Prospectus

Improving the Ergonomics of GI Endoscopes

(Technical Report)

Infrastructures and Trust of Chinese Telemedicine

(STS Research Paper)

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Colorectal cancer is the 3rd leading cause of cancer-related deaths in the United States, and in the current standard of care, colonoscopy is the only procedure capable of screening for colorectal polyps and cancers (Marley & Nan, 2016). In the United States alone, approximately 19 million colonoscopies are conducted by gastroenterologists every year and serve as the primary diagnostic tool to identify these otherwise undetectable gastrointestinal pathologies ("An astounding," 2018). Cohen et al., (2006) found that gastroenterologists in the United States often must perform an average of 22.3 colonoscopies per week (p. 968-967). A high frequency of colonoscopies has often led to De Quervain's tenosynovitis of the practitioner's left thumb, amongst other related repetitive strain injuries, which is caused by the repetitive "abduction and extension of the thumb to manipulate the dials" of the endoscope (Harvin, 2014, p.591). My technical project aims to improve the endoscopy ergonomics of the modern scope, which not only reduces the risk for repetitive strain injuries (RSI), but also offers a solution to improve the quality of life for the physician.

In my STS thesis, I will shift gears and focus on the social context of Chinese telemedicine. Telemedicine, a subsection of smart health based on telecommunications technology, allows the provision of healthcare and the interaction between patients and healthcare providers over a long distance. In recent years, there has been a growing amount of interest in developing and adopting telemedicine frameworks due to the increased recognition of its benefits (Hailey, Roine, & Ohinmaa, 2002, p.118; Mantas & Hasman, 2013). In this growing field, the United States, Japan, and China are the three industry-leading markets, with China on pace to overtake the rest of the world in the telemedicine market due to its fast growth (Trinh & Zamanian, 2017; 无锡情报所, 2018). In a unique country of China, many different social, technological, and political factors are in play to promote this fast growth altogether. In this STS thesis, I aim to thoroughly analyze how the relevant stakeholders interact to shape the overall development and public perception of Chinese telemedicine under the Social Construction of Technology (SCOT) framework.

TECHNICAL PAPER: IMPROVING THE ERGONOMICS OF THE ENDOSCOPE

Gastroenterologists who frequently perform a high volume of colonoscopies risk musculoskeletal overuse injury due to the mechanical challenges posed by operating the scope. Current endoscopes often require the physician to use their left thumb and forearm muscles to exert and sustain forces on a system of dials to control and maintain its position of the scope during the procedure. The current design allows the physician to deflect the distal end of the scope so that the tortuous bends of the gastrointestinal tract can be navigated (K. Chang, personal communication, September 25, 2019). The repetitive abduction and extension of the left thumb often leads to De Quervain's tenosynovitis which accounts for 19% of common musculoskeletal overuse pathologies affecting up to 89% of the colonoscopists surveyed (Byun et al., 2008). Though various strategies have been proposed to address these issues include self-propelling scopes (Vucelic et al., 2006), joy-stick controlled scopes (Woo, Choi, Seo, Kim, & Yi, 2017), and robotic systems (Lee & Chung, 2013), highly-skilled gastroenterologists are reluctant to exchange their years of experience and training operating the dials on the traditional endoscope for the sake of learning an entirely different system.

Many studies that attempt to identify the root cause of these musculoskeletal injuries find that poor ergonomic design of the modern endoscope is a likely risk factor. There is a strong hypothesis that hand injuries resulting from the practice of colonoscopy are caused by some combination of the following three risk factors: prolonged strain on the thumb, repetitive action

of the thumb, and high forces being exerted on the thumb to operate the dials (Harris-Adamson et al., 2015, p. 33). Shergill, Harris-Adamson, Lee, McQuaid, & Rempel, (2016) found over a cohort of 12 endoscopists that while they were performing colon insertion, their hands exerted an average peak thumb force of 15 Newtons (N) on the left thumb and spent 17% of their procedure time exerting high pinch forces above 10 N (Shergill et al., 2016). A separate study also found that those with occupations that require them to spend more than 11% of their work exerting high pinch forces increased their risk of overuse injury (Harris-Adamson et al., 2015). Therefore, this technical project aims to address this problem by reducing at least 2 out of the 3 identified risk factors that frequently lead to repetitive strain injuries. By putting the health of the physician first, our team aims to potentially reverse any loss of productivity from endoscopy-related injuries, allowing more patients to be seen in a day and streamlining the patient experience in the endoscopy suite.

