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Deep Fakes: Potential Benefits, Concerns, Privacy, & Legal Regulations

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Introduction

Deep fakes are a new type of technology that has been emerging rapidly in the past few years. This research paper is a survey of the current information about deep fake technologies with a focus on the potential benefits, concerns, privacy, & legal regulations. They have been becoming more accessible to people on the internet and they can be potentially used for many positive benefits, but malicious actors can use them in concerning ways. Deep fakes are created using artificial intelligence as a method of replicating the image or video of someone else and manipulating its content. Deep fakes started emerging in 2017 and have been improving in quality over time. Since they are relatively new, there are many challenges with detecting and regulating them. The most popular deep fakes have been made of celebrities and public figures. The term was first coined when a reddit user with the username "deepfakes" posted pornographic videos with superimposed faces of celebrities like Gal Gadot and Scarlett Johannsen[1]. Celebrities are often the target of deep fakes because they have so many hours of video footage and pictures easily available online. Due to their influence, fake videos of famous people can be damaging to reputation, privacy, personal boundaries, public safety, and more. Therefore, even though deep fakes can be used as a tool for creativity and innovation, there also needs to be privacy and legal regulations to mitigate its harmful effects.

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[1] Paris, Britt, and Joan Donovan. "Deep Fakes and Cheap Fakes," n.d., 50.

Technology

The word deep fake is derived from a combination of "deep learning" and "fake videos". Deep fakes are a type of deep learning where an artificial neural network is trained on hours of data. The network uses a series of nodes where it takes information from the input layer and runs it through various nodes until it gets the generated output layer. They can be created using autoencoders, which is a neural network that is trained to copy the input to the output using an encoder and decoder.[2] By using a Generative Adversarial Network (GAN), the computer can create convincingly accurate faces for the videos.[3] The GAN has two main components, which are the generator and the discriminator. The first component generates natural looking images and the other component discriminates between the images to decide whether they are real or fake. Then the generator keeps making images trying to fool the discriminator from finding the fake ones. These tools are very helpful in creating realistic deep fakes that are difficult to tell apart from the real person.

There are three common types of deep fakes that are used on celebrities which are face swap, lip sync, and puppet master[4]. Face swap is when the face in a video is automatically replaced with another person's face using multiple images and video clips synthesized together. Lip sync is when only the mouth region is changed on the face and synced with an audio recording to make it look like the person is saying something that they never did. The puppet master technique is when one person is the target person and they are animated by someone else.

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[2] Jessica Ice. "Defamatory Political Deepfakes and the First Amendment." *Case Western Reserve Law Review* 70, no. 2 (n.d.): 422.
[3] Ibid.
[4] Agarwal, Shruti, Hany Farid, Yuming Gu, Mingming He, Koki Nagano, and Hao Li. "Protecting World Leaders Against Deep Fakes," n.d., 8.

The other person acts out different facial expressions, head movements, and eye movements which are superimposed on the target person's face.

Benefits

Although deep fakes can be used by malicious actors on the internet to impersonate identities and create chaos, there are many ways that deep fakes can be used creatively to positively impact society. They can be used at the intersection of different fields like history, art, entertainment, education, journalism, accessibility, and more. The following examples show different ways that deep fakes can be used to benefit society and provide users with a creative tool to use on the internet.

Deep fakes can be an innovative tool in modern art galleries and museums. One example is the Salvador Dalí Museum in St. Petersburg, Florida. The Museum features an exhibit with the famous 20th century artist Dalí, who has been brought back to life with machine learning. Visitors to the museum can interact with the exhibit and see Dalí say his famous quotes[5]. This is a really fascinating experience that can be potentially used with other artists and celebrities to help their legacy live on. Another example is when researchers on the Samsung AI Team in Moscow created a deep fake of the Mona Lisa[6]. Using the famous painting, they used other people's facial expressions and mapped it onto Mona Lisa's face to create a video of her talking. This is a technique that can potentially bring static paintings to life and make creative ways to experience the world of art through technology.

[5] Dami Lee. "Deepfake Salvador Dalí Takes Selfies with Museum Visitors." The Verge, May 10, 2019.
[6] "Mona Lisa 'brought to Life' with Deepfake AI." BBC News, May 24, 2019, sec. Technology. https://www.bbc.com/news/technology-48395521.

