracking, connectivity, accessibility, and driving are the practical assistance that elders demand from software gadgets. To meet the elderly's social needs, assistive robotics or speech help ranks better than human caretakers. While technology should only support human service and not substitute it, a well-programmed robotic assistant may be more compassionate and more effective than a caregiver. Failing memory, lack of awareness, and reduced elder mobility need the caregiver to be patient and calm all the time. Robotic elderly treatment or voice assistance can address repeated queries, send prescription reminders, monitor health indices, and even conduct conversations.

Voice assistance technology is definitely a revolution for elderly healthcare, as they can utilize this tech by doing what they have been doing throughout their life, and that's just talking. Voice assisted home care is attracting everyone from professional service providers, families, and elders due to its increased convenience and accessibility. Voice technology will make the time spent by elders at home more relaxed and interactive.

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[4] (n.d.). Vocalis Health. Retrieved April 20, 2020, from https://vocalishealth.com/

[5] (2017, August 4). Voice-controlled virtual assistants for the older people ... - NCBI. Retrieved April 20, 2020, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5770711/

Making them self-sufficient in their golden years is the primary objective behind this tech. Controlling smart appliances like smart bulbs, air conditioners, turning off the geyser in the bathroom, etc. by voice command are some of the applications of the voice technology in this direction.[6]

Potential use case in COVID-19 outbreak

There were instances in Spain and Italy in March 2020, when old people were found dead in isolation inside their home. It was mainly due to their age and inability to communicate or connect with family members or healthcare personnel in emergency scenarios. In these cases, voice tech assistants would have been easily approachable devices for alerting authorities without much effort, which would have created the difference. For quarantine and self-isolation during the lockdown, voice assistants can effectively alleviate isolation and loneliness by providing recent updates, news, and by making conversations.

Recent Developments

Below stated startups have explored different areas of elderly healthcare where they can take advantage of voice-first technology.

- **Cuida Health**: Assists old people to get in touch with family, to enhance accessibility, self-sufficient, and to acquire a healthy routine.
- **Ava**: Helps deaf & people with the significant hearing disorder to make regular day to day tasks easy by making them visibly aware of the speech.
- **VocaliD**: Uses large voice datasets and copyrighted voice mixing techniques to generate distinct audible identity for these voice assistance devices.
- **Voiceitt**: They are researching and developing the first-ever speech and recognizing the device to even understand the complex non-understandable speech[7].

[6] (2019 Feb21). Hearing the voices of older adult patients: processes and findings to inform health services research. Retrieved April 15, 2020, from https://researchinvolvement.biomedcentral.com/articles/10.1186/s40900-019-0143-5

[7] (31 Oct 2017). Smart Homes for Elderly Healthcare—Recent Advances and Research Challenges. Retrieved April 17, 2020, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5712846/

Disabled Patients

Voice Controlled Intelligent Personal partners fueled by AI voice-tech are not really planned in view of availability. Be that as it may, these insightful gadgets do discover clients with visual hindrance and other physical inabilities utilizing them. The significance of speech technology to individuals with inabilities can't be underestimated.

Recently, (Pradhan, Mehta, & Findlater, 2018)[8] have demonstrated in their study that the "*Amazon Echo Network*" has already been embraced by a huge population with disabilities such as speech impairment, visual impairment, cognitive impairment, hearing loss, mobility impairment and many more as a practical solution to several everyday challenges. Furthermore, it has been noted that such devices can save precious time for people who are visually impaired by having tasks done, helping people with speech impairments by forcing them to talk slowly, clearly, and loudly. In addition, those with dyslexia can use Alexa software to read book recordings and ask questions, and those with memory problems can use it to set reminders.

Recent Developments

1) **Google's Project Euphonia:** The biggest focus of Euphonia (Shor & Emanuel, 2019)[9] will be collecting more voice data from people with impaired speech. It is intended to resolve the problem of AI bias created by insufficient training data. Furthermore, the company is working on new interactive AI systems that identify behaviours like gestures and facial expressions. This would mean that individuals with extreme handicaps who can't talk at all could likewise utilize innovation like savvy home speakers and lights.

2) A valuable insight has been offered by **Thomas Chappell**[10] in designing resources to support people with poor vision or hearing loss. For instance, **Ava**, a real-time voice-to-text program allows someone to know what is being said while replying via a "speech" that reads a typed response. In addition, the **Aira** app supports people with low vision by linking them to members who explain the surroundings on the basis of the cell phone's camera.

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[8] (2018, April 21). "Accessibility Came by Accident" | Proceedings of the 2018 .... Retrieved April 18, 2020, from https://dl.acm.org/doi/10.1145/3173574.3174033

[9] (2019, August 13). Project Euphonia's Personalized Speech Recognition for Non .... Retrieved April 18, 2020, from http://ai.googleblog.com/2019/08/project-euphonias-personalized-speech.html

[10] (2019, October 18). This silent developer speaks volumes, giving others a voice .... Retrieved April 20, 2020, from https://news.prudential.com/this-silent-developer-speaks-volumes-giving-others-voice.htm

Vocal Biomarkers / Chronic Diseases

As humans, we strive to move towards a personal gear of life to comfort our health factor, which is an uncertain element. The technology and usage of various algorithms that help to detect voice in the healthcare industry have advanced and given us a new innovation term i.e., vocal biomarkers. The concept of vocal biomarkers comprises signal processing methodologies that help identify the various chronic diseases in a patient by its shimmer, jitter, aspiration, pitch and energy levels while accessing the voice technology, which can be monitored by using smart sensors and the daily activities of the patient[11]. Certain medical conditions can affect the nerves controlling vocal cords and the best practices under this research include diseases falling under Cardiovascular, Sleep, Respiratory Disorders, Diabetes and Neuropsychiatric health disorders[12]. It is more pitched towards the detection of mental illness and has broad research on neurological disease management like Multiple Sclerosis, Parkinson's, Alzheimer's, Amyotrophic lateral sclerosis (ALS), and Huntington disease.

