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Survey and Analysis of Deepfake Media as it Applies to the New era of Disinformation

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RIT

Survey and Analysis of Deepfake Media as it Applies to the New era of Disinformation

By

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A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Fine Arts in Visual Communication Design

School/Department of Design

College of Art and Design

Rochester Institute of Technology

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December 1, 2021

Committee Approval:

Adam Smith Date

Director (Coordinator) of Ph.D. program/Dissertation Examination

Chairperson/Supervisor/Department Chair(person)(Head)/Program

Director/Chief Advisor/Dissertation (Thesis) Advisor

Abstract

The world has become a place where technology and the internet is so integrated into every-day life that people rely on the media and internet access to stay informed and connected. But, that has exposed us to a whole new world of positives and negatives, and the negatives could be catastrophic for our society. It will soon be very difficult for the average person to distinguish between figment and reality; primarily with video, which has always been seen as a credible form of evidence. Deepfake videos are a prime example of this growing phenomenon. They are videos in which, with the help of AI learning, someone's face or voice is copied and swapped with someone else's. This can easily result in a scenario where an event can be completely fabricated. Misinformation is a very serious global issue and it is only getting worse. And it seems like either no one really sees what is to come or they don't understand the seriousness of the situation. I chose to dive deeper into this topic in order to better understand it. In doing so, I have created a visual awareness campaign using elements of motion design that brings attention to this issue and presents important information. This is an overarching problem that currently does not have a definite solution.

Keywords: Review, Deepfake, Deep Learning, Design, Motion Design, Disinformation

Dedication

I would like to thank everyone that helped me on this journey. Thank you to all of my professors. I came from an illustration background so I was pretty much making a 180 degree switch in major and had to start from scratch to learn both basic design principles, after effects, and 3d software all in 2.5 years. Thank you for your patience, feedback, and for giving me a chance. Thank you to my parents and family, who always believed in and cheered for me, even when I felt like I was making a mistake. Thanks to my father, who allowed me to stay at home while I finished this degree in order to save money; who talked me through my frequent phases of self doubt and stayed honest with me. To my classmates who became some of the best friends I've ever had, thank you for being in the trenches right along with me, laughing, crying, and celebrating when things actually worked out for once. I already miss the late night lab sessions, going out for food, and having mini holiday celebrations with everyone. Let's get out there and show the word what we can do; that all of the stress and madness wasn't without reason. I hope to visit at least some of you again soon.

Problem Statement

With the rapid development of deepfake videos, it will soon be very difficult for the average person to distinguish between figment and reality, and most don't seem to know what's coming or aren't taking it seriously.

Critical Analysis

What Are Deepfakes?

Deepfake videos are like photoshop but for videos. With the power of AI learning, someone's face or voice is copied and swapped with someone else's. This can easily lead to a scenario where an event can be completely fabricated. Technology is constantly improving to the point where some home computers can now accomplish feats similar to film cgi. Using deep/AI learning algorithms, a computer can be trained to recognize specific facial features and expressions over time after being given either thousands of images or a few source videos to sift through. Once enough data is collected on the desired people, that information can be lifted and applied to other target faces. This can also be accomplished with audio. If given enough source audio files to work with, it can pick up and recognize someone's tone, speech pattern, and inflection. This data can be used to mimic a person's voice[11].

Deepfakes began as a form of entertainment. But that does not mean that the technology cannot be used for ill. There is growing concern that, as the tech improves and streamlines, there will be more opportunities for it to negatively affect how we see and trust visual media. People's reputations and lives could be ruined very quickly if it were to be used as a direct cyber attack.

Unfortunately there is an example of this already happening. A Pennsylvania mother was arrested on March 4 of this year and charged with three counts of cyber harassment of a child and three counts of harassment. She "allegedly sent deepfake photos and video of her teenage daughter's cheerleading rivals depicting them naked, drinking and smoking to their coaches in a bid to get them kicked off the team," according to Hilltown Township Police Department[22]. Over the past few years, manipulated

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[1]1 Ian Sample. "What are deepfakes – and how can you spot them?" theguardian.com. Jan 13, 2020. https://www.theguardian.com/technology/2020/jan/13/what-are-deepfakes-and-how-can-you-spot-them

[2]2 Lenthang, Marlene. "Cheerleader's mom created deepfake videos to allegedly harass her daughter's rivals." abcnews.go.com. March 13, 2021

media has begun to affect the political world. There was a past incident where a suspected deepfake may have contributed to an attempted coup in Gabon and to an unsuccessful effort to discredit Malaysia's economic affairs minister and drive him from office. A disinformation campaign tried to prevent Emmanuel Macron from being elected as France's president in 2017. It was thwarted in time, but it would have been much worse if officials weren't prepared[33]. Imagine if the technology was more advanced.

Solutions?

Several governments, conglomerates, and academic institutions have been brainstorming on possible solutions. One option that they are exploring is making their own algorithms for detection.

