Providing Patient Home Clinical Decision Support using Off-the-shelf Cloud-based Smart Voice Recognition

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Abstract

The paper examines the feasibility of a cloud-based voice recognition technology, as the means to delivering structured home care, using clinical decision support, to complement more traditional care delivery methods (human caregiver). The feasibility study has used a cloud-based voice recognition service provided by Amazon Echo, on top of which a custom application was developed. The application is able to receive voice-based input by the patient, and perform simple clinical decision support algorithms.

Introduction

In recent years, there has been the impetus for patients to self-manage their healthcare, for both physical and mental health issues. Advances in the way humans interact with computers, such as gesture and voice recognition, has allowed easier modes of interaction with IT applications, requiring very little technical skill. Furthermore, the evolution of mobile computer devices (e.g. mobile phones), has provided a platform for integrating sensors, as well as running applications personalised to the user[1,2]. This has enabled some patients to become increasingly responsible for the self-management of aspects of their care, for a number of aspects of managing their conditions, such as reaction to a suggested care plan, and such as reporting on their wellbeing or adhering with their prescribed medication regimes. Monitoring of adverse trends provides opportunities to trigger early interventions and thereby prevent further deterioration that may otherwise require expensive clinical treatment through traditional primary and secondary care pathways. This kind of home monitoring and clinical decision support has shown promise for use in mental health. For example, in the case of mental health patients receiving social care support in their home, implementing self-reporting solutions of medication compliance, has enabled some patients to adhere to their medication and gain further independence (direct benefit); whilst releasing healthcare professionals' time (indirect benefit) to work with those patients that require intervention[3].

Methods

Provision of clinical decision support to home care was implemented by developing a custom application, using the Amazon Echo service. Amazon Echo provides a voice

recognition interface, using a Wi-Fi connected device, consisting of a speaker and microphone. The study tested technical feasibility, hence privacy and security were not within the scope. Figure 1 gives an overview of the steps of integrating this service with a custom CDS application. Initially the patient activates the device, by voice. The application then guides the patient, through the various options of the offered functionality.

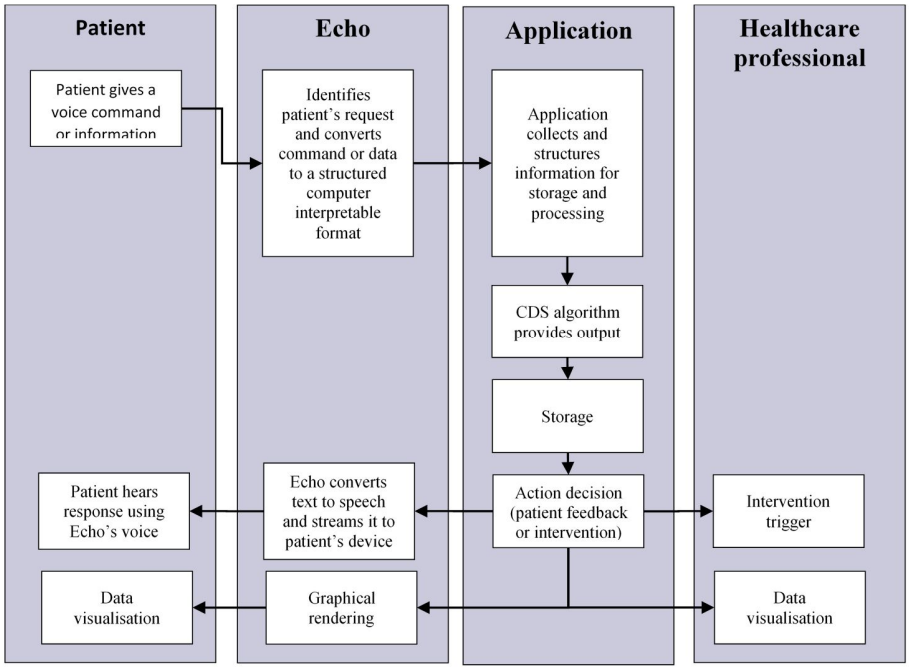

Figure 1 – Overview of the operation using the Amazon Echo service

Each time the patient will talk to the device, it will upload the recording to the service's cloud where the voice will be recognized and converted into a format that can be understood and processed by software. During this process, information is converted to data (e.g. measurements converted from voice to numbers). The converted input is then used by the custom application, which passes the data through the CDS algorithm, and stores them to a database in a format facilitating further use (such as use by EHR). The application will then decide on whether to give the patient any feedback (e.g. in the case of compliance with medication, further tailored prompting), or trigger interventions (e.g. contact additional assessments or contact family or other healthcare professionals such as social worker or a specialist). If necessary, the application can also offer visualization (dashboards) of data to complement the feedback given to the patient, or the information offered to a healthcare professional.

Results

The study resulted in an operational proof of concept. An application was developed that managed to successfully deliver a number of CDS functions to the patient. The prototype includes the following functionality that has been considered the most common types of home based CDS, based on literature: a) a function asking the patient for an assessment of their well-being (phrased as "how do you feel today?"). The function can understand a number of potential responses, which are then are automatically transformed into a metric capturing the various levels of the patient's response. The function is able to detect unexpected changes in mood, as well as a trend based on the last responses. The patient then is offered further advice (e.g. to contact their doctor). b) A second function implements

an assessment of BMI as well as diabetes risk. This has been added to demonstrate the ability of this system to deliver commonly used clinical algorithms and criteria. c) The prototype allows self-quantification by being able to record a number of data that can be collected by the patient, such as weight, exercise levels, heart rate and blood pressure. The data is stored so that, if the patient permits, the data can be accessed by their doctor. d) Finally the prototype can prompt a patient to take their medication using natural language tailored to promote compliance and ask the patient whether they have taken their medication, in order to record adherence.

Discussion and way forward

Early observations demonstrate convenience as expected by literature. Ease of entering measurements can offer rich data to calculate clinically relevant trends and criteria Self reporting using natural language processing is of particular importance to those patients that require personalized human (or pseudo human) engagement and do not have the confidence or the will to utilise traditional paper or mobile application reporting methods. A situation that is prevalent in the certain demographics and sectors of mental health patients. Future work will systematically analyse a complete mental health service, including all potential workflow branches and implement it in Amazon Echo to reduce the reliance upon data collection and low-value engagement by support workers. It is envisaged that by enabling data collection of a broad range of physical and mental wellbeing metrics, together with behavior and environmental metrics, using natural voice processing and sensor and mobile technologies, a more holistic and nuanced digital picture of a patient's wellbeing can be recoded. Future functionality of the prototype could include a more complex analysis and action algorithms (e.g. comparison of patient reported information with prescription data) and integration with other SMART equipment such as body weight and BMI scales.

Conclusion

Voice commanded clinical decision support can be used to facilitate self-management of healthcare. There are numerous issues remaining following this initial technical feasibility study, such as reliability of data, security, privacy and safety of the devices as well as the efficacy of the device across different healthcare segments. However, this study shows promising results in terms of patient benefit, which if verified by the future work planned, will offer a cost effective approach to the health system.

References

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