Recent Developments

- **BeyondVerbal**: It has developed a technology that extracts various acoustic features from a speaker's voice in real-time, giving insights on personal health condition, wellbeing, and emotional understanding.
- **Cogito**: It improves care management with real-time emotional intelligence.
- **Corti**: It is a digital assistant that leverages deep learning to help medical personnel make critical decisions in the heat of the moment.
- **Healthymize**: It provides personalized speech monitoring based on the analysis of patients' voices and breathing during regular voice calls.
- **NeuroLex**: It strives to be the world's leading platform company to advance linguistics as a tool to characterize various health conditions.
- **Sonde**: It is developing a voice-based technology with the potential to transform the way we monitor and diagnose mental and physical health.
- **Winter Light Labs**: It has developed a novel AI technology that can quickly and accurately quantify speech and language patterns to help detect and monitor cognitive and mental diseases.

[11] (n.d.). Tue.SS4.06 Vocal-Source Biomarkers for ... - ISCA Speech. Retrieved April 20, 2020, from https://www.isca-speech.org/archive/archive_papers/interspeech_2012/i12_1059.pdf

[12] (n.d.). The future of healthcare: Smart sensors and digital biomarkers .... Retrieved April 20, 2020, from https://www.prescouter.com/2019/12/future-healthcare-smart-sensors-digital-biomarkers/

Literature Review

Introduction to all the research areas

Voice technology has emerged as the next frontier for self-service in healthcare, promising a more “human” experience and enabling users to access information quickly without navigating a complicated interface. The key concepts of using voice technology in healthcare comprised of key research areas that are; the emerging services in the COVID-19 pandemic, how to engage elderly patients in accomplishing the daily tasks with comfort, how to engage people with disabilities, and the role of vocal biomarkers in this innovative era to get control over chronic diseases. The current pandemic situation is affecting the entire economy with its paranoia of getting trapped by the virus and the problem of physically meeting the doctors that have been controlled by some emerging applications like vocalishealth. The elderly patients can be treated easily by the use of recent developments mentioned but suffer from some issues. The disabled patient research gets broader time to time as the categories of human conditions like visual impairment, deaf and dumb conditions, etc. have various use cases concerning limitations. The effective and sensitive issue like depression also has wide research in the field of technology and medicine, wherein the interesting study includes various neurological disease analysis like multiple sclerosis, etc. These research areas have proven that there should be a concern raised while accessing such Hi-Tech devices with a serious issue of privacy that must be considered. The ethical risks and the challenges faced must be reviewed before even accessing the features and trying to be alert.

Gaps and Issues in the respective field of Research

COVID-19 Pandemic

Risks

The following risks have been identified with respect to the usage of Voice Technology in COVID-19:

1. The devices have been trained on very recent and unreliable data, so the accuracy of it identifying a patient with a new virus like COVID19 is questionable. This may result in False positives or highly risky false negatives.
2. If used for making payments, there is a huge risk of credit card fraud as the data security is an issue in dynamic scenarios of pandemics, and impersonation is a reality.
3. Risk of datafication by commercial actors as they have complete access to patient data.
4. Technology non-compliance issues with regulations need to be addressed before we start using it in hospitals. The issue is that time is of the essence during pandemics.

Ethics

A few ethical challenges in the use of Voicetech in Pandemics are:

1. As doctors and nurses are overworked, they may rely on the usage of Voicetech devices. But the device accuracy isn't perfect. In cases where they pick wrong words from healthcare professionals and/or patients, and the advice is made based on that. If that results in negative results, would we blame technology or the user?
2. When we use voice assistants for collecting information due to overworked staff, it may never get the true sense of what the patient is trying to say in terms of the human touch that a nurse is supposed to provide to a patient in need.
3. Doctors getting updates on the go from Voicetech devices and accessing them in shared spaces like hallways, elevators, etc. poses data privacy issues.

Elderly Patients

Gaps & Challenges:

- Accessibility and use challenges - Many older adults are reluctant to use new technologies, especially if installation and troubleshooting seem difficult. Currently, there are some barriers to full accessibility and use-ease. For example, the password is set-up through a visual interface and needs to be reset every two weeks, which the blind wouldn’t be able to do without assistance.
- How VAs should talk to older people - Current design knowledge for VAs lacks in this regard, adopting a one-size-fits-all approach, i.e., we always talk to the same VAs, regardless of age (or social needs, norms, etc.). Also, conversational datasets are “limited to databases that have been produced from online forums, social media interactions, movie subtitles,” where older people (along with minorities and vulnerable groups) are underrepresented, and the variety of social encounters, limited, hindering the performativity of VAs.
- Failure to provide an appropriate response - Lack of emotional and Telephone conversational agents often failed to provide appropriate information when asked questions about mental health and domestic violence issues. Google Assistant, much

like other conversational agents, does not respond effectively to terms like depression, suicide, rape, or domestic violence.

