DIGITAL TWINS FOR PEOPLE IN BUSINESS AND SOCIETAL ROLES

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Abstract

The International Society of Service Innovation Professionals, ISSIP, is a non-profit organization whose mission is to promote innovation in the global service economy. ISSIP is partnering with the Pennsylvania State University to research applications for digital twins to increase productivity for ISSIP community members.

While digital twins have traditionally been associated with physical objects, systems, or processes, we are now witnessing the advent of personal digital twins – virtual representations of individuals themselves. For this project, a digital twin will focus on purely digital tasks, and will be utilized to create video presentations for users from textual input (authored papers, research resources, notes, etc.). Furthermore, with the textual input, allowing the panel to ask questions to the user's digital twin. By exploring this capability, we seek to provide ISSIP leadership and members of professional associations and communities of practice with a glimpse into the possibilities that personal digital twins can offer, enabling users to maintain a virtual presence and contribute their expertise even in their physical absence during panels, meetings, and other engagements.

Having delved into the realm of current AI digital twin applications (industry use and personal) and identified the diverse array of tasks digital twins could potentially streamline in the workforce, along with developing a simulation to explore their potential applications, numerous factors emerge that could profoundly influence the ISSIP community.

Upon closer examination of the specific tasks associated with ISSIP members' professions and more, from O*NET. The responsibilities can be broadly categorized into three main areas: strategic decision-making and planning, communication and networking, and training/mentorship. Soon, personal digital twins could revolutionize professional interactions, attending job interviews or assisting as virtual liaisons during role transitions. By bridging the gap between the physical and digital realms, personal digital twins could streamline various professional endeavors, fostering more efficient communication, collaboration, and knowledge transfer.

In the process of creating digital twins, we explored the capabilities and limitations of current APIs and prompt engineering to access the possibilities of bringing a digital twin to fruition. With this knowledge in hand, leveraging digital twins could significantly benefit members of the ISSIP community by enhancing their productivity and that of those around them. At its current level, the adoption of digital twins as assistants primarily aids in managing workloads more efficiently. However, as advancements in digital twin technology continue to evolve and progress digital twins become “a collection of tools to assistants, collaborators, coaches, mentors, and mediators” (Spohrer & Siddike, 2018). This progression enables individuals to glean valuable insights through collaboration with others, whether they be humans or other digital twins.

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1.0 Introduction

1.1 The International Society of Innovation Professionals

The International Society of Service Innovation Professionals, ISSIP, partnered with the Pennsylvania State University to research and explore the creation of digital twins to help their volunteers be more productive and able to have high quality interactions with more ISSIP community members. ISSIP is a non-profit that focuses on enhancing the global service economy for both businesses and individuals. ISSIP is a community of more than 1,800 members representing 300 companies that focus on five main objectives that are professional development, education, research, practice, and policy (ISSIP, 2023).

ISSIP has engaged with students from Penn State with whom they collaborate, to provide insights into potential applications of AI into their business needs. A recent challenge has surfaced where board members occasionally find themselves unable to participate in scheduled panel discussions or meetings due to conflicting obligations. This issue is encountered across various industries, necessitating the search for replacements to convey the intended message. However, there is not always consistent communication and message delivery through the substitutes. That is an opportunity where Artificial Intelligence (AI) can facilitate virtual interactions for ISSIP members that enable the original panelist to engage with the audience remotely. Over the past semester, the team has taken part in the exploration of many AI platforms to aid ISSIP in identifying optimal solutions and to spread awareness about the power of AI.