Facebook, Microsoft, and AWS collaborated to host a deepfake detection challenge, allowing volunteers to contribute and test their own programs against the training dataset of over 100,000 videos. The winning teams managed 85% accuracy on the dataset but only 65% with other real-world deapfakes that were not a part of that set[44]. That's not enough to be a viable solution and even if improvements were made, the deepfake technology itself is improving at a similar rate if not faster. Another algorithm called AMTENnet (Adaptive Manipulation Traces Extraction Network) is under development in China that uses a different method for detection. Overall accuracy is marginally better (81% overall) but still not enough for a permanent solution[55].

Opinions are slowly swaying away from viewing detection as a long term solution. Ashish Jaiman, director of Technology operations at Microsoft, believes that only a combination of "legislation, media literacy, and technology" working together will hope to head off the use of malicious use of deepfakes[6] [4]. I agree with this notion. In other words, technology will prove useful in helping us keep track of and

.https://abcnews.go.com/US/cheerleaders-mom-created-deepfake-videos-allegedly-harass-daughters/story?id=76437596

[3]3 Galston, A.William. "Is seeing still believing? The deepfake challenge to truth in politics" brookings.edu. Jan 8, 2020. https://www.brookings.edu/research/is-seeing-still-believing-the-deepfake-challenge-to-truth-in-politics/

[4]4 Ashish Jaiman. "Deepfake Detection is Super Hard!!!." towardsdatascience.com. July2, 2020. https://towardsdatascience.com/deepfake-detection-is-super-hard-38f98241ee49

[5]5 Manuel Silverio. "Detection of DeepFakes and other facial image manipulations via AMTENnet." towardsdatascience.com. Jan 22, 2021.

https://towardsdatascience.com/detection-of-deepfakes-and-other-facial-image-manipulations-via-amtennet-82689132bec2

[6]4

verify media via watermarks, reverse image searches, and digital markers/signatures, but it is ultimately up to us to actually use those to do our own research and verify for ourselves.

My solution

I am reiterating that my solution is not to solve the problem of deepfakes for everyone. My solution is to create a visually compelling PSA or visual awareness campaign that will give viewers the basic information that they need to know and that will inspire them to go forth and research further. My objectives with this are to address, inform, advise, and answer the relevant questions: What is going on? Why should anyone care about this? How might this phenomenon affect us? Who is affected? Dealing with the future? Another main objective is to make the video as visibly impressive as I can possibly make it in order to leave an impression on the viewers. Final deliverables include a 1-minute video using elements of 2D, 3D, and motion design. It contains several examples of deepfake videos and imagery that represent how often media of this nature is present in our everyday lives. Major themes found in the video include our relationships with our phones, computers, and our tendency to believe most things that we find on the internet, to our own detriment.

Conclusion

While my project may not solve the problem, it contributes to the proposed solutions so far by spreading awareness and giving the public a chance to arm themselves with knowledge. The long term solution is basically critical thinking and research (with the help of technology of course). I would like to think that my project assists with that concept. The most important aspect of this project however, would be the exploration of the power of design (as well as the tools utilized to create). Design has the power to create the untruth but it also has the power to reveal it. Several parts were created using 3d software like Cinema 4D and Blender. Illustrator was used to add some 2d elements, and After Effects brought everything together with compositing and supporting animation. These tools, along with some machine learning, make it easier to create the concerningly convincing deepfake media that I am simultaneously trying to warn viewers against. We are advancing technologically as a society and our lives are slowly but steadily improving but at what cost?

Appendix A: Bibliography

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THE DEEPFAKE

Spreading Awareness on Disinformation

Jade L. Wise

Process Deck

RIT VCD 2020

Problem

With the rapid development of deepfake media, it will soon be very difficult for the average person to distinguish between hoaxes and reality, and most don't seem to know what's coming or aren't taking it seriously.

Solution

There currently isn't a difinitive solution for detection or prevention of deepfakes. So, my solution is to focus on planning for the future. The best way to combat disinformation is awareness and improved media literacy.

Objectives

Visual Awareness Campaign. We have been and will continue to be exploited if we don't have the right information to act on. Fill the public in on what they need to know in a visually compelling way.

- What is going on?
- Why should anyone care about this?
- How might this phenomenon affect us? Who is effected?
- Dealing with the future?

— Address

— Inform

— Advise

What Are Deepfakes?

Deepfake videos are videos in which, with the help of AI learning, someone's face or voice is copied and swapped with someone else's. This can easily lead to a scenario where an event can be completely fabricated.

For a long time, it was difficult for the average person to manipulate media in this way. The technology and skill required was mostly limited to those in the film industry. However, technology is constantly improving to the point where some home computers can now accomplish similar results.

Research-How?

How are deepfakes made? Using deep/AI learning algorithms, a computer can be trained to recognize specific facial features and expressions over time after being given either thousandss of images or a few source videos to sift through. Once enough data is collected on the desired people, that information can be lifted and applied to other target faces.[1]

This can also be accomplished with audio. If given enough source audio files to work with, it can pick up and recognize someones tone, speech pattern, and inflection. This data can be used to mimic a person's voice.