Risks and Ethical Issues:

- Current privacy controls do not meet people's needs. Most people using voice technology don't even realize that data was being analyzed to serve targeted ads at them.
- Machine-learning enabled voice chat data can be used to make predictions about the speaker's age, education, personality, etc. by analyzing accent and intonation data.
- There is a possibility of companies using voice data to identify sexual orientation for advertisement purposes using the style of speaking.
- The speech examples used to train machine learning applications are going to learn societal biases.
- AI might make mistakes by detecting a strong accent and inferring that this means the speaker is less educated because the training data could have been skewed by societal stereotypes resulting in a smart speaker with dumb down responses to those with strong accents.
- There already exist some worrying examples of voice analysis being used on phone lines for benefit claimants to detect potential false claims. The UK government wasted £2.4M on a voice lie detection system that was scientifically incapable of working[13].

Disabled Patients

Challenges:

- While smart speakers can be a great benefit to those who have the power of speech, these devices may not always serve the needs of those with hearing or speech impairments, such as the need to enunciate clearly and speak loudly.
- Speech output challenges for the users with hearing loss experienced difficulty in understanding the output.

[13] (2016, March 14). Hey, Siri, I'm depressed | News Center | Stanford Medicine. Retrieved April 20, 2020, from https://med.stanford.edu/news/all-news/2016/03/hello-siri-im-depressed.html

- Difficulties in remembering voice commands, particularly problematic for older adults or users with cognitive impairments. For example, remembering how to wake the device (with the word “Alexa”).

Risk & Ethical Issues:

- Security and Privacy: **"Always On"** features of voice tech devices pose a challenge to the individual's privacy. The collection of large quantities of personal data can be used to train AI-based systems for various purposes, such as targeted advertising and promotions and personalization.
- Interestingly, I would also like to add one of the tweets shared by me on the Risk & Ethical Issues of the consumers. Though it is not part of Voicetech but covers the issues in healthcare during **COVID-19,** which is one of our segments going to be discussed in the presentation[14].

Vocal Biomarkers / Chronic Diseases

Risks and Challenges:

- Difficulty in understanding the vocal signals of a human voice. The pitch and energy level signal methodology might have problems while filtering and analyzing the vocal cords and might misinterpret the results[15].
- If a person is likely to be detected as a mental depression patient but is a heart patient. This can cause problems in analyzing incorrect data points.
- There can be technical challenges faced while observing and examining the patient's health and can cause major injuries. For example: while identifying heart failure with the help of various biomarker techniques[16].

[14] (2018, April 21). Accessibility Came by Accident - ACM Digital Library. Retrieved April 20, 2020, from https://dl.acm.org/doi/10.1145/3173574.3174033

[15] (n.d.). Tue.SS4.06 Vocal-Source Biomarkers for ... - ISCA Speech. Retrieved April 20, 2020, from https://www.isca-speech.org/archive/archive_papers/interspeech_2012/i12_1059.pdf

[16] (2020, January 2). (PDF) Artificial intelligence supported patient self-care in .... Retrieved April 20, 2020, from https://www.researchgate.net/publication/337458760_Artificial_intelligence_supported_patient_self-care_in_chronic_heart_failure_a_paradigm_shift_from_reactive_to_predictive_preventive_and_personalised_care

- Due to the lack of physical interaction, the patient is likely to be diagnosed incorrectly as they are still machines that lack the human element[17].
- Inaccuracies in data and difficulty in understanding requests and nuances of human dialogue[18].

Group Research Response

Reviewing the available literature and research articles to know the extent up to which voice technology has been able to assist doctors and healthcare practitioners, we found some gaps and challenges in the existing technology. Voice data collection by these devices also poses a risk to Data privacy and ethics. We discussed and analyzed the implications of these challenges and figured out the ways in which these gaps can be filled. Currently, most of the organizations are working towards enabling and expanding their device's usage in multiple dimensions of healthcare before fixing the issues in existing technology. Below are the responses generated from the group's discussions and analysis on the ongoing usage:

Smart and Filtered intake of data

Voice data is different from the usual types of data as it informs about much more than what was said. It passes information about an individual's identity, sentiments, intent, surroundings, medical conditions, fitness. Machine learning and AI has also been used to get an idea of socio-economic and educational conditions from our intonations and dialects.

Organizations have been gathering and storing all the possible voice data like conversations with Voice Assistants, even though direct conversations with smart devices are also getting stored. Although to comply with the policies and laws of data privacy, they filter the data for usage. But sensitive data still exist in their databases. This data, if passed on to the wrong hands (intentionally or unintentionally), can result in misuse of information for marketing purposes, unethical surveillance, monetary losses, etc. To minimize this, voice technology can be used to warn and filter out data at the time of collection. During conversations involving sensitive information like bank account details, medical history, or personal details, the smart VA can ask the user to turn the device off or can pause the audio capture.