UNDERSTANDING AND APPLYING ERGONOMICS TO ENDOSCOPY

The technical project will involve the design of an experiment and the design of a device solution. The experimental approach will prioritize validating the underlying cause of musculoskeletal injury in endoscopists by evaluating the left hand activation of the muscles associated with the abductor pollicis longus (APL) tendon and the extensor pollicis brevis (EPB) tendon as well as the forces exerted by the thumb while performing a colonoscopy. The study will compare data collected before and after the implementation of our proposed design. The experiment may require Institutional Review Board (IRB) approval to gather a cohort of endoscopists for the experiment. These endoscopists will be tasked to perform a simulated colonoscopy on a training model of the colon commonly used in gastroenterology fellowships. During the procedure, force sensors and electromyography (EMG) will be used to measure the force exerted by the thumb and the muscle activity in the hand, respectively. Insights gathered in this study will help guide the device design phase.

The space used to conduct research on hand muscle activity and force exertion for the first phase of the technical project has yet to be determined, but will ideally take place in an endoscopy training suite that supplies a model colon capable of simulating a colonoscopy. Muscle activity will be measured using the BioRadio electromyogram (EMG), and the forces exerted by the thumb will be measured using a force sensor. The technical advisor, Professor William Guilford, has generously provided access to a three-dimensional (3D) printer, as well as an estimated budget of $4,000, so that prototypes from the second phase of the technical project may be produced and iterated. By the end of the year, the technical project team hopes to produce a working prototype that alleviates these musculoskeletal overuse injuries for the physicians, followed by a technical paper publication on the comparative study elucidating the efficacy of our proposed design.

STS THESIS: INFRASTRUCTURES AND TRUST OF CHINESE TELEMEDICINE

INTRODUCTION & BACKGROUND

Telemedicine, under the recent Healthy China 2030 blueprint, is at the center of China's focus for development and innovation (Tan, Liu, & Shao, 2017). In March 2019, with the world's first 5G-powered remote brain surgery on a human patient performed in China, this vision of improving healthcare through telemedicine is now becoming a reality (CGTN, 2019). In this groundbreaking milestone, with the newest developments in 5G technology and infrastructure, doctors were able to control robotic arms from 3000 km away with micrometer precision and almost zero lag. The innovations in telemedicine are very exciting in that they serve to help improve patient accessibility to healthcare as well as hospital efficiency, which embody the future of healthcare.

Even though telemedicine brought enormous benefits to the healthcare field, many unforeseen issues also surfaced. Many policy makers are still debating on issues of hospital administration, data security, physician-patient interactions, as well as ethical concerns including patient privacy. Perhaps one of the biggest issues facing Chinese telemedicine is the issue of public trust. As reported by the Los Angeles Times, many Chinese patients distrust China's healthcare system altogether, and they turn to telemedicine apps that connect them instead to US doctors (Meyers, 2018). Without public trust in the system, Chinese telemedicine will encounter many roadblocks before widespread acceptance.

Therefore, it is important to develop an understanding of public trust of Chinese telemedicine, which is another research question in my STS thesis. Behind the rapid development of Chinese telemedicine, many relevant social, technological, and political infrastructures, as well as ethical concerns, must be in place for the realization of this nation-wide initiative. For example, technological innovations such as 5G broadband network are pivotal in driving the advances in telemedicine. However, without the government's push in implementing the necessary legislations, the achievements in telemedicine cannot be reached. To dissect this complex socio-technical system and analyze these relevant infrastructures and stakeholders, I will adopt the Social Construction of Technology (SCOT) framework to fully comprehend the factors that contribute to the development of Chinese telemedicine.

LITERATURE REVIEW

Since the 1980's, telemedicine has been explored in China, which paved the way for today's innovations. Z. Wang & Gu, (2009) outlined many milestones in the history of the development of Chinese telemedicine. The first telemedicine networks were telegraph and email-based systems, where information must be stored and then transmitted. Gradually, as technology started advancing, telemedicine networks started migrating towards the internet, satellite, wireless systems, and later, mobile phone-based systems. Evidently, China has decades of history developing telemedicine, which played an important role in setting up systems and infrastructures seen today.

