Translating Sign Language to Auditory English

Artificial Intelligence: The Unforeseen Threats

A Thesis Prospectus
In STS 4500
Presented to
The Faculty of the
School of Engineering and Applied Science
University of Virginia
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Computer Science

By
Dev Kumar

December 13, 2019

Technical Project Team Members
Courtney Baugh
Monica Sanad

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.

Signed:_____ Date:_____

Approved: Date:_____
Catherine D. Baritaud, STS Division, Department of Engineering and Society

Approved:_____ Date:_____
Vicente Ordóñez, Department of Computer Science

The Information Age has made the industry more information-intensive and less labor and capital-intensive. With the required data, computers are in a state of continual improvement and can perform remarkable feats. In 1997, IBM's chess computer Deep Blue famously defeated the world chess champion Garry Kasparov (Nwankpa, 2018). Twenty years later, self driving cars are being used as shuttles to transport the public to their offices. Artificial Intelligence (AI) is still in its very early stages. As of now, most AI systems have very narrow applications such as detecting faces or driving vehicles. However, “a long-held goal in the field has been the development of artificial intelligence that can learn and adapt to a very broad range of challenges” (“Risks from Artificial Intelligence,” n.d., p. 2). Eventually, it may be “superintelligent”, superior to humans in all domains. AI is a discipline that is able to be applied in practically all areas to aid us. Although there are multiple applications that can translate one language to another, there are very few, if any, that can translate sign language.

As a technical project, one such application will be made with the intent of being able to translate the sign language in videos into auditory english. While society’s perception of AI is largely favorable, there are understated risks that come with its development. As a research project, a closer look to the uncertainties of AI will be investigated. An examination of current, future, and possible legislation will also be discussed in order to mitigate the likelihood of unanticipated consequences. The technical project is being started the semester of Fall 2019 and its scope and objectives may or may not change as the semester ends. There is a possibility of the project to be continued the following two semesters although it will be at the discretion of the technical advisor. The research project will also be started the semester of Fall 2019 and will be continued in Fall 2020. Both projects will be temporarily paused Spring 2020 in lieu of a spring

internship. Below is a Gantt Chart on the outline of the semester timeline.

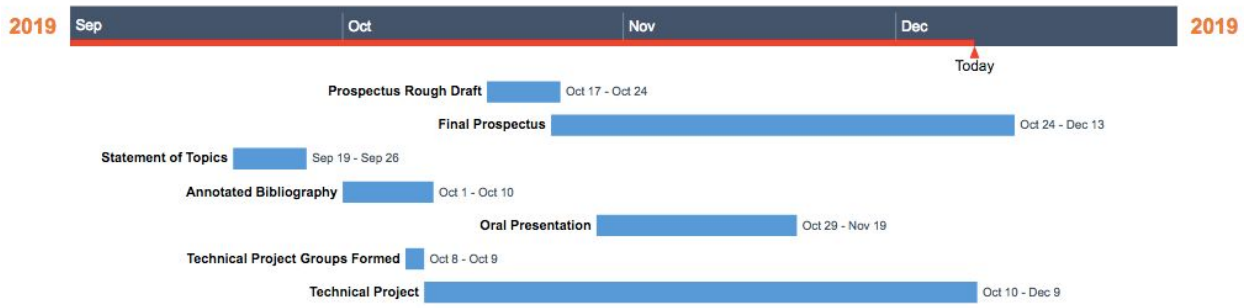

Figure 1: Gantt chart: A timeline of the development of the thesis (Created by Kumar, 2019).

EASING COMMUNICATION FOR THE DEAF

Communication with the general public is a hindrance to the deaf. A great majority of the public does not know sign language. Carrying a pen and paper is a cumbersome option that takes significant time, and eye tracking software like DynaVox is expensive and awkward. A working solution is a program that will translate American Sign Language into auditory American English. There are solutions that do not implement that do not use artificial intelligence. For example, Isaywhatyousee is a product that translates English to text in real time (Szczerba, 2015, p. 6). Related works had been developed in the 90s (Kulkarni, 2010). They have generally fallen into two different categories. The first of which relies on electromechanical devices to measure the hand's position, angle, and location of fingertips. These glove-based systems are inconvenient and unnatural. The second category attempts to use computer vision and image processing in order to recognize hand gestures. Another promising product was UNI, a two way communication tool developed by MotionSavvy. It was in prototype after 10 months of development but the startup is now shutdown (Szczerba, 2015, p. 4). The technical project falls