[17] (2018, February 1). Vocal markers of motor, cognitive, and ... - IEEE Xplore. Retrieved April 20, 2020, from http://ieeexplore.ieee.org/document/8273581/

[18] (n.d.). Observational Study - ResearchGate. Retrieved April 20, 2020, from https://www.researchgate.net/publication/327104795_Patient_and_Consumer_Safety_when_using_Conversational_Assistants_for_Medical_Information_Observational_Study_Preprint

Educating vulnerable sections (elderly + children) about Data privacy issues

Safeguarding voice data privacy in the healthcare industry is highly important, and any breach of privacy results in adverse impacts on the stakeholders. According to the researches, it has been found that most elderly and children disagreed from the risk of privacy and are of the belief that their medical data is valueless for the third parties for any potential misuse. This is because of the less understanding of the recent technologies and the risks posed by the malicious third party when they get access to user's highly sensitive health and medical data. Beliefs and perceptions change significantly for the privacy risks involved when the users are informed and educated about the ways in which their voice data can be misused.

Research on technology to understand discourse

Currently, conversational assistants have a limited capacity to participate in dynamic, mixed-initiative interactions as people do. For most instances, they operate by studying the principles of trial and error, but the instances of error cases are not often obvious. Further work and technology research is required to design these conversational assistants for safety-critical communication, which encourages natural language to be versatile and articulate while maintaining the integrity of any decisions made. Considering the most recent developments in voice technology (Natural Language Understanding), conversational health therapy assistants should not be programmed to use unrestricted natural language inputs even if it's in answer to an incredibly small request. Furthermore, consumers should always validate the recommendations given by any non-authoritative source with medical practitioners before following the advice.

Defence

This section talks about why we believe the areas identified must be researched, why it is important, and why others have failed to consider these aspects.

The reason why we are insisting on filtering the data at the source is because of the inherent philosophy behind cloud data storage. It is stored in multiple copies at various locations to ensure constant availability and reliability. This means that managing access control later is very difficult compared to not having sensitive data out there in the first place.

The second aspect related to children’s data is critical because, unlike us, they are Digital Natives and have a huge Digital footprint. As per dictionary.com, Digital footprint or digital shadow refers to “one's unique set of digital activities, actions, and communications that leave a data trace on the Internet or on a computer or other digital device and can identify the particular

user or device."[19] So they must necessarily be taught about privacy issues right from their formative years.

A lot of research is needed with respect to the trial and error method of using voicetech in healthcare. We must appreciate that healthcare deals with people's lives and even high accuracy levels aren't good enough for technology to be used as it might lead to fatalities or grave consequences.

Another critical aspect is with respect to usage of discretion in emergency situations like Covid19, where even HIPAA non-compliant technologies may be allowed[20] usage in healthcare due to facilities getting overwhelmed. Here we run the real risk of surveillance and information misuse by actors controlling the data.

Key questions to consider

Talking about why this is important, we need to answer a few questions before having voicetech as an integral part of the industry.

- ❏ Who owns the data we are capturing?
- ❏ Who manages the data?
- ❏ What are they allowed to do, and more importantly, what can't they do with this data?
- ❏ Who pays for the storage of such huge amounts of data?
- ❏ Is the patient information anonymised or are the commercial actors authorized to use the data later?
- ❏ Who would be accountable for any incorrect decisions taken by a machine if the diagnosis or prescription goes wrong?

Why is existing research limited?

Why others have failed to research more into these areas is directly linked to the costs they have to bear and the benefits they expect to reap from this research. A simple cost-benefit analysis of activities like stakeholder education or filtered data input would not yield profitable results for the commercial actors, who therefore discourage research efforts in this direction.

Also, the narrative built by companies around the usage of technologies is always about the benefits far outweighing the risks as few people understand how the data may be used far and

[19] (n.d.). Digital footprint | Definition of Digital footprint at Dictionary.com. Retrieved April 20, 2020, from https://www.dictionary.com/browse/digital-footprint

[20] (2020, April 2). Covid-19 and Health Care's Digital Revolution | NEJM. Retrieved April 20, 2020, from https://www.nejm.org/doi/full/10.1056/NEJMp2005835

wide. If they actually start to educate the users on risks and ethics around information privacy, they run the risk of weakening their own argument.

Another aspect is that healthcare is much more complicated than other industries like retail or consumer electronics. Unlike other industries, errors made by technology usage might result in customer grievance, but in case of similar errors made in healthcare, the legal aspects may be catastrophic for the organization.

Conclusion

Medical practice has always employed technology to improve its productivity and effectiveness. In order of time, the last chapter of this relationship reflects artificial intelligence. This technology seems to guarantee ever more personalized medicine and, hopefully, free of human error. The implementation of voice assistants using NLP and AI in e-health, therefore, offer some positive outcomes, while shielding bleak scenarios. In this respect, the law plays a key role in allowing a methodology to be regulated in a "human" way that could potentially lead to dehumanization phenomena[21].