1.2 The Evolution of Digital Twins

Digital Twins are the reproduction of human beings, processes, real-world objects, and systems through the application of artificial intelligence to precisely replicate their physical entities ("Human Digital Twins"). In recent years, the concept of digital twins has gained substantial attention with the advancements in computer science and technology. The term digital twin has gained popularity in many industries as they are exploring how to incorporate AI. Currently the use of digital AI twins is prevalent in manufacturing, healthcare, and supply chain to enhance decision making, optimize processes, and reduce waste. For example, in the healthcare industry, "AI-powered diagnostics leverage machine learning algorithms are used to analyze diverse data like medical records, genetics, and scans for early disease detection by identifying subtle patterns and anomalies often missed by human doctors" (Yahoo!, 2024). These AI capabilities are saving hundreds of lives by detecting new diseases and detecting diseases in humans at earlier stages.

ISSIP, along with a diverse range of individuals and organizations, is interested in exploring beneficial applications of digital twins of people to provide better service productivity and quality. For example, the ISSIP AI Collab program has already partnered with student teams to explore the use of generative AI tools for developing historical service innovation cases for a range of innovation (Spohrer, 2023).

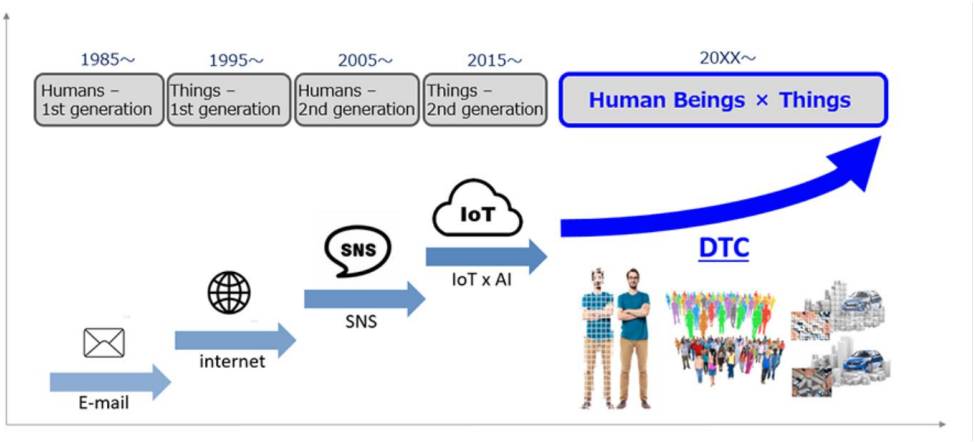

Figure 1.2.1: Focus of Digitalization Over Time ("Human digital Twins")

Figure 1.2.1, visually displays that over the past four decades the focus of digitalization has undergone periodic shifts, occurring approximately every decade, alternating emphases on the digitization of human interactions and physical entities. In 1985, there was the introduction of electronic mail (e-mail), a worldwide communication tool that allows individuals to virtually communicate with the use of text. In 1995, the focus of digitalization transitioned towards physical entities with the creation of online timetables and maps that are still integral components used in businesses today. Advancing another decade to 2005, digitization once again directed its attention to human interactions with the creation of social media platforms (Human Digital Twins). In the current decade, researchers and scientists are once again interested in the digitalization of human digital twins and the advancements have potential to benefit the ISSIP community.

Although the concept of a digital twin has been practiced since 1960, like displayed in the examples above, Michael Grieves is credited and thought to be the developer of digital AI twins as they became widely popular in 2002.

Michael Grieves, a distinguished faculty member at the University of Michigan is credited with the development of Digital Twin Technology in 2002. During a presentation focused on technology and Product Lifecycle Management, Grieves introduced a management model with “three components: real space, virtual space, and linking mechanism for the flow of data/information between the two; the model was then referred to as ‘Mirrored Spaces Model’” (Singh, 2021). The Mirrored Spaces Model established the groundwork for digital twin technology by integrating physical and virtual worlds.