So for example, you can film youself saying "I ate all of the chocolate chip cookies," and replace your face and voice with Tom Cruise's.

Research-Why?

The first deepfake videos emerged in 2017 when a reddit user posted several of them to the site. The faces of well known actresses' were swapped out and placed onto the faces of adult video actresses instead. Around 96% of deepfake videos are of this nature[1]. The other 4% are being created for humor or to potentially cause harm.

A more recent and very interesting example of deepfake technology being used for a unique purpose would be MyHeritage. They are a genealogy website that allows people to "bring photos of their family members to life." Their specific algorithm allows for reanimation of still images, with movement of the eyes and some minor facial expressions. Reactions[2] to this are mixed. Some are moved to tears with happiness and some are extremely uncomfortable with the concept, placing it in the vacinity of uncanny-valley.

Research-Effects

As was mentioned earlier, deepfakes started as a means of entertainment. But that does not mean that the technology cannot be used for ill. There is growing concern that, as the tech improves and streamlines, there will be more oportunities for it to negatively effect how we see and trust visual media. People's reputations and lives could be ruined very quickly if it were to be used as a direct cyber attack.

Unfortunately there is an example of this already happening. A Pennsylvania mother was arrested on March 4 of this year and charged with three counts of cyber harassment of a child and three counts of harassment. She "allegedly sent deepfake photos and video of her teenage daughter's cheerleading rivals depicting them naked, drinking and smoking to their coaches in a bid to get them kicked off the team," according to Hilltown Township Police Department.[5] Imagine if the technology was more advanced...

Research-Effects

Of course, deepfake technology can also negatively effect politics and the reputations of the people we look up to in media; activists, scientists, movie actors. If there are photos or videos of them up on the internet, then their likenesses are fair game.

There was especially some fear of malicious media manipulation during this past U.S. 2020 presidential election. While the election is now behind us and deepfake videos were not directly involved this time, disinformation still played a very large part in the events that transpired and the time to fear deepfake technology is defiitely coming. It's a question of "when," not "if."

As far as examples in politics go, there was a past incident where a suspected deepfake may have contributed to an attempted coup in Gabon and to an unsuccessful effort to discredit Malaysia's economic affairs minister and drive him from office. A disinformation campaign tried to prevent the election of Emmanuel Macron as France's president in 2017. It was thwarted in time, but it would have been much worse if officials weren't prepapred. It's already happening.

Research-Solutions?

The powers that be have been keeping an eye on the progression of the deepfake phenomenon and they are beginning to realize that this technology may cause several very serious problems in the near future. So, Several governments, conglomerates, and academic institutions have been brainstorming on possible solutions. One option that they are exploring is making their own algorithms for detection.

Facebook, Microsoft, and AWS announced that they were contributing to the development of a deepfake detection algorithm and hosted a coding challenge, allowing volunteers to contribute and test their own programs against the training dataset of over 100,000 videos. The winning teams managed %85 accuracy on the dataset but only %65 with other real-world deapfakes that were not a part of that set. That's not enough to be a viable solution and even if improvements were made, the deepfake technology itself is improving at a similar rate if not faster.

3.

Research-Solutions?

Other players participating in the detection race are researchers in China. A paper was published fron the Hunan and Nanjing university that explains AMTENnet (Adaptive Manipulation Traces Extraction Network). It's an algorithm that tackles deepfake detection in a different way. [4]

"Typical face manipulation forensics attempts to predict the manipulation of traces and extract them. However, AMTEN uses the difference between the input image and the output feature map to extract these manipulation traces."

-- Manuel Silverio, PHD in Digital Transformation, Coventry University, UK

The accuracy of this method is higher(%81 overall) than the results obtained from the Facebook Deepfake Detection Challenge (%75 overall). However, it is still not enough to label this as an effective solution and more data needs to be collected. Theres is also the possibility that deepfake tech will evolve even further and this solution may not apply anymore by the time it leaves the ground.

Research-Solutions?

While detection may be a somewhat effective solution that is worth investing time to promote improvement, it may not be enough to solve the problem in the long term. Ashish Jaiman, director of Technology operations at Microsoft, believes that only a combination of "legislation, media literacy, and technology" working together will hope to head off the use of malicious deepfakes. [3] **I agree with this notion. Jaiman also breaks the possible countermeasures into three categories:**

- **Media Authentication:** watermarking, media verification markers, signatures, and chain-of-custody logging; is supposed to be the most effective because it verifies and tracks integrity throughout its interweb journey and verifies it at its start point of distribution.[3]
- **Media provenance:** Sort of like reverse image search. If you know where the media first originated, then it's easier to determine if and when it was manipulated. This together with authentication may be more effective than detection through AI.
- **Deepfake Detection:** Can include manual techniques with human media forensic practitioners, often armed with software tools. And ofcourse AI detection with algorithms. AI may be helpful in the short term but not so much long term.[2]