into the latter category. Additionally, a project report will be completed by the conclusion of the semester. The anticipated outcome of the project is to be able to analyze and translate images of sign language. This work may be extended to classifying dynamic movements in real time for a future project. When given a video of a person delivering a message in sign language, the project's application will translate the video into multiple picture frames. The program will take these frames and compare them to a dataset stored in the Modified National Institute of Standards Technology (MNIST). A line detection algorithm taught by Professor Vicente, Assistant Professor in the Department of Computer Science, will be used to compare the frames from the video to frames used to train an AI model. The technical advisor for the project is Professor Vicente. The professor was chosen as he has extensive knowledge over Computer Vision, Natural Language Processing, and Machine Learning which are all major subfields of Artificial Intelligence. Additionally, a significant part of his teachings will be used for the technical project and his expertise in the subject will guide the project toward a proper outcome. The technical and research projects are loosely coupled with each other as they both deal with Artificial Intelligence, but progress in one project will not contribute to progress in the other.

A line detection algorithm will be used to match lines formed by each letter, and potentially some words, with the lines formed by someone using sign language. In order to understand the algorithm, there should be a familiarity with how edges are detected. The first step is performing a sobel edge detection on an image. The sobel operator goes through each pixel in an image and compares it to its neighbors. If the gradient, the range of differences between two pixels, is above a certain threshold, the two pixels are considered part of an edge. To increase the accuracy of edge detection, images are often first put through a grayscale filter to

further differentiate one range of colors to another. The output of a sobel edge detection is the input of another algorithm known as canny edge detection. The sobel operator often returns edges that are too thick to be effective. The canny edge algorithm thins the edges so that they are one pixel wide, a technique called non-maximum suppression (Canny, 1986). Put simply, the algorithm locates the local maximum of the edge and then filters out the noise, the least dominant pixels of edges. Thus a high threshold is used to start edge curves and the low threshold is used to keep pixels that are not as strong but still part of an edge. Pixels below the low threshold are excluded from being part of the edge.

The Hough line detection algorithm does not always use canny edge detection. Instead of a more conventional y = mx + b equation to represent lines, the Hough line detection uses x cosθ + y sinθ = ρ (Duda & Hart, 1972, p. 2). Theta is the angle of the line while ρ represents the radius. Figure 2 illustrates the line equation more clearly. The code scans through the sobel edge output and checks the pixels around it. It will iterate through each pixel part of the edge while also checking for other pixels around it.

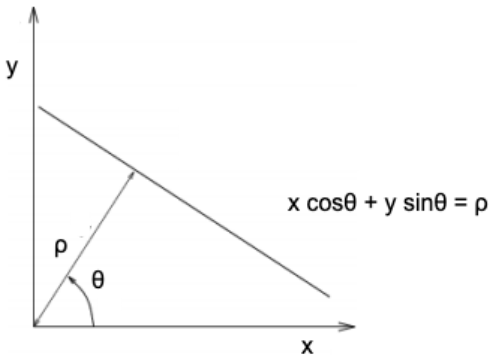

Figure 2: Hough line detection equation: The algorithm finds lines by comparing each pixel to its neighbors (Created by Kumar, 2019).

After the lines of a hand have been identified, it will be compared to other sign language signals. A supervised learning algorithm, classification, will be used to classify each input into a letter or word. A candidate for the classification algorithm is the k-nearest neighbors algorithm. The algorithm, commonly abbreviated as kNN, compares an input to a variety of possible classifications (Kataria, 2013).

The number of neighbors, k, determines how many classification points each input will be compared to. The second candidate is soft-max regression. The regression model calculates the probability of each classification belonging to each output. Softmax is used to scale the values so that they sum up to one. The classification that the input is put into is the one with the maximum probability.

The only resource needed for the project are laptops. Each project member will use their individual laptop in order to contribute to the targeted outcome. The code will be written in Python and will also use OpenCV. OpenCV is a library of functions that are used for real-time computer vision. While the technical project will likely not be completed by the end of the Fall 2019 semester, a working prototype should be available. Multiple discussions with the technical advisor will be important in determining the scope and feasibility of the project.