Ideally, in voice assistants, the voice data is typically converted to text, mainly because (i) the required storage capacity for text is comparatively less than voice, and (ii) it is easier and efficient to mine and extract the text data. Since voice assistants are voice-enabled and connected via the internet, they can be used as a part of a spoken message between the patients and the doctors[22]. All the voice assistants like Amazon's Alexa, Apple's Siri, and Google Assistant follow the ideal flow of voice to text conversion via the speech recognition server, further sending the text content of the patients on storage servers where they are made accessible to the healthcare providers for analysis. The healthcare voice data is categorized as a very rich, sensitive and private type of data, i.e., useful voice-specific information such as voice, volume and pitch is given, and this richness cannot be preserved in speech recognition thus invading the privacy of the patient[23]. We suggest the use of embedded chips in the design, which filters the data at the source of its collection, thus ensuring that the data is encrypted before making it available to the healthcare providers, and no personal voice data is stored on the cloud.

In the case of elderly patients, voice recognition software can help keep the prescription schedule in line. However, it can be difficult to take care of the medications, whether it's getting

[21] Guarda, P. (2019). "Ok Google, am I sick?": Artificial intelligence, e-health, and data protection regulation. BioLaw Journal, 2019(1), 359–375. https://doi.org/10.15168/2284-4503/369

[22] Hadian, M., Altuwaiyan, T., Liang, X., & Li, W. (2019). Privacy-preserving voice-based search over mHealth data. Smart Health, 12, 24-34. https://doi.org/10.1016/j.smhl.2018.04.001.

[23] Forsberg, M. (2003) 'Why is Speech Recognition Difficult?', *Technology, (March),* pp. 1–10.

them filled or remembering which ones to take and at what times. With unconstrained natural language interfaces, general-purpose voice assistants are limited in their ability to advise on both the safety-critical health prompts and lifestyle prompts.[24]

The recent outbreak of coronavirus shows why voice assistants can respond to health with accuracy and use. An unscientific experiment asking voice assistants about the disease found that they had been using reputable sources such as the World Health Organization for their responses. However, questions about accuracy meant that Google Assistant had to hastily delete a bunch of fact sheets and quizzes on coronavirus from its voice app store. The same level of treatment and accuracy in other main health problems will probably be part of the potential growth of voice assistants as more people view them like personal physicians.

Aarogya setu app designed with the concept of privacy-first by design is a Bluetooth-based COVID-19 tracker launched by the Government of India which tries to determine the danger based on the location of the user and keeps them updated in case they have crossed paths with the positive COVID-19 case within 6 feet of proximity[25]. There is a high likelihood of finding a pattern in the way a person speaks using voice biomarker research in viruses such as the Coronavirus, which harms the respiratory system[26]. By implementing voice tech in the Aarogya setu application, researchers may use the data to develop automated vocal coronavirus testing, an integral part of limiting disease spread. The more data you collect, the more accurate the resulting algorithm would be.

Technology is progressing rapidly, but the threats are progressing just as quickly. It provides specific opportunities and risks to ensure the security, honesty, access, and non-repudiation (identity authenticity) of information. While the perimeter protections have fallen down, cyber attacks have become more complex, persistent, and impactful. But at the same time, it is important to remember that attacks are not inherently more sophisticated, but it is the low-level, easier-to-see, shear number that targets users that increase vulnerability. Traditional security mechanisms, such as strong, complex passwords (when used), simply become inadequate for

[24] Kocaballi, A. B., Quiroz, J. C., Rezazadegan, D., Berkovsky, S., Magrabi, F., Coiera, E., & Laranjo, L. (2020). Responses of Conversational Agents to Health and Lifestyle Prompts: Investigation of Appropriateness and Presentation Structures. Journal of Medical Internet Research, 22(2), e15823. https://doi.org/10.2196/15823

[25] Javaid, A. (2020). Aarogya Setu App: What is it, its benefits, how to download and more. Jagranjosh.com. Retrieved 19 April 2020, from https://www.jagranjosh.com/general-knowledge/aarogya-setu-app-1586848268-1.

[26] Pitts, P., & Louet, H. (2020). How irrational exuberance over AI could backfire - Opinion - MM&M - Medical Marketing and Media. MM&M - Medical Marketing and Media. Retrieved 14 April 2020, from https://www.mmm-online.com/home/opinion/how-irrational-exuberance-over-ai-could-backfire/.

the wired world of modern times[27]. Keeping all the privacy risks and ethics in mind, it is necessary to adopt privacy first by design principle and create awareness among the users regarding the use of health data as privacy, data security, and informed consent are integrally related, both from the safety and compliance standpoints.

[27] Barbara L Filkins, S. (2020). Privacy and security in the era of digital health: what should translational researchers know and do about it?. Retrieved 18 April 2020, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4859641/

Activity Log

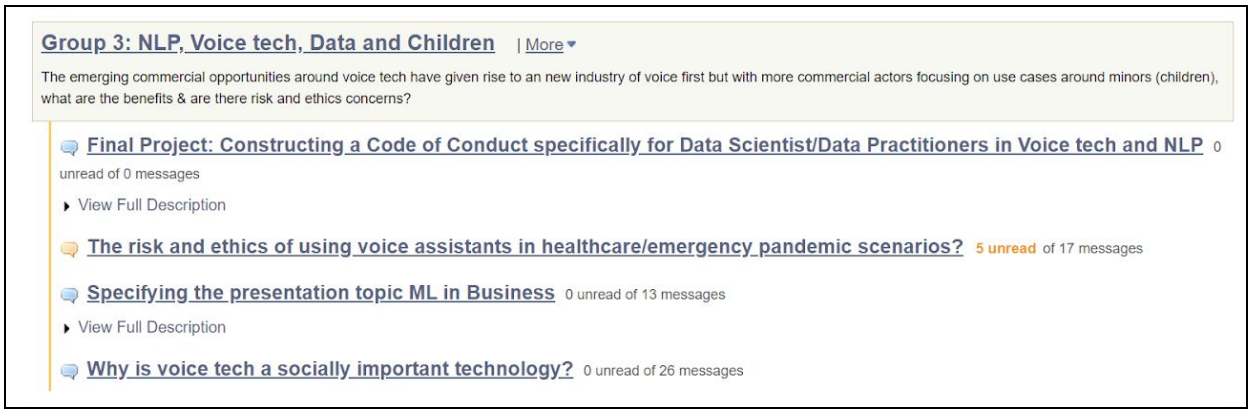
We followed three aspects of group collaboration in our team working as we were working in physical isolation and across different time zones while being located on multiple continents. The various tools used to this end are listed and described below.