My Solution

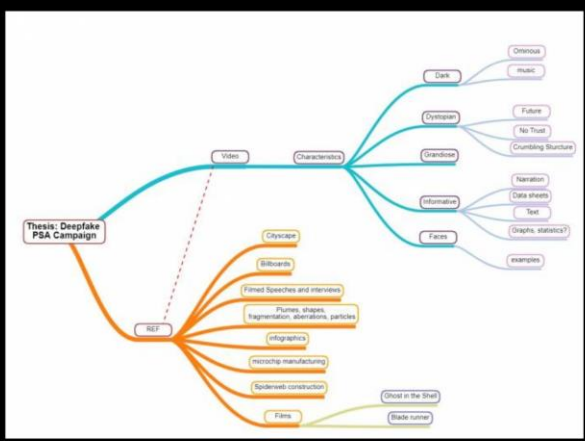
I am reiterating that my solution is not to solve the problem of deepfakes for everyone. My solution is to create a visually compelling PSA that will give viewers the basic information that they need to know and that will inspire them to go forth and research further.

Deliverables

- 1 minute video using elements of 2D, 3D, and motion design

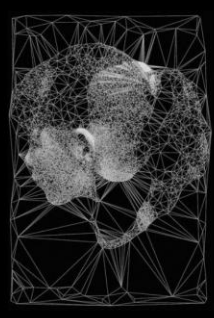
Design Process

It started with an idea and a mind map. The subject matter for this project carries a dark undertone so I already knew that I wanted to lean more toward imagery that could be considered ominous, mysterious, and dystopian for inspiration. It seemed like the best fit for the aesthetic.



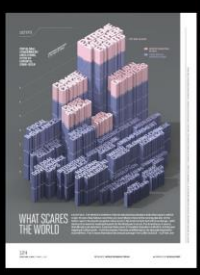
Design Process-Inspiration

The face aspect is a big one of course. but I originally became attached to the idea of faces being artificially created, as if the AI is crafting more pieces to a larger puzzle as it gathers more facial data.



Design Process-Inspiration

Ciities, modular objects, glow effects for a dark, future dystopian feeling.

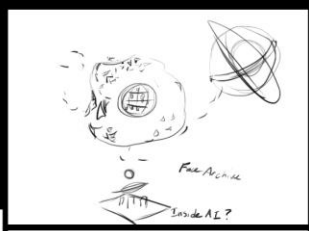


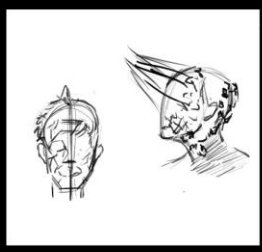
Design Process-Sketches

Thumbnail sketches, experimenting with concepts based on reference images.

Eventually, 3 main scenes kept showing up in the iterations:

- Nexux/plexus network: internet/servers/cyberspace
- Facial construction: Deepfakes
- City Streets/billboards: media/greater society





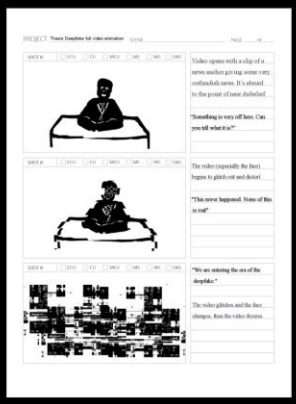
Design Process-Sketches

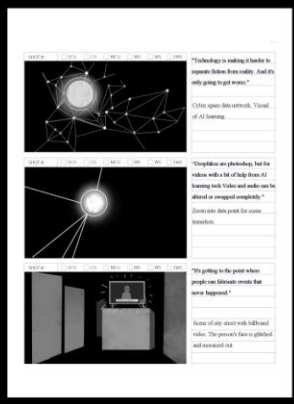
First pass at storyboarding, figuring out how each scene and elements might fit together more seamlessly.

The project began to present itself a bit more narratively other than abstract. Wasn't sure how I felt about it at first, but over time, I began to think of new directions it could go in to make that work.

Design Process-Storyboard

Second pass at storyboarding, working on softening the abrupt changes in imagery and getting them to work together. There's a reason for each scene, but they still have to work together visually.

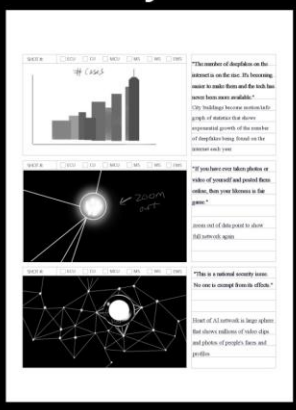


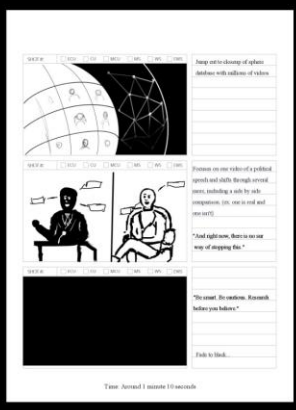


Jade Wise VCD Thesis Process Deck 19

Design Process-Storyboard

Storyboard second half.