SOCIETY'S IMPACT ON AI AND VICE-VERSA

Artificial Intelligence (AI) is still in its very early stages. As of now, most AI systems have very narrow applications such as detecting faces or driving vehicles. As AI becomes more intelligent, we must not let the benefits of developing artificial intelligence obscure its drawbacks. Laymen are praising self driving cars, Snapchat filters, etc., but there have already been cases of AI being used in controversial ways. One of the more well known examples was when Target sent a high schooler coupons for cribs and baby clothes because the company inferred correctly that she was pregnant (Wagstaff, 2012). However, the main inspiration of the research topic came from a video of Elon Musk talking to Jack Ma, founder of the world's

largest ecommerce and retail company, Alibaba, at the World Artificial Intelligence Conference ("Elon Musk," 2009). One of Musk's points was that policymakers do not generally have enough expertise on Artificial Intelligence to realize how powerful it is. Coincidentally, Jack Ma has a more optimistic view on the subject, stating "I'm not a tech guy. I think more about life" ("Elon Musk," 2009). Ma dismisses the threat of AI without examining the field more indepthly. Musk compared how humans see AI to how chimpanzees see humans; they do not necessarily see us as smarter and more capable, but as "strange aliens" ("Elon Musk," 2009).

Another complication of the development of AI may be the rise of emotional dependence of humans on such technologies. In fact, the feelings toward autonomous social robots will be similar to our affection for pets (Lin, Abney,& Bekey, 2014). Researchers claim that these robots will be so socially intelligent that they will have the ability to cause emotional harm (Lin et al., 2014). Thus, this type of dependence is different than other kinds of human dependencies on technology. Other topics the scientists cover will be discussed in the research project, including which ethical regulations robots should operate within on the battlefield, how society and ethics may change through robot development, and whether robots should have rights (Lin et al., 2014).

If society wants to make reasonable decisions concerning such technology, it would have to understand its capabilities, something only a small percentage of scientists can claim they do. Fortunately, awareness to AI's potential hazards is increasing due to organizations such as Centre for the Study of Existential Risk (CSER), and publications including Nick Bostrom's *Superintelligence*. CSER is a team dedicated to the mitigation of threats that could lead to either human extinction or civilization collapse. *Superintelligence* warns that AI could replace humans as the dominant life force on Earth.

Two responses to technological determinism, how technology influences societal culture and values, include the Social Construction of Technology (SCOT) and Actor Network Theory (ANT). SCOT argues that different social groups influence the development of technology. In contrast, ANT argues that society is part of a network that contains various actors, all equal in their contribution to technological success. Figure 2 attempts to demonstrate a network of actants all contributing to the system. Car manufacturers have to abide by the regulations of policy makers. These manufacturers develop autonomous vehicles that are built by engineers. Customer perception and the media play a role in which vehicles get developed. It may be questioned how technology can have an equal impact as humans.

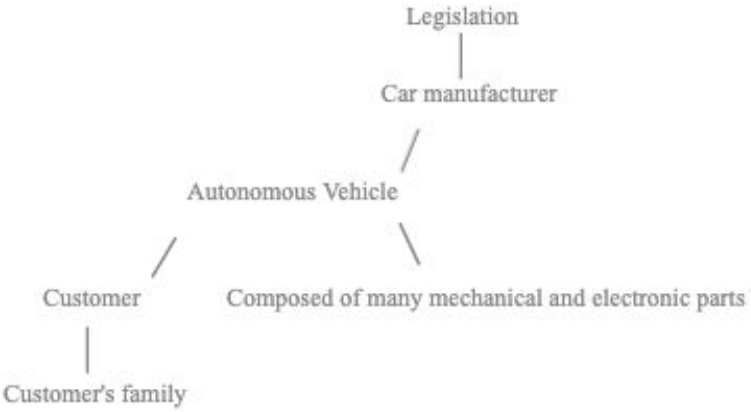

Figure 2: The actants of an autonomous vehicle, which is an actant for a bigger network. (Kumar, 2019)

For example, a technology can only be identified because we differentiate it from human actors. With the emergence of AI, technology more than ever before has the ability to communicate with humanity. Kiel Brennan-Marquez and Stephen Henderson (2019), law professors at the University of Connecticut and the University of Oklahoma respectively, question the impact humans should have in an increasingly AI driven criminal investigation (Brennan & Henderson,

