**Chapter 1 Introduction**

The Electronic Health Record (EHR) serves as a collection of patients’ health record and health status throughout their whole life for clinical purposes. It is a computer information system which can support data collection, storage and access in both hospitals and healthcare centers to uniform the medical record format [1]. Artificial Intelligence (AI) has been commonly implemented into many fields in daily life and can be used in EHR form filling process. This chapter will introduce the background and motivation of this project, and outlines the aims and objectives of the work.

**1.1 Background**

Comparing to traditional paper records, EHRs offered advantages such as remote data access, unified data standard, searchable digital database and integrated patient records including medical history [3]. The Chinese government, as well as Ministry of Health (MoH) of China, had regarded EHR as an efficient tool to improve the safety and quality of Chinese health care service and set a goal to ensure the universal usage of EHR among the whole population in most of the hospitals and clinics by the end of 2020 [2]. A research taken by Jennifer King demonstrated that over 75% of EHR adopters identified that EHR enhanced the health care service [4].

EHRs offered more efficient entry and retrieval of relevant patient information. However, a potential weakness of EHR is the discommodious input interaction using traditional keyboard and mouse. The maximum number of words per minutes (WPM) was 80, when concentrating on typing [4]. A 2016 study estimated that doctors spent between 37% and 49% of their working hours on clerical tasks [5]. Doctors were overwhelmed by this clerical work and had a great possibility to make serious mistakes by typing manually under this circumstance [6]. All that paperwork contributed to the high level of burnout and depression in the profession, according to a 2018 study [3].

To resolve the shortage of traditional computer systems such as EHR, which require tedious and numerous manual processes, Artificial Intelligence (AI) has been implemented into many aspects of human daily lives, especially in clinical workflow [7]. It shows its influence on clinicians, health systems and patients since it produces accurate image interpretation, reduce manual errors and provide high accurate health diagnosis. [8]. Voice Recognition, Natural Language Processing (NLP) and Deep Learning methods are well developed and comprehensive. These mechanisms can contribute to support doctors when generating EHR forms. With reduced clerical working load, doctors can be more concentrate on diagnosing patients. This will have a high probability to achieve higher accuracy and higher efficiency.

**1.2 Motivation**

To solve the inefficiency of current situation of traditional input of EHR system, voice assistant can serve as clinical stenographers that transcribe doctors’ observations and instructions and insert them into a patient’s EHR [3]. After all relative information are extracted, possible diseases analyzed by a deep learning model can be listed to reduce the probability of misdiagnose. With the assist of this automated report generation system, it will liberate doctors from tedious clerical work and improve the accuracy and quality of EHRs.

As the practice of voice recognition in the past 10 years, the accuracy of the outputs is not ideal. A research in 2010 implemented a voice recognition method and compared result with the manually translated content. The average accuracy was less than 82%, with 6.1% of incorrect recognition and 11.2% of rejected voice [9]. Even though speech averages about 110-150 Words Per Minute (WPM) and typing is only about 40 WPM, due to the poor performance of voice recognition system, 70% of extra time was required to correct errors [3]. At present, with the development of the machine learning, plenty of voice recognition methods or pretrained models were provided with a higher accuracy, such as Google voice recognition Application Programming Interface (API) [10] and Baidu voice recognition API [11]. Combined with noise reduction algorithm to obtain a clear voice input, the accuracy would achieve near 99%, if the speech was made clearly.

Apart from voice recognition methods, an approach was necessarily required to allow machine to derive meaning from human languages, as well as decompose a sentence into independent words. Many Natural Language Processing (NLP) studies had been conducted and developed to analyze the Part of Speech (PoS) and the meaning of languages. Tested by Che et al. [12], a sufficient accuracy and speed have been attained in some of Chinese processing modules, including WordSeg (97.4% of accuracy, 185KB/s of speed), POSTag (97.80% of accuracy, 56.3KB/s of speed), NER (92.25% of accuracy, 7.2KB/s of speed) and so on. With a further training on an additional dictionary containing specific disease names and medical drug names, it can be perfectly adapted to medical segmentation analysis.

Despite of all the benefits listed above, EHR adoption in China has low prevalence as well as low quality. Nearly 30% of hospitals are still using handwriting medical records without the use of computers and another 30% only have the basic functions of EHR [1]. The application delivered in this project has high possibility to improve the efficiency and quality on processing these clerical works. However, there are numerous hospitals and health-care centers in China. High installation fee, high training cost and inefficient popularization from main hospital to tertiary hospitals are remaining obstacles [1]. In addition, the number of research conducted on EHR in China is much lower than researches in the USA. During 2008-2017, there are 1031 publications on EHR in the USA while there are only 173 publications in China [13]. Research on EHR is a relatively new emerging and promising field in China. This project mainly aims to explore the feasibility of implementing voice recognition methods (speech to text), NLP methods (text analysis) and deep learning methods (disease prediction) in Chinese EHR System (CEHRS) to contribute to EHR in medical field.

**1.3 Aims and Objectives**

The main objective of this project is to create an auto-filling system using voice recognition to reduce the working load of doctors. Using this system, the speech of doctors should be able to be recognized and analyzed to fill into the EHR form at the same time when doctors are diagnosing the disease of patients. After that, the system should provide a preliminary prediction of possible diseases from extracted information. In this way, doctors can save those time spent on writing clerical documents or typing in digital records and be more focused on diagnose. The system needs to be capable of translating real time voice input or audio files into plain text and process and analysis the key points to fill in the electronic health record (EHR). In other words, the system is an automated report generation system can serve as clinical stenographers that transcribe doctors’ observations and instructions, insert them into a patient’s EHR and provide basic and simple disease predictions.

The key objectives of this project are:

1. Collection of diagnose prescription from doctors for testing the feasibility and accuracy of the system.
2. Voice recognition methods implementation for transcribing doctors’ speech into text.
3. Chinese language processing algorithms implementation for analyzing the text and fill in the EHR. Together with objective 2, it can allow doctors use voice as input instead of keyboards and mouse.
4. Assessment of different voice recognition methods and different Chinese language processing algorithms for achieving higher accuracy.
5. Basic and simple prediction function of possible diseases using deep learning methods.
6. Development of prototype to demonstrate the proposed work for simulating the realistic situation.