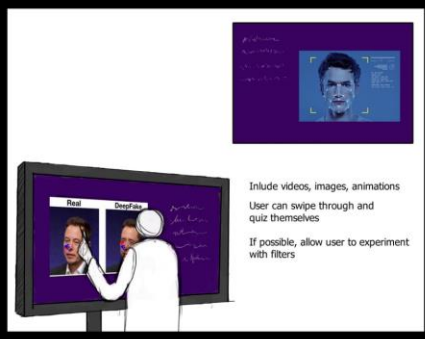




Jade Wise VCD Thesis Process Deck 20

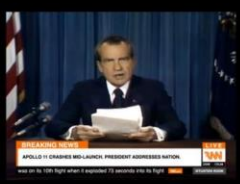
Design Process-Pandemic

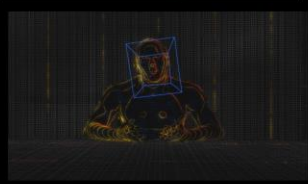
Very early stage planning for imagine at RIT before the pandemic hit in full force and the festival was cancelled. The original idea was to build an exhibit and find a way to use AR technology in order to allow viewers to make deepfakes using their own faces. The technology to make high quality deepfakes in real time hasn't been invented yet, but making some AR filters for fun would've been an interesting idea.



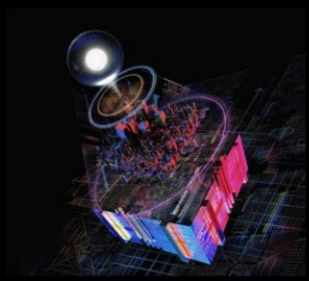
Design Process-Iterations

The start of experiments and iterations for the project itself. Exploring the possibilities ans seeing what was possible within the boundaries of my own skill level. The hardest part is bringing your ideas out into the physical world and figuring out the "How."





Design Process-Iterations

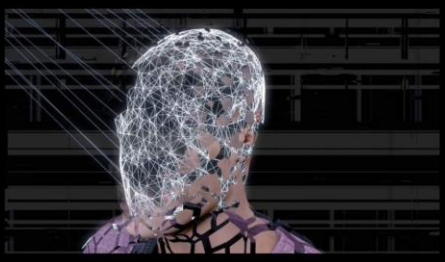


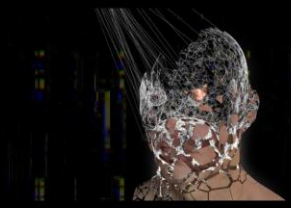
Design Process-Iterations

Color Palette that will be present throughout the project:

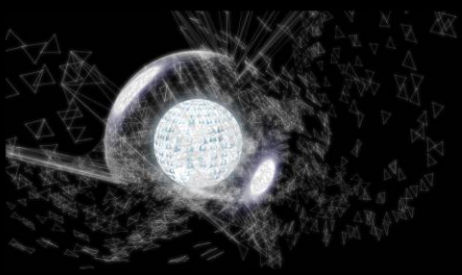
#2A2D34 #204A78 #39B7CE #A53F2B #FFFFFF

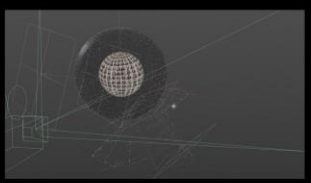
Design Process-Iterations



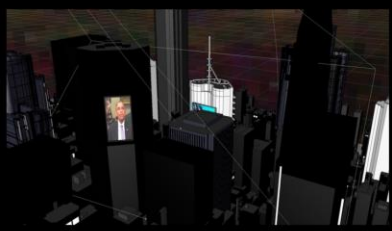


Design Process-Iterations





Design Process-Iterations



Design Process-Iterations

Final Style Frames

For the final iterations of style frames, I chose to forego some of the extra 3D elements in favor of focusing more on the deepfakes themselves and sybolizing the far-reaching consequences of spreading false information.

Jade Wise VCD Thesis Process Deck 29

Screenshots

Jade Wise VCD Thesis Process Deck 30

Final Video

On Semplice Webpage:

https://designed.cad.rit.edu/vcdthesis/project/jade-wisepreview_id3522previewtrue?preview_id=3522&preview=true

