Fall Risk Classification Among Seniors

(Technical Paper)

E-Waste Management: An Analysis of The Transition of E-waste Management in China

(STS Paper)

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

The advancement of newly developed technology in data science allows for unprecedented methods and ideas for engineers to approach unsolved problems and to improve the quality of life of all human beings. Large amount of data collected provides fundamental chances into investigation of various societal problems, while data processing technology provides different ways for interpreting and gaining insights from such data.

Falls in elderly people are the leading cause of visits to emergency departments and can lead to serious health problems. It is reported that nearly 28-35% of people aged 65 years and above fall each year and this percentage increases to 32-42% for those over 70 years of age (Fuller, 2000). Annually, 1800 falls directly result in death while 9500 deaths in the elderly Americans are associated with falling (Sharif et al., 2018). Advancement in data collection allows simple procedures for both clinicians and patients to collect valuable information on gait features, while there is also growing interest in the development of predictive models and classification. Physicians can use such models to reliably identify fallers in the patients by simply taking several measurements and assign appropriate assistance to them.

My STS thesis focus is on learning lessons from China about processing waste. While it is not closely related to my Capstone project, it also requires interpretation of data. For past years China had been the largest importer of recyclable waste in the world, but as China is now refusing to import waste, the US is in dire need to explore new, efficient ways to deal with its own waste. The technology for processing waste China used, the environmental and anthropogenic impact on dealing with that large amount of waste are problems worth of investigation and reflection.

Technical Topic

According to the U.S. Centers for Disease Control and Prevention, one in four Americans aged 65+ falls each year and 1800 falls directly result in death while 9500 deaths are associated with falling annually. Falling is also the major factor that contributes to fracture risk, and most injuries in the elderly are the result of falls; fractures of the hip, forearm, humerus, and pelvis usually result from the combined effect of falls and osteoporosis, which lead to further limitation of activity to the extent of loss of mobility (Prevention et al., 1992). Falling might also induce future fear of falling, which is defined as a lasting concern about falling that can lead an individual to avoid activities that he/she remains capable of performing, leading to more sedentary activities (Adelsberg et al., 1989). A strategy towards falling which has proved successful is to select patients at high risk and target prevention strategies (Oliver et al., 1997). Therefore, developing a method for predicting risk of falling is critical in order to target high-risk individuals for preventive intervention. However, to predict falling risks among seniors can be challenging due to the difficulties in gathering large set of well documented gait data and integrating it. Even with enough volunteers participating, designing of an experiment capable of accurately recording sufficient gait features that contribute to the individual's falling can also be challenging. In measurement of gait features challenges include but are not limited to whether a sit-to-stand movement or only walk movement should be recorded, lack of data that includes a real fall since most of the falls do not occur during the measurement. Furthermore, analysing the data and integrating multiple gait features into the prediction can be complicated and requires a large amount of time.

A total of over 400 clinical characteristics have been identified to be associated with an increased incidence of falls occurring at home or outdoors (Oakley et al., 1996). Most current

computational modeling related to the issue focuses on one particular clinical characteristic of interest and while a few immediately assessable factors may successfully predict a large proportion of the falls, it is not comprehensive. This project aims to develop a machine learning program that integrates multiple easily measurable gait features, such as stride length, stride time variability, force balance, ...etc. for predicting risk of falling with high accuracy as well as reduced time.

If the program turns out to be effective, it will become a reliable tool for clinical practice. The elderly who are exposed to risks of falling can take a measurement that takes a few minutes in the clinics by walking a designed path and the program will generate results indicating whether the patient is a faller in the near future within minutes. Once a patient is identified as a faller, the clinicians can give medications or advise accordingly to allow valid preventative intervention, and thus reduce numbers of deaths and injuries resulted from falling. If successful, the program could also efficiently revise the process in taking measurements of gait features, simplifying and formalizing the in-lab procedures. The computational program can provide insights into the contributions of each factor and identify most critical clinical characteristics, leading to corresponding design criteria in the experiment. Researchers can carry out further research into these influential clinical characteristics and seek for solutions to these negative effects. In addition, the machine learning program developed will be a revolutionary method in predicting falling. Part of this project aims to develop a convolutional neural network (CNN) for predicting falling. CNN is mostly used for processing image, and in this project CNN will be employed by treating the spatial and temporal data collected as three-dimensional data. If the program turns out successful, further research that implements machine learning programs could consider CNN and LSTM as an alternative to conventional neural networks.