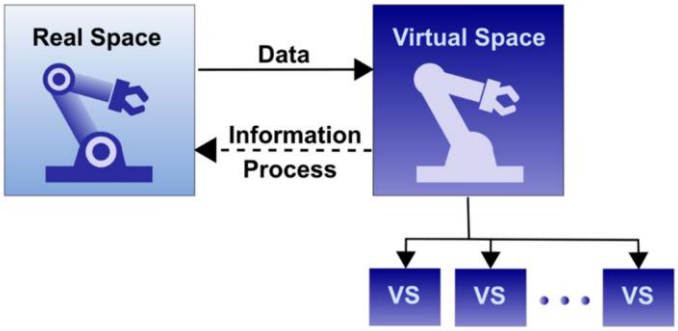

Figure 1.2.2: Mirrored Spaces Model (Singh, 2021)

Figure 1.2.2 visualizes the relationship between real space, representing the physical entity, and the virtual space, representing the digital twin. It emphasizes the connection between the two spaces and any change to either space will be mirrored to the other space, creating a twin representation (Singh, 2021). ISSIP ideally wants to replicate this model creating a digital twin of their members. The twins would be updated over time to accurately depict their messages and be used to assist the members and operations within the non-profit.

2.0 Current Digital Twin Applications

2.1 Industry Use of Digital Twins

Digital twins are now starting to become more prominent as companies investigate the potential benefits associated with them. Some companies, however, have already started incorporating some AI digital twin applications into their projects. Notable twins have been developed in almost every industry imaginable. One of the notable projects is "IntelligentEngine" by Rolls Royce which is an artificially intelligent replica of every motor they produce, allowing for real time diagnostics and predictive maintenance.

Another pioneering project is the digital twin of the cross rail in Elizabeth, London this allows experts of the rail industry to analyze over 250,000 models compiled into one that closely reflects the final project goal helping throughout the whole construction process. Furthermore, in the car industry digital twins have had a huge impact. Substantial amounts of investment in the automation world have been on self-driving cars and the most efficient way of testing these new functions and features is through these environments that reflect real world scenarios. Before autonomous vehicles can be safely used by the human population companies need to ensure the driving algorithms are perfect which would not be possible without these twin testing scenarios.

Another application comes in a different sector, the energy production department. The company Shell has been creating digital twins of their offshore platforms to improve safety and production efficiency. They have been able to achieve this through a variety of sensors that compile real time data and artificially simulate different scenarios. From this we

see on the industry side, the use of digital twin's being used more for processes, systems, and real-world objects.

2.2 Personal Uses of Digital Twins

Even though companies are making great advancements in the digital twin technologies they use for their products, people have started to develop their own artificially intelligent twins for their own interesting applications. For example, Julio Fernandez shared on a LinkedIn post a way in which his "Get to know Julio GPT" AI digital twin can facilitate every aspect of networking. By having the ability to converse about Julio's specific professional background and personal interests with recruiters 24/7. This allows for a more simultaneous interaction so companies and Julio can save time creating a mutually beneficial relationship. This example showcases how digital twins of humans can be utilized.

More applications such as these are constantly being created by individuals. To support this a CNN article speaks on the use of AI digital twin for stricter lawmaking against gun violence. Policy makers were sent voice recordings of some of the past victims to appeal to their emotions and change current policies. So even though this example involves a sad story the appeal and impact of individual AI digital twins being created is evident. Which is how our group was able to draw inspiration for our demonstration idea for the ISSIP board. Since the digital twin we are looking to develop will present ISSIP members with methods of how to create digital twins to assist in their daily lives.

3.0 Digital Twin Capabilities

Through O*NET, the team was able to investigate some of the key activities that a wide variety of jobs entail and areas AI digital twins could assist in. When researching the different occupations, it was important to take a wide range of professions that being technical, non-technical, entry-level, and more. While many ISSIP community members hold many technical, managerial, and senior roles, it is important to still investigate how digital twins can help many entry level jobs. In Table 3.1, the common tasks of the researched occupations are shown.