- **Sulis Forum:** Discussion and engagement among team members by using text posts and points of view
- **Trello:** Online collaboration board for sharing content, links, images, etc. in real-time
- **Skype:** Video conferencing to replace scheduled and unscheduled face to face meetings
- **Twitter:** Sharing tweets on the twitter regarding research to help the team
- **Google Drive:** Google Docs and Google Slides to prepare the final report and presentation while checking real-time updates and version changes

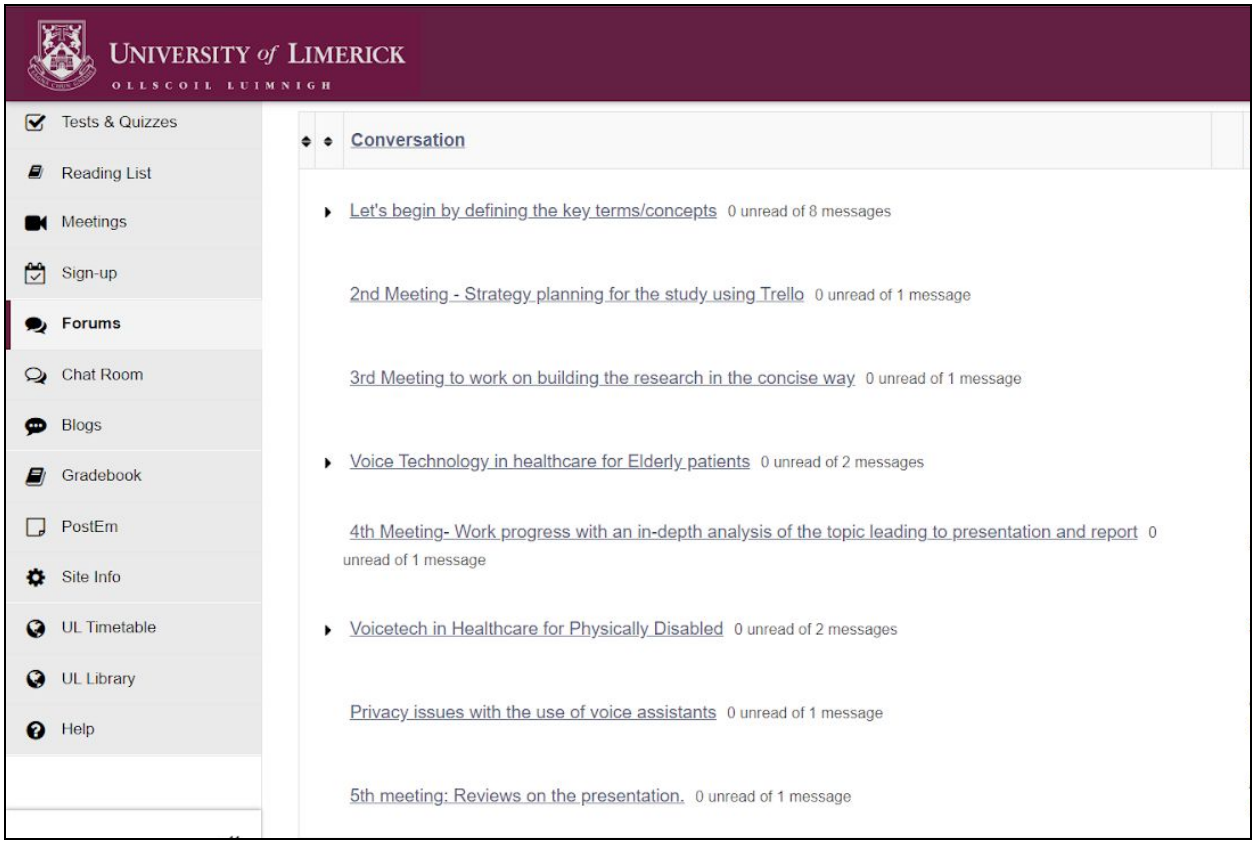
Sulis Forum

We started to discuss the topic broadly on Sulis Forum and took a top-down approach to gradually narrow down to the final topic, with ongoing moderation from the module leader. It was also used as the platform to publish minutes of meetings after conducting every Skype video conferencing meeting.

Sulis Forum overall snapshot



Minutes of meetings log



Sample Minutes of Meeting

Hi Team,

As discussed in our kick-off meeting today, we have decided on the following course of action.