Source Endnotes

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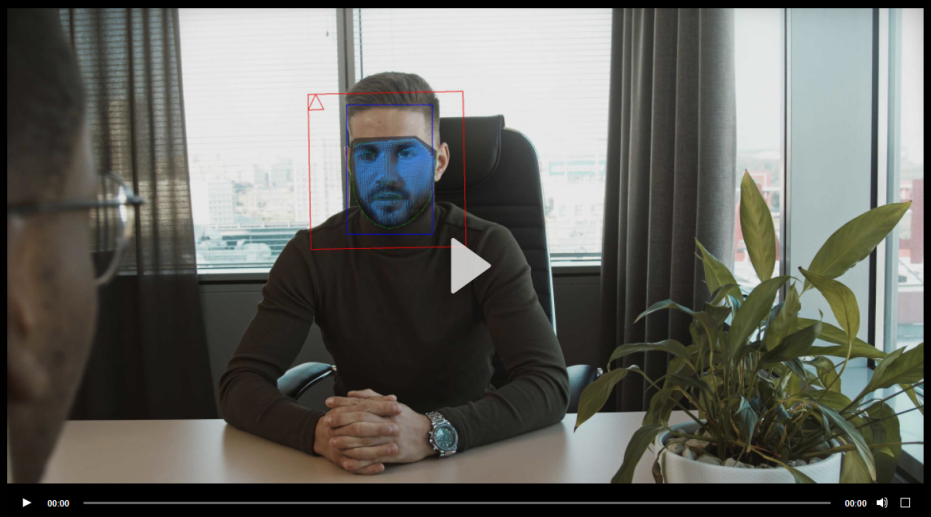


Full Video

Process Deck

Deepfake

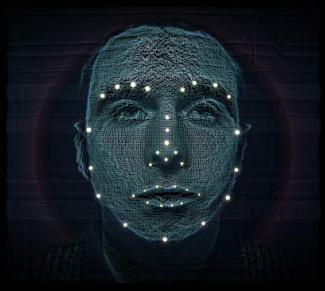
Synthetic media in which a person in an existing image or video is replaced with someone else's likeness using AI learning software. And anyone's likeness is fair game.

Problem

Technological advancement is making increasingly more difficult for the average person to determine what is real and what isn't. For years we have considered video footage to be the most concrete source of truth and evidence. That is no longer the case.

The number of videos being produced continues to rise and it is becoming easier for anyone with a powerful enough computer to make their own. The software is also free for download. Despite the seriousness of the situation, there currently is no solution. Research is in progress but in the meantime, this still needs to be brought to everyone's attention.

- According to a study conducted by a company named Deeptrace, there were more than 15,000 deepfake videos recorded on the internet in December of 2019. That's an 84% increase from december of 2018.



Objective

Visual Awareness Campaign. We have been and will continue to be exploited if we don't have the right information to act on. Fill the masses in on what they need to know in a visually compelling way.

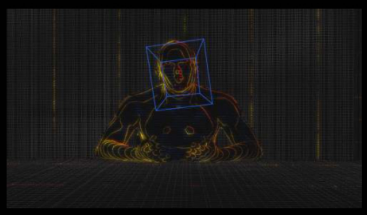
- **What is going on?**
- **Why should anyone care about this?**
- **How might this phenomenon affect us? Who is effected?**
- **Dealing with the future?**

Address

Inform

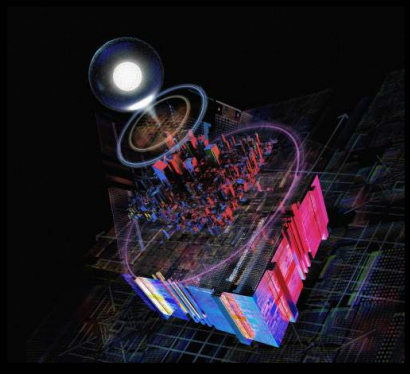
Advise

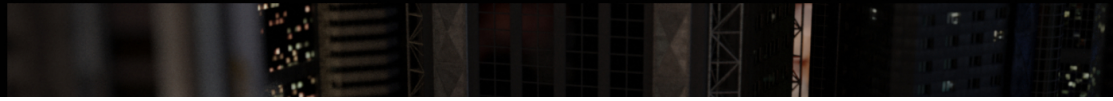
Deliverables



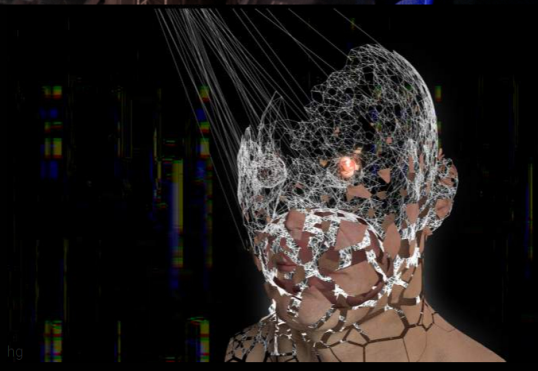
1- minute PSA video using elements of motion design and cinematic visualization. A visually compelling experience that will stay in viewers' minds long after they have watched it.