Table 3.1: O*NET Job Analytics

Jobs/ Metrics	Emails	Calls/ Presentations	Scheduling	Decision making	Job specific activities	AI Digital Twin applicability score
CEO 11-1011.00	X	X	X			60%
Receptionist and Information Clerks 43-4171.00	X	X	X	X	X	100%
Driver/ Sales Worker 53-3031.00	X	X	X	X		90%
Teacher 25-2022.00	X	X	X	X		80%
Industrial Engineer 17-2112.00	X	X	X			60%
Trade Jobs (plumber, electrician, painter) 47-2152.00	X	X	X			60%

This chart reveals some of the general tasks of every job and whether an AI digital twin would have an impact on those depending on the specific occupation. The applicability score is a percentage of a job a digital twin has the potential to take over in the next several decades.

3.1 Technical & Management Occupations

When diving into O*Net research and looking at the different tasks of some of the more technical jobs, the main responsibilities could be split into three categories: strategic decision-making and planning, communication and networking, and training/mentorship. The creation of digital twins in those areas could greatly benefit a variety of technical roles. For example, digital twins facilitate work for people in leadership positions such as chief executive officers. Not only are those individuals in charge of key decision making for the directions companies are taking but they are also responsible for constant communication with the team. As revealed by a Harvard study on over 300 individuals within the position "CEOs are always on, and there is always more to be done. The leaders in our study worked 9.7 hours per weekday, on average. They also conducted business on 79% of weekend days, putting in an average of 3.9 hours daily, and on 70% of vacation days, averaging 2.4 hours daily. As these figures show, the CEO's job is relentless" (Porter & Nohria, 2018). This reveals the need for a more direct assistant such as an AI digital twin that could take the perspective of the individual and ensure any urgent questions are attended to instantly.

3.2 Less Technical & Customer-Facing Occupations

While there is a need for many high level, very technical jobs, there are also many areas for digital twins to help less technical and entry level jobs. To start, AI digital twins

will take over some of the more tedious tasks that certain jobs require. For example, for teachers grading assignments. Most in the profession enjoy the interactions with students and showing them new things, however not spending countless hours reviewing assignments. Artificial intelligence could replace that by recognizing certain key words/steps and providing feedback.

Another job sector that will be greatly affected is cashiers and receptionists doing certain customer-facing jobs. To support this the company Hour One has developed AI digital twins of receptionists for COVID protection known as “ALICE Receptionist system which can greet and check-in guests, verify face mask coverings and body temperature levels, and collect health surveys as well as print visitor badges” (Schneider, 2021). This sort of technology application can replace human interaction at the initial point of contact. These sorts of basic tasks such as check ins, payment transactions, and basic email responses are something artificial intelligence can quickly learn and replicate through human looking digital twins.

Figure 3.2.1: AI Digital Twin- Receptionist System (Copier Fax Business 2024)

Lastly, AI digital twins could also benefit trades in specific areas. Plumbers, electricians, and painters all enjoy the hands-on aspect of their job, however, sometimes

struggle optimizing their schedules. This causes them to lose job opportunities and customers which is where an AI digital assistant would be key. It could ask customers for key questions and automatically produce optimal working schedules that calculate driving distance and average repair times.

However, there are other specific roles that AI digital twins could not only help with but possibly take over. Starting with drivers/sales workers providing food deliveries and human rides. The potential for AI digital twins in self-driving cars opens a completely new industry. These cars will be capable of reducing the human error aspect of accidents on the road and at the same time safely perform the same functions as human drivers. As stated by the uber CEO by 2030 he believes “self-driving cars could make up a double-digit percentage of trips, CEO Dara Khosrowshahi said during an on-stage interview at the Aspen Ideas Festival” (Khosrowshahi, 2023). This shows how leadership within these rides sharing and food delivery industries believe in the potential for AI digital twins in autonomous vehicles to slowly take over the industry.