Another potential benefit of using deep fake videos is charity, public service announcements, and advertising. For example, David Beckham starred in an Antimalarial advertisement that informed people about the importance of health in areas that were at risk to malaria[7]. The campaign was called "Speak Up" and the video was translated into nine different languages. It appeared as if David Beckham was speaking multiple languages fluently, but his mouth movements were just being shaped using the lip sync deep fake technique. By allowing important people to appear to speak different languages, these deep fakes can be used powerfully to send messages around the world using technology. Deep fakes can be used by non-profit organizations and corporations to raise awareness, ask for donations, or give people a tool to talk to others even if they don't understand the language. These use cases illustrate how deep fakes can bridge barriers across the world and unite people by improving communication.

In terms of education, deep fakes can create interactive and immersive experiences for students to grasp a better understanding of concepts like history. For example, JFK's final speech at the Dallas Trade Mart was never heard because he was shot dead before giving it. However, it was an extremely powerful and historical speech that has been recreated using his synthetic voice. By using sound engineering, researchers took 831 speeches and 116,777 phonetic sound units to piece together the different sounds and manipulate his voice to make him say the speech[8]. This speech has been shared around the world with over 1 billion views. Classrooms can thoroughly improve the educational experience of millions of students by using these technologies and allowing them to engage with the content in a impactful and memorable way.

Furthermore, another way that deep fakes can be helpful to society is through accessibility. For people who may lose their voice, like those who have Amyotrophic Lateral

[7] "David Beckham Launches the World's First Voice Petition to End Malaria | Malaria Must Die."
[8] "JFK Unsilenced | CereProc Text-to-Speech." Accessed May 14, 2021.

Sclerosis (ALS), it would be amazing to have technology that synthesizes their voice and allows them to speak even after they lose it. Technology being developed by Team Gleason can help people still have their voice and use it in ways that can help them communicate with their friends and family[9]. Additionally, their face can be used only with their voice to create avatars of themselves that they can use online. Therefore, even if people are not able to speak or communicate with others, deep fakes can provide an outlet to let them express themselves however they want to in an online format.

And finally, although it may seem like a privacy problem, deep fakes can also provide an opportunity to enhance privacy online. By allowing people to express themselves anonymously, deep fakes can help preserve someone's individual identity online. For example, journalists and human rights activists might not be able to send their messages to people without facing the danger of exposing their identity to the public[10]. They might be scared of punishment or repercussions from the government. Therefore, they can create new avatars that speak for them using a synthetic voice and face. Although anonymity has many problems on the internet, it also has the benefit of open and honest expression online.

Concerns

While deep fakes can be utilized in many innovative ways, they also be used in many dangerous ways in society. The professor Hany Farid at Berkeley has done extensive research on the potential dangers of deep fakes and looking at ways to detect them. By impersonating someone else, like a celebrity or public figure, there are endless ways where people on the

[9] Ashish Jaiman. "Positive Use Cases of Deepfakes."
[10] Ashish Jaiman. "Positive Use Cases of Deepfakes."

internet can use the technology to lie and spread misinformation on the internet. Hany Farid has expressed concern about the following different options for using deep fakes.

One concerning way that someone can use a deep fake is to manipulate what a world leader or politician says to the public[11]. Using the virality of the internet, these videos can say false information and make it appear extremely realistic to millions of people. If there was a false video of a leader declaring war or insulting another country, there can be serious threats to world security. Deep fakes can be used as a tool to make fake news travel even faster and also seem more believable to the public. It can mess up elections by causing politicians to appear like they are saying and doing things that are completely fabricated using technology.

There can even be economic consequences for using deep fakes. For example, if someone shows a video of an important CEO making false claims about a company, then it can persuade people to adjust their stocks[12]. This can have huge consequences for the stock market and also any business or corporation in the world. Reputation is very important to many people's career and personal success, and it can be easily damaged through deep fake videos that are circulated to mass audiences.

There are many concerns with consent in videos since they are often made without asking the permission of the person whose face is used. One of the most common destructive ways that deep fakes are already commonly used are in pornographic videos. Since there is a lot of footage of celebrity videos in the media, people are able to map the celebrities' faces onto naked bodies that go viral on the internet. This can be very damaging to someone's reputation for many

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[11] Jessica Ice. "Defamatory Political Deepfakes and the First Amendment." *Case Western Reserve Law Review* 70, no. 2 (n.d.): 40.

