Thesis Portfolio

Carbon Capture, Utilization, and Storage from Power Plant Emissions

(Technical Report)

A Study of Artificial Intelligence for Creative Uses in Music

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

This thesis includes a technical capstone project and an STS research paper in two areas of study: chemical engineering and computer science. Although the two separate portions of this thesis are not strictly connected, there are strong motivations for the research done in each area. The technical aspect of this thesis involves modeling the retrofitting of an amine scrubbing carbon capture and utilization system onto a natural gas power plant. The final product of the carbon capture process is carbon-neutral heavy diesel fuels. The motivation behind this project lies in the rising levels of greenhouse gas emissions, specifically emissions resulting from power generation. The transformation of power plant stack gas into carbon-neutral fuels will aid in this increasingly concerning issue as the world looks to move towards greener energy sources. The STS research portion of this thesis involves a study of artificial intelligence (AI) in the music industry. This study was motivated by the rise of sophisticated creative AI in recent years and the emergence of such technology in music. As artificially intelligent systems become increasingly more prominent in society, it is critical to understand the motivations behind the desire to emulate human creativity and the potential impacts and pitfalls of such an achievement.

The Capstone project involving carbon capture and utilization is modeled on an existing natural gas power plant, the Pastoria Energy Facility near Bakersfield, California. The purpose of this system is to reduce carbon emissions in the energy sector and produce carbon-neutral fuels. The first step of the carbon capture system is to remove carbon dioxide (CO_2) from the power plant stack gas. The gas separation system consists of an absorption column connected to the power plant stack that absorbs CO_2 into lean monoethanolamine (MEA) and a stripping column that allows for the isolation of CO_2 gas. Purified gas is then fed from the stripping column to a reverse water-gas shift reactor, which utilizes hydrogen gas to convert CO_2 into carbon

monoxide (CO). The final step of the process involves the Fischer-Tropsch reaction, in which CO reacts with hydrogen gas to produce heavy hydrocarbons that can be used as diesel fuel. Aspen Plus Process Simulation is used to model each step of the process independently. The final analysis includes material, energy, economic considerations throughout each section of the process to provide recommendations for equipment sizing and operating conditions. Each of these aspects is taken into account to make recommendations that maximize economic gain and positive environmental impact.

The STS research paper analyzes the current state of AI programs that produce instrumental components of popular music or produce entirely new music from scratch. This analysis aims to answer the question of how mimicry of musical creativity by computers would impact the musical community and society as a whole. The question is mainly answered through case studies of current AI projects in both popular music and in imitations of classically composed music. Small-scale Turing tests are also conducted using the programs from these different cases, and streaming and charting data is examined for cases involving popular music. The STS theories of technological momentum and actor-network theory are employed to analyze the sociotechnical factors behind the motivations for and potential impacts of computer programs achieving convincing musical creativity. This research is significant due to the rise of artificially intelligent programs and the accompanying ethical concerns about how far computer science should venture in attempts to emulate human behavior. Viewing the efforts of creative AI through the lens of original beats and melodies allows for conclusions to be made about larger societal impacts, given the universality and widespread cultural significance of music.

Due to the lack of proximity in topics between this technical Capstone and the STS research paper, the value of completing these two projects simultaneously comes not from the

topics informing each other, but rather from the breadth of knowledge obtained from researching two vastly different topics in the engineering world. In today's world, it is crucial to stay informed on many different topics, especially as an engineer who may need to think critically across many different disciplines when making a decision in the workplace. Having the opportunity to conduct in-depth research on topics that have little connection helps enhance this ability to stay up-to-date on the different corners of the engineering world and think critically about a wide variety of technical topics and their impacts.