Promotional

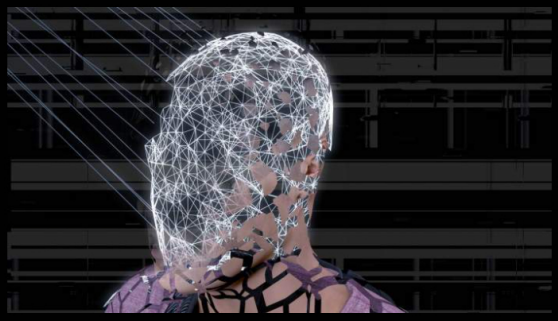




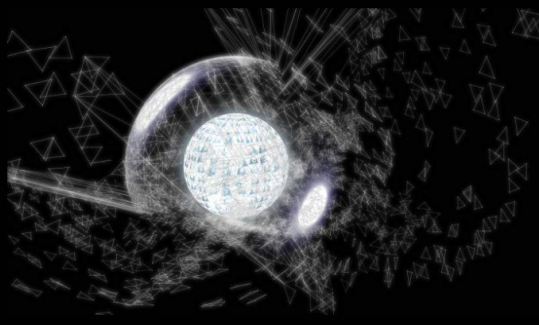
Fun visuals as promotional material.



Process/Inspiration

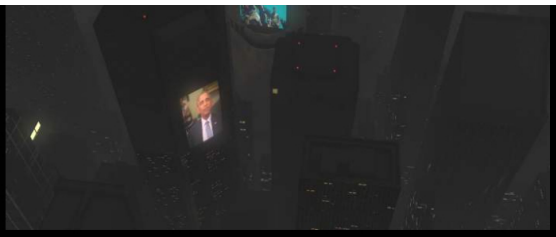


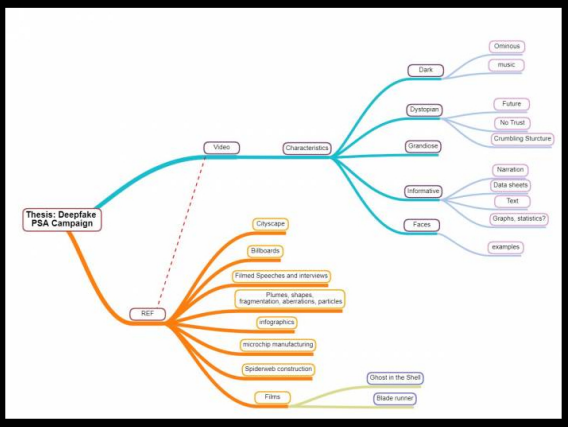
Visually interesting representation of the deepfake AI software learning distinguishing features and facial expressions.



Represents the expansive network of the identities of anyone who has shared their likeness on the internet.

Potential future in which the problem of deepfakes would spread and affect everyone, from surveillance footage to official political speeches.

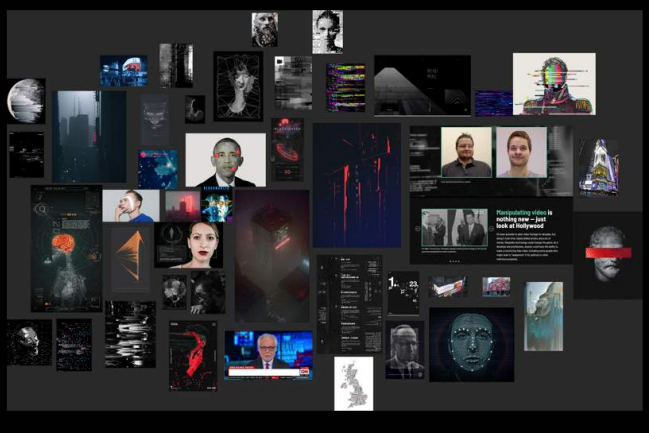




Mind Map

Map to keep initial thoughts organized and to explore what the limitations are for the characteristics.

- **Influences gathering of references for mood or style boards; they feed from each other.**
- **Helps limit characteristics of the overall visual style.**
- **leads to other helpful references during ideation process.**
- **Future/dystopian due to the possible future effects in the real world.**



Style Board/References

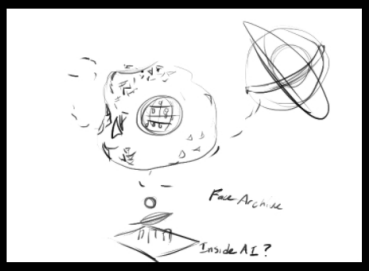
The subject matter for this project carries a dark undertone. Gravitating more toward imagery that could be considered ominous, mysterious, and dystopian for inspiration seemed like the best fit for the aesthetic.

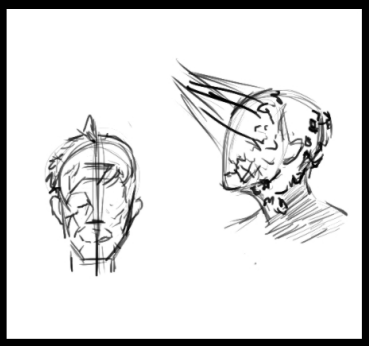
- **Futuristic/dystopian imagery.**
- **mainly dark color palette with one or two bright accent colors.**
- **particle and glow effects.**

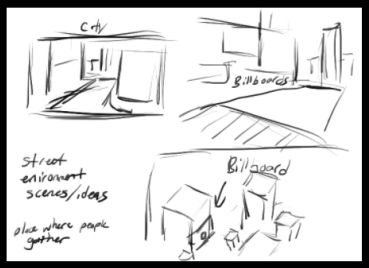
Sketches/Ideation

Started with random ideation sketches and shape experiments once the references were collected. Then moved to rough storyboarding to carve out the narrative.