[12] Bateman, Jon, and Jon Bateman. "Deepfakes and Synthetic Media in the Financial System: Assessing Threat Scenarios." Carnegie Endowment for International Peace.

different reasons. It can also cause personal trauma to the person who is non-consensually involved in the video.

Even when deep fakes are used in a way that is trying to be productive, there are still issues with consent. For example, a useful marketing strategy that is used in advertising is getting influential celebrities to showcase the product and praise it online. These brand deals can be very expensive for companies and also help them immensely. By using deep fakes, advertisers can easily get someone to promote their product for free. Even if charities, art museums, and exhibits are using deep fakes with good intentions, they are still using someone's face without their permission. Someone's face, image, and body is being manipulated to create a false persona that has been fabricated with technology. This technology can easily be used to create a historical narrative that is misleading to the public. While there are many opportunities for creativity, there are also many downsides that are inevitable.

Another concern with deep fakes is anonymity. While it can be a form of free expression, it also becomes very hard to detect the creators online. When these deep fakes are made and circulated through the internet, it becomes challenging to trace them back to the distributor and hold them accountable for any damage caused. People online from different countries can weaponize deep fakes against each other and the countries will not know where they came from. Without any global regulations, they can be used dangerously and incite major conflict. Since information moves so quickly on the internet, there are many avenues for misinformation to spread like wildfire if there are no preventative measures and regulations. One of the first challenges is determining which videos are deep fakes and which ones are real, so that the fake ones can be taken down.

Detection

Detecting deep fakes has been a difficult challenge, but it has been approached by many different strategies. In Hany Farid's research, he learned that one way to detect deepfakes is by focusing on the eye movements and blinking[13]. Since people usually blink for 0.1 - 0.4 seconds and they blink every 2 - 10 seconds on average, that is a non-trivial amount of blinking to be manually added to the deep fake videos[14]. It is difficult to get data for the machine learning models because most pictures of people don't show them with their eyes closed. There are ways to detect irregular blinking in videos using long-term recurrent convolutional networks (LRCN) to determine the approximate blinking rate and identify whether there is a lack or excess of blinking in it. This is a useful technique that has been successful in detecting poorly created deep fakes. However, one problem with finding solutions is that once they become public, then people will build around them. The latest deep fake videos have blinking added to them to circumvent the detection system.

Another way that researchers have been able to tell apart deep fakes is by looking at the inconsistent head poses and orientation of the face[15]. The researchers Yang, Li, and Lyu have developed a system where they can look at the head and eye positioning on the synthesized and real face and make 2D landmarks to compare their locations. In the deep fake videos, the landmarks on the central part of the face are mismatched to the overall face pose and orientation, so the researchers can use mathematical models to compare the differences. Then they train an

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[13] Agarwal, Shruti, Hany Farid, Tarek El-Gaaly, and Ser-Nam Lim. "Detecting Deep-Fake Videos from Appearance and Behavior." In 2020 IEEE International Workshop on Information Forensics and Security (WIFS), 1–6. New York, NY, USA: IEEE, 2020.

[14] Ibid.

[15] Yang, Xin, Yuezun Li, and Siwei Lyu. "Exposing Deep Fakes Using Inconsistent Head Poses." In ICASSP 2019 - 2019 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), 8261–65, 2019.

SVM based classifier using the head differences as a feature vector so that they can differentiate between the real and fake videos.

Additionally, researchers from Cornell have been able to tell apart videos based on the disparities in color components[16]. Since deep network generated (DNG) images have been created using Generative Adversarial Network (GANs), the colors have been transformed by the vectors in the network. Therefore, the colors have different components compared to a normal image captured by a camera with natural lighting from the real world. Therefore, the researchers were able to differentiate between the subtle differences in the coloration of the fake images that were manipulated by the GANs and the real images that were taken naturally. They are able to use the discoloration and determine whether the videos are deep fakes or not.

Another strategy for detecting deep fakes is looking at the aural dynamics of the face, which has also been researched by Hany Farid of Berkeley[17]. The ears are an important part of speaking that is often overlooked, but further research shows specific details that emphasize the connection between the jaw movement and the different parts of the ear lobes, ear canal, outer ear, and inner ear. Therefore, looking at the video, researchers can predict how the ear should move in response to the jaw movement, and check if the alignment is accurate in the deep fake video.