2019). Role-reversibility is a notion that states that individuals making decisions should be subjected to the impact of the aforementioned decisions. The law professors believe that although some democratic traditions may change due to AI, role-reversibility is too important to dismiss. They discuss how AI cannot be fairly subjected to role-reversibility as it does not have a conscious. While a major component of the research project is concerning the impact of legislation on AI, the professors demonstrate how AI may be able to impact legislation (Brennan & Henderson, 2019). Another example of the role of AI development on legislation is demonstrated through autonomous vehicles. There is much debate on what role these vehicles should take in a lose-lose scenario (Hevelke & Nida-Rümelin, 2014). Figure 3 illustrates an example of a lose-lose situation. Three important questions emerge immediately. The first question is whether there should be a tort liability, a legal obligation of one party to a victim of an accident, with car manufacturers. If manufacturers are liable, it could deter the technology's development. The second question asks if "drivers" have a practical chance to intervene if the car is driving itself. Finally, Hevelke and Nida-Rümelin discuss if the driver should be solely financially responsible for the accident instead of criminally (2014). Revisiting laws in response to the growth of AI is not limited to the United States. Jaume-Palasi discusses how nations and international organizations are

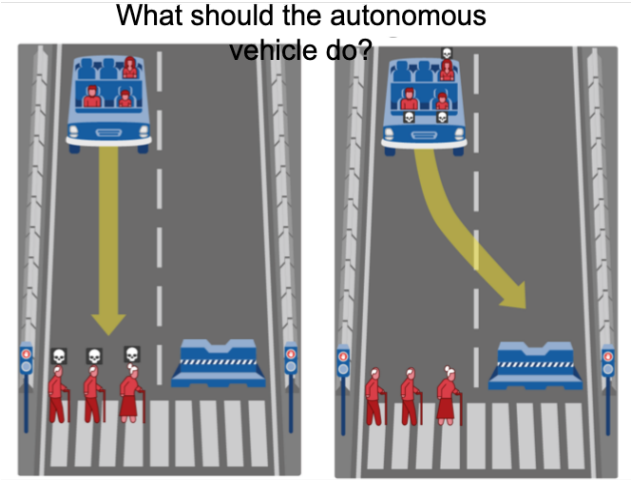

Figure 3: A lose-lose scenario an autonomous vehicle will have to take: It could hit the pedestrians or swerve to crash into another obstacle (Adapted by Dev Kumar from Edmond Awad, 2018)

revising laws in response to the growing presence of AI (Jaume-Palasi, 2019). He explains how "every second week a new 'ethical code' seeks to present principles to fill a gap that public opinion fears has been opened by this technology" (p. 4).

There is an argument that soft infrastructure, regulatory institutions, should focus on human values and be technology neutral so that technology cannot contribute to legal uncertainties. Society's role in the development of AI is critical in order to ensure AI is used constructively. Risse displays how artificial intelligence can affect "just about all rights" of the Universal Declaration of Human Rights through its discriminatory algorithms (Risse, 2019, p. 6). He argues that protection of human rights has an underlying assumption that human life should be valued more than other lives. However, the evolution of AI will bring entities superior to us intelligently and probably morally, and thus the research project will discuss how human rights should be preserved.

Another problem mentioned is the involuntary involvement of people as participants in machine learning algorithms. The expansion of computing technology will impact our understanding of human rights. Roman V. Yampolskiy published a journal proving that it is impossible to consistently predict what choices a technology smarter than humans will take (Yampolskiy, 2019). There are fundamental theoretical limits to the ability to verify what a particular piece of code will carry out. The journal reveals that both AI's harmful effects and its decision making processes are unpredictable. Its unpredictability results in difficulty in making certain that its use abides by the law. Yampolskiy's paper is imperative as a major component of

the research project is to investigate Elon Musk's assertion that AI will be too unpredictable to control.

The rapid advancement of technology in the 21st century may be fruitful, but following precautions will be imperative in preventing unexpected consequences. Training a model to recognize sign language is just one of the ways the field of artificial intelligence can be used to improve the standard of living. As models become more powerful, it is of best interest to consider the significance of a world run by machines.

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