4.0 Societal Implications of Digital Twins

4.1 Ethical Considerations

The utilization of digital twins within the ISSIP community presents many ethical considerations that should be addressed before integrating AI into business operations. ISSIP should attempt to ensure that the digital twin technology they are implementing is free from bias and discrimination. The implementation of routine audits for AI systems and establishing ethical guidelines for the development and deployment of these technologies can mitigate risks associated with these concerns.

The primary ethical consideration in the creation of digital twins within the ISSIP community pertains to obtaining consent from members. The process of capturing visual or auditory data for the development of a digital twin may intrude on personal privacy and can potentially be an invasion of privacy. The creation of digital twins requires uploading images, videos, and audio recordings, so it is essential to obtain consent from all involved parties. Gaining consent is essential to uphold ethical standards within ISSIP and to mitigate legal issues from using unauthorized data.

4.1.1 Intellectual Property

ISSIP should consider establishing protocols governing access, ownership, and management of digital twin data. Information collected and uploaded to create AI twins of individuals can be sensitive and should not be public to all members. Breaches in data security could expose ISSIP to legal liabilities and compromise the privacy of individuals. Security measures should be implemented to protect this data and prevent breaches in the

system. Furthermore, ISSIP should address long-term considerations, such as considering what to do with the digital twins when the person they are replicating dies (Kerckhove, 2021).

Given the stage of digital twin technology, the designation of rights and ownership isn't clear, extending to both the creators of these digital twins and the individuals whose likenesses are replicated. As ISSIP delves deeper into the development and deployment of digital twins, it must navigate the complex legal and ethical terrain surrounding these issues, addressing who holds the intellectual property rights to a digital twin—the creator or the person replicated—and considering the necessity of informed consent from individuals being digitized. Furthermore, the rights of digital twins themselves could become a subject of discussion, raising philosophical and legal questions about the rights of AI entities that mirror human beings closely. There are also significant concerns about the misuse of digital twins, including identity theft and unauthorized use of a person's likeness, necessitating clear guidelines on the usage, sharing, and distribution of digital twin data. ISSIP should develop a framework that balances innovation with the protection of individual rights, ensuring responsible and ethical use of digital twins.

4.2 Workforce and Job Security Impacts

The digital twin market is continuously evolving and is projected to witness substantial growth, amounting to $32 billion invested into this tool from 2021 to 2026. Across various industries, there is a strategic focus on integrating AI capabilities, with nearly 60% of executives intending to implement digital twins into their operations by 2028 (Attaran, 2023). There are many advantages of implementing AI technology into companies,

but there is a concern on its potential impact on employment, particularly in terms of jobs displacement. Human digital twins can complete routine or complex tasks, aid in decision making, and present messages at meetings. If industries find a way to successfully incorporate AI into their operations it puts human jobs in jeopardy. There is potential that incorporating AI would be cheaper than paying a human, so businesses would have to decide what would work for them. This could have a negative effect on the economy and result in employees having fewer social interactions with one another.

5.0 Digital Twins Simulation Approach

In exploring the myriad applications of digital twins, one prominent challenge faced by ISSIP revolves around the conflicting schedules of panel participants, often resulting in last-minute withdrawals. To mitigate the repercussions of losing a panel member's unique perspective, the development of a simulation was created to leverage the concept of digital twins. This simulation incorporates input from papers, the type of audience, and sample video the user talking to generate a video representation of the absent panel member presenting their “speech”, thereby preserving their contribution despite physical absence. As an overview of the simulation of the use of digital twins, the ISSIP member will input pertinent papers, specify the audience's characteristics, set the timeframe, and provide video samples that offer both audio and visual cues. Then a video presentation will be generated specific to that event and audience. Additionally, after initially presenting, the host can manually type questions from the audience in. The goal of this simulation is to act as a case study to showcase methods and resources to develop your own digital twin to help assist with a certain problem. This digital twin simulation is specifically trying to assist in missing panel members.