Date and Time: 28th March 2020, 1200 hrs to 1250 hrs

Attendees: Samruddhi, Swasti, Aishwarya, Abhishek, Sumit

Minutes of Meeting

Sl. No.	Point of Discussion	Plan of Action	Responsibility
1	We would need an online collaborative software to keep sharing ideas and progress with the team in a real-time as members are unable to meet physically.	To identify a suitable software by 29th March	Collective
2	We need to do secondary research on five core aspects of healthcare - Doctors, patients, labs, pharmaceuticals, insurance from Voicetech perspective	Share all the relevant case studies, articles, research papers by 30th March	Collective
3	We need to identify the key researchers in this area and question them	Find them on Twitter/LinkedIn and ask questions, but inform the team so there is no repetition	Collective
4	We need to identify the major gaps in the studies and research undertaken in the field of using Voicetech in Healthcare	Share all the identified gaps by 30th March	Collective
5	We Need to take up sub-topics for in-depth research as individuals to have a well-rounded study	Each team member to decide on a sub-topic for going into deeper research by the next meeting on 30th March	Collective
6	In everything we are studying, the most important aspect is the ethical angle of the technology in use and the risks involved in terms of privacy or safety of all the stakeholders involved.	All the above points to be looked at and acted upon from Ethics and Risk perspective	Collective

As discussed, the agenda of the next meeting on 30th March would be to come back with initial research, pin down the exact areas of further research, and identify areas for deeper study so individual responsibilities may be assigned to all team members.

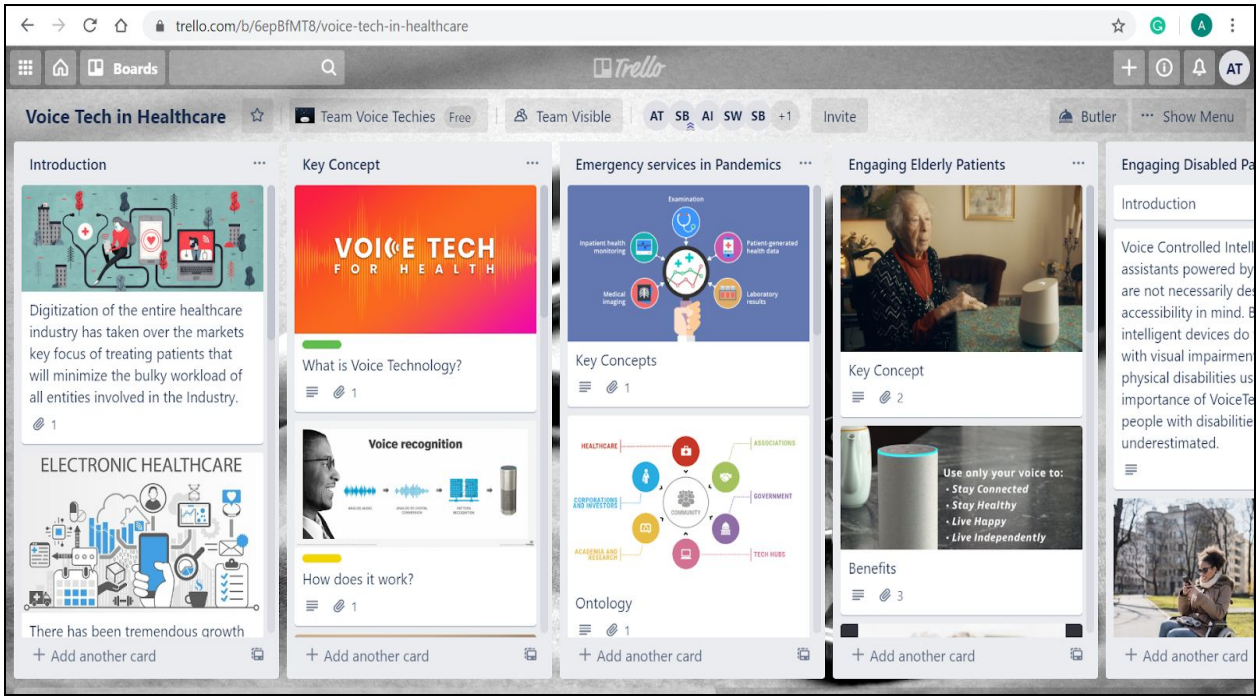
Attached is a picture of the meeting as a souvenir for the strange times we worked through.

tempImage.jpg

Trello

After zeroing down on the research topic, we listed down various aspects related to Voicetech in Healthcare viz. Emergency services, Elderly patients, Disabled patients, Voice biomarkers, etc. and decided to take up a topic each for in-depth research. Trello board was used to create separate cards for each concept wherein the team members could share and look at others' work as well in real time.

Trello board snapshot



Skype

Apart from text collaboration, it was critical to have face to face meetings. Since it was not possible physically, we used Skype for the same. We conducted 5 scheduled meetings lasting between 60-90 minutes each, apart from a few unscheduled meetings to touch base with the team. All MoMs and respective pictures have been updated on Sulis at the end of each meeting.

Skype meetings

Twitter

Social media platforms like Twitter helped us to collect the ongoing research on our topic and collaborate them on the forums to engage effectively.