Introduction to STS Thesis

China as a country had been taking and processing waste from other countries for almost 20 years. From Chinese customs statistics, in 2004 China imported 4.1 million tons of waste plastics, 12.3 million tons of used paper, 10.22 million tons of scrap iron, 3.95 million tons of copper scrap, and 1.2 million tons of aluminum scrap that year, accounting for more than 90 percent of imports from Asia, Europe, North America, and neighboring countries. However, in December 2017, China banned importing foreign waste due to non-negligible threat to its environment. At that moment, countries including the US were forced to take the responsibility of managing waste on themselves. Given this challenge, we explore what can be learned from China in handling with that large amount of waste. More specifically, we discuss what aspects in waste management in China led to the dramatic impact on its environment and its people, and how can these lessons pave the way for managing waste in the US less sinuated.

At the beginning of the strategy of importing waste, China was far after other countries in economy and technology and was in dire need of fast development. Although China had large labor force and was one of the largest producers of plastics, even this enormous production capacity was far from meeting vigorous domestic demand, leaving the Chinese government with no choice but to rely on imports. Importing waste gave China access to cheaper than virgin raw materials and of higher quality than domestically-generated waste, imports of waste plastics were rising exponentially (Yoshida, 1995). However, while importing waste granted China benefits and improvement in manufacturing technology, in China the recycling lacked a central, stable and flexible intermediate between waste generation and landfill like recycling centers to transform the waste into recycled secondary construction materials (Zhao et al., 2010). In addition, the recycle technology was still immature when handling with massive amount of waste

(Huang et al., 2009). China paid a painful price on waste management. In a small town called Guiyu in Guangdong Province, nearly 60–80% of families in the town have engaged in waste operations managed by family-run workshops (Huo et al, 2007). The processes and techniques used during the recycling activities in Guiyu were very primitive. Furthermore, Process residues were dumped in workshops, open fields and rivers and it was found that released hazardous chemicals from the process residue resulted in elevated blood lead levels of children in Guiyu (Huo et al, 2007). Soaring levels of toxic heavy metals and organic contaminants in samples of surface water were also evidenced in Guiyu (Wang & Guo, 2006). Guiyu is just one example among all the towns where its community rely on waste processing for most of its income but such income was exchanged with the health of the community members and its environment quality.

To mediate the polluted environment and to relieve negative anthropogenic impact, Chinese government implemented several strategies that also required engagement of citizens who produced most of the waste. In 2008, China banned free plastic bags in shops; In 2019, Chinese President Jinping Xi announced a plan which aims to set a standard waste sorting system by 2020. However, 11 years on from the ban on free plastic bags, the single-fee system failed fulfilling the goal of reducing overall plastic use. The new standard for sorting waste, while won consumer's notice, still faced the challenge of keeping the consumers sorting their waste with high standards.

China's ban on importing waste transferred the waste issue back to the US government, the US citizens and the companies that are responsible for sorting and recycling waste in the US. Then, for each of the relevant societal groups, what can be learned from China's experience so that the US can figure out a way to solve the problem with less detours? In order to address the

issue, I will start with identifying stakeholders and their roles in this issue. Because the topic relates to various social groups and addresses various conflicts between them, I will use the framework of Social Construction of Technology (SOCT) to discuss the impacts of waste management strategies on each of the relevant social groups. The stakeholders participate in waste management will be discussed are both China and the US are governments, community at where the waste processing happens, citizens who produce the waste. The SCOT framework will allow analysis on different interpretations from different social groups towards design standards of waste management.

Conclusion

Although my capstone and STS topics of my capstone project are loosely related, they both address critical issues for improving the quality of life.

My technical topic focuses on predicting fall risk among seniors. If successful, the algorithm developed in this project will help clinicians to give advice or medication to assist patients who are identified as potential fallers to avoid falling and thus improve their life quality.

For my STS topic, I aim to provide suggestions to the relevant social groups in the US to design an effective solution to recycling waste by investigating and reflecting on China's experience with waste management and utilizing SCOT for analysis. The Chinese ban on importing waste asked the US to face the challenge of managing it own waste inevitably. However, it also provides an excellent chance for the US to cast a re-evaluation on its waste management and recycling system that is long overdue.

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