5.1 Leveraging Application Programing Interfaces (APIs)

One method of creating a digital twin is leveraging application programming interfaces (APIs) and employing prompt engineering. “An API or application programming interface, is a set of rules or protocols that let software applications communicate with each other to exchange data, features and functionality.” (IBM, 2024) APIs serve as conduits for communication between the client or simulation server and facilitate the exchange of data and services. This process can be shown in Figure 5.1.1. Chat-GPT, Google, YouTube, along

with numerous other software platforms, offer APIs that enable seamless integration of their services with your codebase.

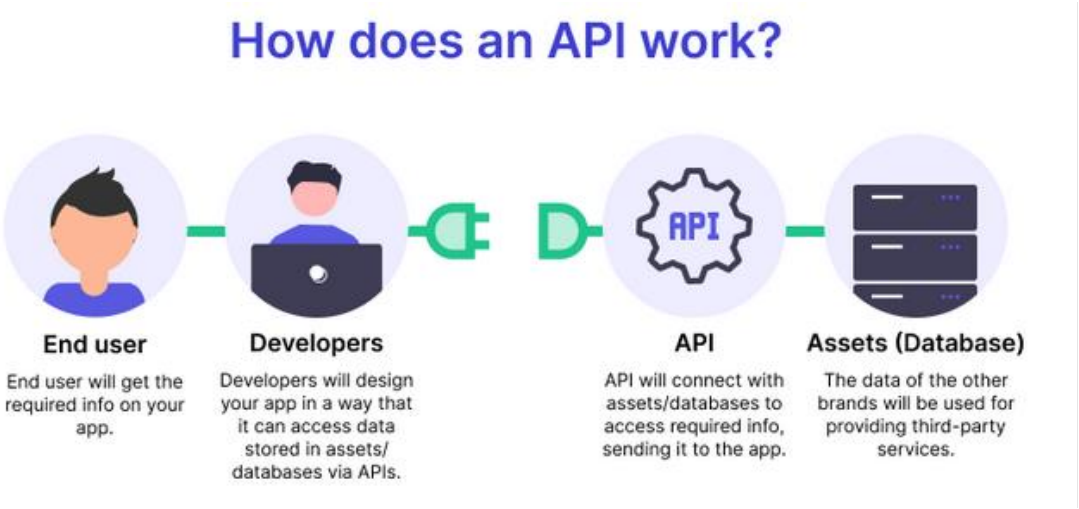

Figure 5.1.1: Application Programming Interface (Adkuloo, 2022)

5.1.1 API Selection Criteria

When trying to develop code to utilize APIs for personal use, there are many factors that need to be considered when determining the best API to use. First, is selecting the API for the purpose of the problem. If you need a Generative Pre-trained Transformer (GPT), Google search, translating languages, selecting proper APIs that will help with that. The second most important factor when selecting the APIs utilized in this simulation was making sure the APIs were public. Public APIs are open to anyone to use. An activation code is used to access the API for security purposes. Then the API can be accessed for free or with paid tokens. This was one of the biggest factors when creating the simulation of a digital twin. For example, when considering the GPT API for the simulation of a digital twin, Google Gemini, Chat GPT, Anthropic Clause, and Microsoft

Copilot were all considered. When looking deeper into which ones were public, Google Gemini and Chat GPT were the two that were public APIs and could be accessed at the time (Spring 2024). Table 5.1.1 shows the factors considered when selecting the GPT API and how we rated them. Some of the other factors that could be considered are flexibility, scalability, security, and speed. (Iwuozor, 2023)

Table 5.1.1: Decision Matrix of GPT API

Metric	Weight	Google Gemini		ChatGPT		Anthropic Claude	Microsoft Copilot
		Rating	Value	Rating	Value		
Ease of API Use	30	5/5	30	5/5	30	**NOT PUBLIC API**	
Prior Experience/ Knowledge	5	3/5	3	5/5	5		
Cost	15	5/5	15	3/5	9		
Speech Writing Ability	20	4/5	16	5/5	20		
Perspective Fine Turning	30	2/5	12	5/5	30		
Total	**100**		**73**		**94**	**N/A**	**N/A**