- **While sketching out ideas, the words "futuristic", "ominous", and "tension" were consantly kept in mind.**

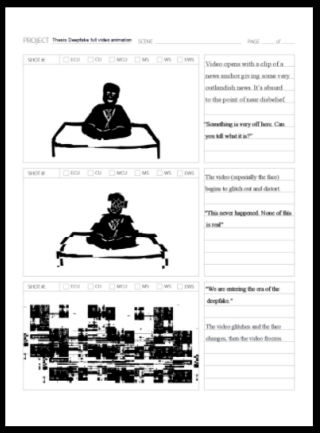


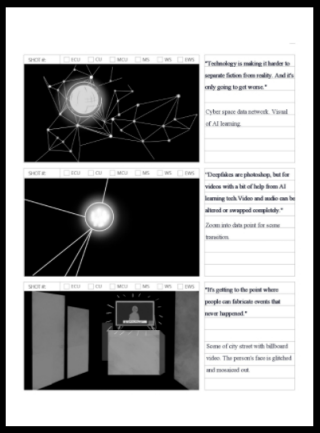




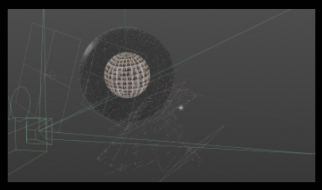
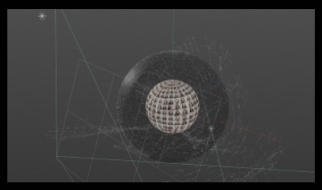
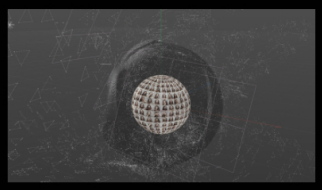
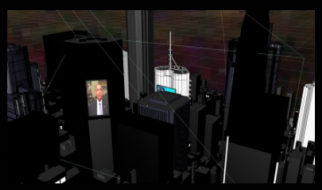
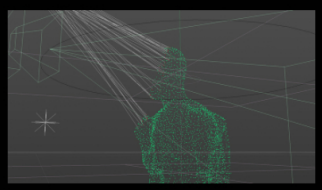
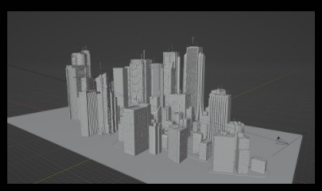
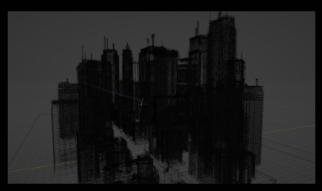
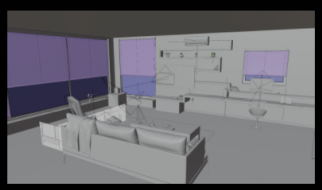
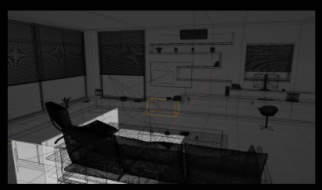
Storyboarding

First pass of Storyboards to show the progression and transition of scenes.





Time: Around 1 minute 10 seconds

3D Progress shots

This process included the heavy usage of adobe After Effects for footage manipulation, and both Cinema 4D Blender for scene construction.

- Modeling and animation= Cinema 4d, Blender
- Post effects= After Effects
- X-particles was also used to create the knitting effect as seen in a few of these process shots.

Final Style Frames

Conclusion

Throughout this process, I have learned a large amount about the topic of deepfakes and how they may affect our world in the future. I also learned how to create my own deepfake, which truly revealed how easy the process actually is. This encouraged my own passion for this topic even further and it helped inspire me to make this campaign. This is happening right now and it feels as if no one is aware of it. People do not realize that our right to feel safe and to trust is slowly being taken away.

The biggest challenge was pinning down my visual style and coming up with the relevant imagery to convey my message. That ended up being the main challenge after collecting research. How can I take this information and present it in a way that would capture attention, be informative, and stay within the viewers' minds? It's especially difficult considering all of the readily available information that is shortening people's attention spans. I chose to trust the process to and stop second guesing my own decisions.

Allowing the viewers to see this and experience the emotions that the visuals and information present to them is the main goal. I hope that they are inspired

to research this topic further afterward.

Thank you for taking the time to view this page.

Some References

1. https://www.youtube.com/watch?v=g5wLaJYBAm4&t=54s
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5. https://soundcloud.com/rittigers/intersections-episode-32-deep-fakes

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Adam Smith

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Adobe Illustrator

Adobe Photoshop

Adobe After Effects

Visual Communication Design MFA

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Interaction
Motion & 3D
Design Studies

About the Program