Additionally, there is an AI online that has been developed to verify deep fakes. The FaceForensics++ Dataset was created by training a neural network on over 1000 YouTube videos[18]. The YouTube videos have been manipulated using four popular technologies that

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[16] Li, Haodong, Bin Li, Shunquan Tan, and Jiwu Huang. "Identification of Deep Network Generated Images Using Disparities in Color Components," August 22, 2018.
[17] Shruti Agarwal, Hany Farid. "Detecting Deep-Fake Videos from Aural and Oral Dynamics," n.d., 9.
[18] Rossler, Andreas, Davide Cozzolino, Luisa Verdoliva, Christian Riess, Justus Thies, and Matthias Niessner. "FaceForensics++: Learning to Detect Manipulated Facial Images." In 2019 IEEE/CVF International Conference on Computer Vision (ICCV), 1–11. Seoul, Korea (South): IEEE, 2019.

people use to make deep fakes — Face2Face, DeepFakes, FaceSwap, and Neural Textures. The AI is able to detect whether the video is real or fake by checking whether the video is similar to other videos manipulated using these techniques. However, this dataset is also public, which repeats the problem that publishing ways to detect deep fakes will always give people a way to build around them. But using AI to detect these four deep fake creation technologies has been useful in the past for detecting fake videos that are created using these common softwares.

Laws and Regulations

Since deep fake technologies have only been around for the past few years, there are many uncharted waters when it comes to the laws and regulations. There are not many federal regulations that directly address deep fake distribution, but only laws which encourage the government to research deep fakes and report their findings. The National Defense Authorization Act (NDAA) from 2021 requires the Department of Homeland Security (DHS) and the Department of Defense to research deep fake detection and creation so that they can report it annually for the next five years[19]. The Identifying Outputs of Generative Adversarial Networks (IOGAN) Act[20] from 2020 asks the National Science Foundation and the National Institute of Standards and Technology to also work on deep fake authenticity and work with the private sector on possible solutions. There have been more bills that have been introduced to Congress to try and regulate them, but they have either expired or are still waiting for approval. Specifically, the Malicious Deep Fake Prohibition Act of 2018 attempted to make creation or distribution of

[19] Adam Smith. "Text - H.R.6395 - 116th Congress (2019-2020): National Defense Authorization Act for Fiscal Year 2021." Legislation, January 1, 2021. 2019/2020.
[20] Anthony Gonzalez. "H.R.4355 - 116th Congress (2019-2020): Identifying Outputs of Generative Adversarial Networks Act." Legislation, December 10, 2019. 2019/2020.

fake electronic media a criminal offense, but the bill died in Congress[21]. Another bill, the Defending Each and Every Person from False Appearances by Keeping Exploitation Subject (DEEPFAKES) to Accountability Act of June 2019 was another attempt to regulate use of deepfakes by categorizing it as an advanced technological false personation record[22]. The bill would require all deep fakes to have either a watermark or text description saying that the deep fake was an altered video and not the original. If there was a failure to provide either of those options, then the person caught with creating the deep fake would face a fine up to $150,000.

Although there are not many federal regulations, several states have passed laws to regulate deep fake distribution and creation. However, these laws are different from state to state, For example, in 2019 in California, Assembly Bill 730 makes it illegal to create deep fakes about politicians 60 days before an election in order to reduce misinformation[23]. In 2019, Texas also used Senate Bill 751 to ban political deepfakes that may influence an election[24]. Furthermore, the House Bill 2678 in Virginia also tries to ban deep fakes, specifically ones using pornographic videos and revenge porn[25]. These are all examples of bills that have passed in different states around the U.S., but they have not been widely standardized across the U.S. So even if the video was made in one state, it can easily be spread across the world and country without repercussions since the laws are not globalized.

One of the main obstacles with these bills are the First Amendment laws. Since deep fake videos can be interpreted as a form of freedom of speech, there is strong pushback from banning

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[21] GovTrack.us. "Malicious Deep Fake Prohibition Act of 2018 (2018 - S. 3805)." Accessed May 14, 2021.
[22] Yvette D Clarke. "H.R.3230 - 116th Congress (2019-2020): Defending Each and Every Person from False Appearances by Keeping Exploitation Subject to Accountability Act of 2019." Legislation, June 28, 2019. 2019/2020.
[23] "Bill Text - AB-730 Elections: Deceptive Audio or Visual Media."
[24] "86(R) SB 751 - Enrolled Version - Bill Text."
[25] "Bill Tracking - 2019 Session > Legislation."

them outright. They bring up a similar problem to hate speech and fake news on the internet, which social media platforms already have difficulty with content moderation and regulation. The bills that are brought to Congress face resistance because it is difficult to get them to supersede First Amendment rights. Social media companies like Facebook and Google are the ones who have the power to use content moderation and limit the spread of malicious deep fakes on their platforms. Private companies have more speed and flexibility with regulating their content than the government does, but governmental regulations are necessary for preventing many potential dangers that are unprecedented.