5.1.2 Possible Challenges with API Integration

A challenge encountered while working with APIs, particularly given the rapid pace of technological advancements, was the dynamic nature of API access and availability. The landscape can shift unexpectedly, requiring agility and adaptation. For instance, while developing our simulation and integrating a video generation API, the cost structure underwent a substantial change midway through the project. This forced us to reassess our approach and ultimately pivot to an alternative API solution. When creating a digital twin leveraging APIs, it is crucial to remain vigilant and stay up to date with the

evolving accessibility, pricing models, and overall viability of the APIs in question. The ability to respond swiftly to such changes can mean the difference between a successful implementation and a stalled project. Maintaining a proactive stance and regularly monitoring the API ecosystem is essential to mitigate potential disruptions and ensure a seamless development process.

Additionally, another significant hurdle we encountered was related to the user interface of the D-ID application we were utilizing. The platform itself exhibited technical difficulties that impeded our ability to interact with it as necessary for API creation. These issues were beyond our control and presented an unforeseen challenge that further complicated the development process. The platform's UI bugs and glitches made it difficult to upload the necessary data needed to create the personalized API endpoints leading to delays and requiring us to explore workarounds. This experience underscored the importance of considering the stability and reliability of the tools and platforms we used.

5.2 Prompt Engineering for Generative Tasks

Beyond leveraging APIs, prompt engineering played a pivotal role in the creation of our digital twin, particularly when generating a script from the research paper. Prompt engineering is a critical technique employed when working with generative artificial intelligence (AI) systems, as these models are designed to generate specific outputs based on the quality and specificity of the provided prompts. As IBM states, "Prompt engineering helps generative AI models better comprehend and respond to a wide range of queries, from the simple to the highly technical." (IBM, 2024)

By fine-tuning our prompts and posing more targeted questions to the GPT (Generative Pre-trained Transformer) model, we were able to elicit more appropriate and relevant responses. This process allowed us to extract and synthesize the core ideas and findings from our research paper, enabling the generation of a cohesive and informative script for our digital twin's presentation.

Prompt engineering is a crucial skill in the realm of AI, as it empowers users to effectively communicate their intent and extract the desired outputs from these powerful language models. By mastering this technique, we were able to harness the full potential of generative AI, seamlessly integrating our research into a compelling narrative delivered by our digital twin.

5.3 Digital Twin Panel Simulation

Specifically for this simulation of a digital twin attending a panel, APIs were used to streamline the process of generating scripts and producing videos, all hosted on a website created on Next.js. An example of how these APIs is implemented can be found in the source code in the GitHub (Siddiqui, 2024). The overall flow of data can be viewed in Figure 5.3.1.