Aishwarya Inamdar @AishwaryaInamd1 · Mar 27
Israeli Voice Tech Startup Vocalis Launches Coronavirus Test Study | Health News nocamels.com/2020/03/israel...
@EmergTechEthics @Samrudddhi97 @BhagatSwasti @ajihaan @sumit_1012 #IN6062
Israeli Voice Tech Startup Vocalis Launches Coronavirus Test Study | Heal...
Vocalis developed an AI-based platform that uses voice recordings to monitor health and will use its resources to find a unique vocal ...
nocamels.com
2
9


Abhishek Tomar
@ajihaan
CoronaVoiceDetect is soliciting people to record their voices for an eventual open-source dataset and potential voice test for #COVID19. Can they keep the data anonymous though?
@EmergTechEthics @BhagatSwasti @Samrudddhi97 @sumit_1012 @AishwaryaInamd1
Corona Voice Detect
Corona Voice Detect - Voca
voca.ai
6:21 PM · Mar 28, 2020 · Twitter Web App

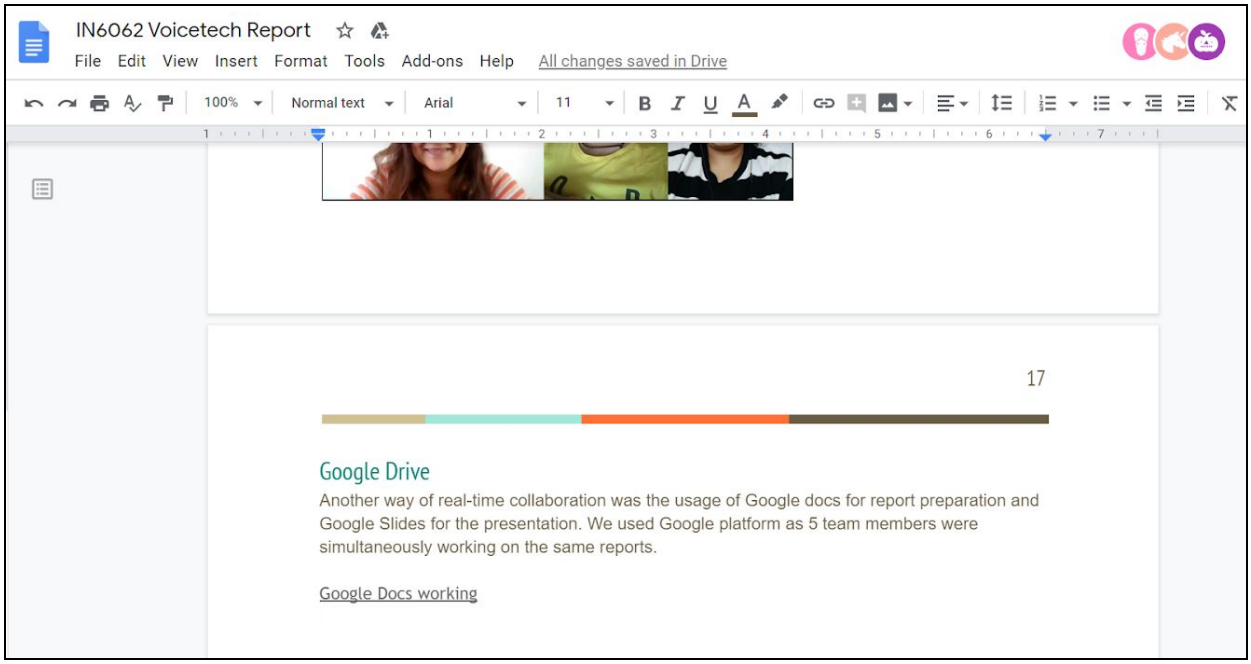

sumit bhadauria @sumit_1012 · Mar 27
Voice chat assistants' evaluation 2 recognize a crisis, respond wid respectful language & refer d user 2 appropriate helpline or resource, resultd in significant inconsistency & gaps of knowledg in d conversational agents
med.stanford.edu/news/all-news/...
#IN6062 #MK6102
@EmergTechEthics
Hey, Siri, I'm depressed
A new study found that telephone conversational agents often failed to provide appropriate information when asked questions about ...
med.stanford.edu


Samruddhi
@Samrudddhi97
Voice Technology in Hospitals Brings Benefits And Risks. #voicetech #healthcare #in6062 #mk6102 @EmergTechEthics @FuturesUI @ajihaan @BhagatSwasti @AishwaryaInamd1 @sumit_1012
Must watch the video as well...
Voice Technology In Hospitals Brings Benefits And Risks For Patients
newsy.com
8:15 pm · 26 Mar 20 · Twitter for Android

Google Drive

Another way of real-time collaboration was the usage of Google docs for report preparation and Google Slides for the presentation. We used Google platform as 5 team members were simultaneously working on the same reports.

Google Docs working



Closing Remarks

Overall, it was a highly collaborative and interactive team effort wherein right from the team formation, to topic finalisation, and from multiple brainstorming sessions to the final project delivery, we worked as a cohesive unit with a common goal. This reflected in insightful forum discussions (**56 posts**), deep Skype meetings (**5 scheduled and 4 unscheduled meetings**), plethora of content on Trello board (**31 cards**), apart from the unquantifiable discussions on WhatsApp forum used for ongoing discussion not captured on the above platforms.