Unfortunately, copyright laws do not provide much support for deep fake regulation. Unless the use is commercial and the video uses other content to make it successful, then there is no reason to have copyright takedown. The ones that need to be taken down are not usually made for commercial value, but their goal is spreading misinformation instead of financial gain. Deep fake videos are also used satirically, which is a legal form of transformative use. They can be very powerful tools to impersonate others and critique them in a meaningful way. However, these critiques seem more intrusive than usual because it is not just someone dressing up and imitating a celebrity or public figure. The technology mutates the person's face to create a false video that can mislead the public.

These uses can have serious consequences on the reputation of the person. Traditionally, threats to reputation have been regulated through defamation law. Defamation law holds accountability for damaged reputation either through slander or libel. Defamation requires a false and defamatory statement and also proof of harm to the person who is the victim in the video[26]. It is difficult to say whether there was "actual malice" in the video because the creator could

[26] Findlaw. "Libel, Slander, and Defamation Law: The Basics."

claim that they were being purely satirical and not trying to confuse the public. Therefore, one suggestion is to require that all deep fake videos clearly have a disclaimer or watermark embedded into the videos to show that it's fake[27]. This will help distinguish between the deep fakes made for positive uses and the ones dedicated to creating chaos on the internet. However, the people who make their videos with malice are not the people who would add clarification watermarks to their videos. Those are not incentivized to reveal that the video is fake because they are hoping to not get caught. Also, watermarks are relatively easy to remove, crop out, or edit, and metadata is usually stripped on social media platforms. Therefore, requiring watermarks will increase more transparency on videos that are made for creative reasons, but the more damaging ones will continue to spread.

Potential Regulations

In my opinion, the state bills in California, Texas, and Virginia are a good start for regulations, and they should be applied on a federal level. Although beneficial, the potential dangers heavily outweigh any of the benefits of deep fake videos. Therefore, for cases like politics, where misinformation is a huge problem, deep fakes should be banned and severely punished so they do not influence an election. Additionally, with pornographic content, the deep fakes can seriously be hurtful to people and therefore should have strict penalties, even if they are made satirically. If someone is caught developing deep fake videos and spreading them on sites, then those accounts should be deleted and banned from those platforms.

It would be ideal if people had a right to their own likeness and publicity so that it cannot be duplicated digitally and used against them. Even for actors or celebrities who are dead, there

[27] Bateman, Jon, and Jon Bateman. "Deepfakes and Synthetic Media in the Financial System: Assessing Threat Scenarios." Carnegie Endowment for International Peace.

should be a time period where there needs to be consent from their will or heirs if people want to use their persona in a deep fake video. Without more harsh regulations and punishments for deep fakes, there will be less barriers for people to create them and cause harm to society. Satirical videos are entertaining and informative, but they are much more controversial when they have the power to deceive the audience. Therefore, using deep fakes to provide any information that is false should have more severe consequences, especially when it's a form of hate speech or fake news. Similar to fact checkers, it would be helpful if the government found a way to provide users with free tools to check whether a video is real or not. The policies that are currently in place do not provide much protection to people since the internet is more far reaching than individual states. That is why it is important to bring legislation to the Supreme Court and federal level so that everyone in the country can have more agency and safety surrounding their online persona and identity.

Conclusion

In general, whenever new technologies are developed, there are new opportunities to use these technologies in productive or malicious ways. With deep fake technologies becoming more advanced, easier, and cheaper to make, there are potential areas of danger which need laws and regulations to combat the detrimental effects to society. While there are many positive opportunities to use deep fakes in creative ways and enhance society, it is important to think about the negative consequences they can have on the lives of individuals and the world. When there is privacy and security at stake, there should be more funding and investment in finding solutions to the evolving problem. Regulation in the digital world is an important challenge in the 21st century that will constantly need updates since technology changes rapidly over time.

There hasn't been much precedent when it comes to novel uses of artificial intelligence and machine learning. Therefore, further research into deep fake detection and policy should be a national priority in order to create a safer environment for everyone on the internet.

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