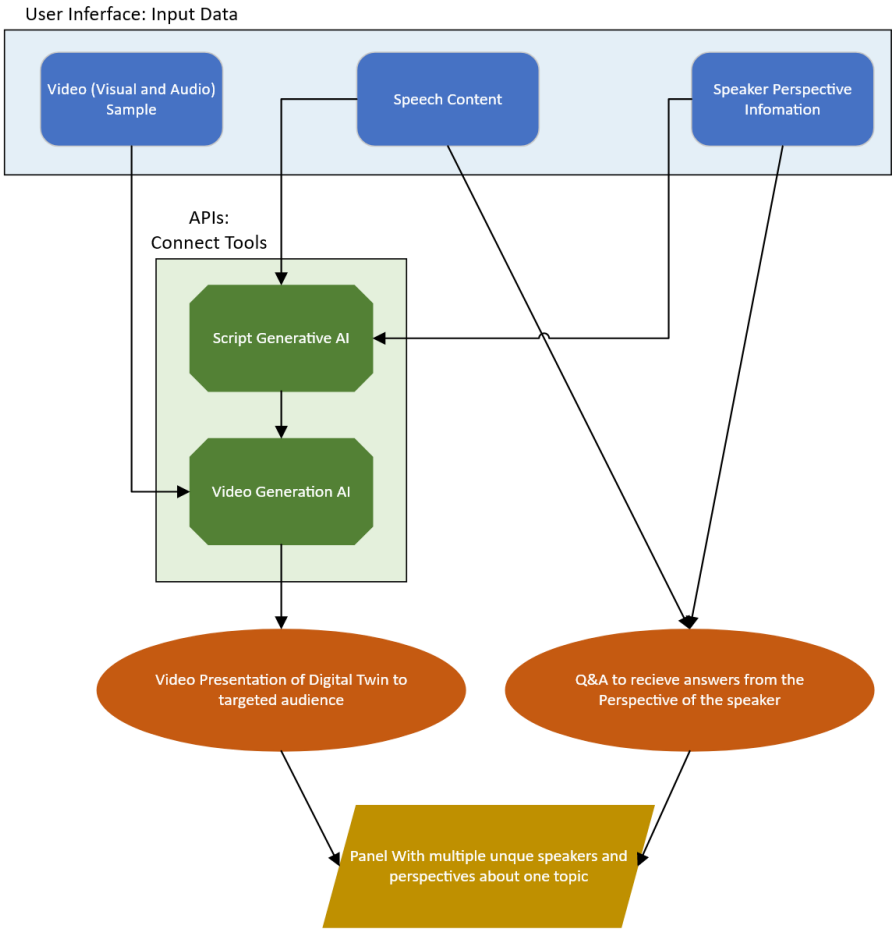

Figure 5.3.1: Flow of Data

For this specific digital twin simulation, we leverage the capabilities of the Chat-GPT and D-ID APIs. The Chat-GPT API, combined with prompt engineering techniques, crafts scripts tailored to the intended audience, ensures that the presentation resonates effectively. By providing the API with the research content and fine-tuning our prompts, a compelling script catered to the audience's needs us generated.

Once the script is generated, D-ID's technology creates a video presentation featuring the user's digital twin. D-ID "combines facial synthesis and deep learning expertise to deliver interactive AI experiences in multiple languages, elevating and scaling the way we connect

and create in the digital world." (D-ID, 2024) Leveraging the generated script and a video sample of the user, D-ID generates a lifelike video presentation seamlessly blending the user's likeness with the scripted content.

5.3.1 Benefits, Limitations, and Knowledge Gaps of Digital Twin Panel

This simulation's main objective is to delve into the diverse applications of digital twins and the accompanying resources and software that facilitate their use. Through this simulation, the aim is to exemplify potential methods for creating personalized digital twins using APIs and prompt engineering. This demonstration illustrates the efficiency gains achievable in creating presentations while still delivering a tailored experience to the intended audience.

Ideally, during the panel discussion segment, the audience could manually submit questions, which are then processed using prompt engineering techniques and fed into the Chat-GPT API. Equipped with the original research material and the presentation script, Chat-GPT generates contextually relevant responses, enabling the digital twin to engage in a dynamic Q&A session with the audience. However, with the limited time and capabilities of the existing technologies we employed, we were unable to implement the Q&A feature. This would require recalling the D-ID APIs to regenerate the video with the new script for the response.

With the utility of digital twins, there remain notable limitations and ample opportunities for further improvement and advancement. A significant limitation lies in the confined knowledge scope of the digital twin, as it can only draw upon the information

provided during its creation. However, future iterations could leverage advancements that enable seamless integration with cloud-based document repositories, allowing the digital twin to access and recall a broader range of knowledge dynamically. This capability would greatly enhance the depth and breadth of information available to the digital twin, fostering more comprehensive and contextualized responses during interactions.

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