In recent years, the government has announced multiple legislations to push for the development of Chinese telemedicine. In October of 2016, the "Healthy China 2030" blueprint was released, which placed the development and innovation of healthcare as a priority in policy implementation (Tan, Liu, & Shao, 2017). Two years after Chairman Xi made this announcement, Premier Li went on to reinforce the initiative by promoting "Internet Plus healthcare" in April of 2018 (Xu, 2018; 国务院办公厅, 2018a). In the same year, the National

Health Commission released three "Measures" regarding the administration of internet-based diagnosis and treatment, internet hospitals, and telemedicine, which serve to be the major driving force for the future development of Chinese telemedicine (K. Wang, 2018; 国务院办公厅, 2018b). In my future research, I will continue to discover the impact of these policy infrastructures.

To thoroughly contextualize the social construction of Chinese telemedicine, one must achieve an understanding of all the stakeholders involved with the issue. Zhan, Lin, & Wang, (2011) identified five main stakeholders in the development of Chinese telemedicine: patients, medical professionals, government agencies, vendors for telemedicine technologies, and educational institutions. In their analysis, each stakeholder possessed a unique perspective that contributed to their support/opposition of telemedicine. This stakeholder analysis provides a solid foundation for my analysis of the factors at play in Chinese telemedicine, and I will further the research of Zhan et al., (2011) by analyzing these relevant infrastructures using the SCOT framework.

The issue of public trust has not been extensively studied in the field of telemedicine. However, similar studies exist that explore factors that contribute to its implementation. Broens et al., (2007) identified 5 key criterias that influence the development of telemedicine: technology, acceptance, financing, organization, and policy and legislation, but trust was not specifically spelled out. Another approach was probing for the satisfaction rate of users. Cai, Wang, Guo, & Bao (2016) conducted research on the satisfaction rate after implementation of telemedicine in Gansu Province, a poor, mountainous region with a low level of access to healthcare. Through surveys and questionnaires, the authors were able to collect primary data on the satisfaction of patients, physicians, and healthcare administrators upon using telemedicine platforms. Cai et al., (2016) provided a great methodology in gauging the satisfaction rate of telemedicine in Gansu. In my research analysis, I plan on adopting similar surveys and questionnaires in my study of public trust of Chinese telemedicine.

RESEARCH METHOD & PLAN

The STS research project will involve three specific research methods: SCOT analysis, interviews, and surveys/questionnaires. To study the social, technological, and political infrastructures that aided the development of Chinese telemedicine, I will combine further literature review with analysis under the SCOT framework to break down the relevant stakeholders involved, and their social interests in shaping the design and implementation of Chinese telemedicine. My analysis will be focused on two specific case studies. I will study Chunyu Doctor, the largest telemedicine platform in China, to find out characteristics that led to its large user base and public acceptance. I will then study Alibaba's ET Medical Brain, an innovative and transforming service that incorporates AI and Big Data to improve healthcare, to gain the perspective of a larger scale city-wide implementation of a telemedicine service. To study the public trust of Chinese telemedicine, I will conduct interviews with Tsinghua University and Zhejiang University students as well as sending out surveys to the relevant stakeholders through Prof. Ku's connections in China. Based on my research findings from studying the infrastructures and public trust, I will also attempt to make a connection between the two topics.

In terms of project timeline, I plan to finish the analysis on infrastructures by mid-February. Surveys will be distributed among the Chinese participants by the end of January to allow for maximum response time. Data collection for surveys and interviews will be performed

throughout the semester. Ultimately, I wish to complete the data collection and analysis by mid-March, will leave me plenty of flexibility to finish my thesis on time.

CONCLUSION

Under the Healthy China 2030 blueprint, the development of telemedicine and smart health rose to the forefront of the innovations in Chinese healthcare. Under the framework of SCOT, I aim to break down the relevant socio-political infrastructures' impact on this fast growth of Chinese telemedicine as well as the public trust of such new technologies. In this STS thesis, by situating Chinese telemedicine in its proper social context, I will help achieve a more holistic understanding of the overall development of telemedicine in China.

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