



University of Colorado

Boulder | Colorado Springs | Denver | Anschutz Medical Campus

February 2018

**Catalin Grigoras, PhD., Director
Cole Whitecotton, IT Professional**

National Center for Media Forensics
University of Colorado Denver

Hosted by:

Ken McConnellogue

CU Vice President of University Communications

- Ken: Welcome to CU On The Air. Today we're talking with representatives of the National Center for Media Forensics at the University of Colorado Denver. We have the Director, Catalin Grigoras and Cole Whitecotton, who's the IT professional. We're talking about media forensics this morning, the scientific study into the collection, analysis, interpretation, and presentation of audio, video, image evidence obtained during the course of investigations and legal proceedings.
- Ken: The Center is the only one of its kind in the United States, and it not only graduates top media forensic specialists, it and its students are helping law enforcement and the government in their investigations. Welcome, gentlemen. We're happy to have you here.
- Cole: Yeah, glad to be here.
- Catalin: Thank you very much. Good morning.
- Ken: Cole, perhaps we could jump right in. The topic of deepfakes is prominent in the media nowadays. What is a deepfake?
- Cole: The term deepfake comes from kind of two different schools. The deep part of it is the AI, artificial intelligence, using deep learning machine learning to develop fakes, face swaps, fake imagery, fake images in general. Particularly, the deepfakes is actually kind of an open source, not really even a specific program, but just an idea that was developed by people. I mean, it hit the Reddit community first, then it's just kind of been out there.
- Cole: It essentially uses machine learning, computer learning, and AI to map features from faces and on to other faces, and then to do face swaps with those. It has a lot of implications. I mean,

there's kind of the creative, artistic side of it that movies, you've seen movies that are de-aging actors and they're bringing, I think it was a Star Wars movie that had an actor that had passed away long ago, but his whole character was brought back in the movie in kind of a CGI way

Cole: This isn't necessarily a part of that, but this has implications for that. They don't have to bring actors back for re-shoots. They can kind of just have their face mapped, and then they can map it onto an actor or a body double or someone else that can be there. Then this also has, in the forensic world, implications for just fake media. Fake images, fake video, fake news, et cetera.

Ken: We'll talk about some of those implications here in a moment. The sense is that this is a highly technical, highly specialized thing, but with some of the software that's come out nowadays, it's not as difficult as it would seem.

Cole: It's not at all kind of in the realm of science fiction. It is definitely a reality. It's not necessarily in the realm of Snapchat and filters and things like that where people can just do it with their cell phones on a whim. It is very technical. It requires quite a bit of computer knowledge, quite a bit of programming knowledge, and even the stuff that was released in to the world, that deepfake kind of package, isn't just a, "Oh, you just install this and then you can go." It's something that you still have to fix and put together and you have to be able to manipulate, manage, and it's a constantly growing thing.

Cole: Once you do get it done, it still takes weeks of computer processing of having a computer develop these things. So maybe huge, large corporations, if you have access to huge servers and giant computer banks, those could be done in a few hours, but the most average person with one or two computers at home, it'll take them a week or a month to get 30 seconds of semi-believable footage.

Ken: So safe to say I won't be doing any fakes any time soon?

Cole: Yeah, not necessarily, but again just it being out there means that Hollywood might latch onto this and kind of develop their own tools, which then will percolate down kind of into the consumer world of stuff as well. So it's still there. It's still a thing. It's just right now, it's not quite worrisome yet.

Catalin: And aside the deepfake we can speak about face-to-face. Face-to-face is a previous generation of deepfakes when only half of the mouth and the face was edited. Now deepfakes as we know are one step further. We can speak about voice changes also.

Catalin: We are aware of vocal projects from Adobe and exactly as Cole mentioned, about faces. Imagine deepfake voices now to replace somebody's voice and to do it on a very good quality. Good enough to cheat or to manipulate people from an artistic, like Hollywood effects. But from our point of view we also know that it is much harder to cheat the mathematics of the samples and of the pixels if we speak about faces.

Ken: Question for both of you. Cole, you talked about the implications of fake media and this is something that's very much pervasive these days. What are some of the implications we see for media? We'll talk a little bit about legal proceedings here in a moment.

Cole: Yeah, in the forensic side of everything, kind of the fear is the kind of inability to authenticate stuff. Authentication is a big part of what you do if from the kind of civilian side, my neighbor says that my dog's messing on his yard or something like that, and he has footage of it. You're like, well, I can then say, "Well, that's not real footage. That's fake or you edited it or something like that." That's where the kind of world of deepfakes is, is that the more believable and more realistic that becomes, the harder it is that to then authenticate that, and we have to look at other avenues for that authentication and for verification of that stuff.

Ken: Are there some prominent examples that have been out there in the media?

Cole: I think where the deepfake particular program kind of blew up is with a lot of Nic Cage videos, people putting Nic Cage into movies and scenes and stuff that he was never actually a part of. There has been footage of Obama, a deepfake of Obama's face on an actor basically making it look like Obama was saying and doing things that he never actually did.

Audio Clip: Excerpt from a BuzzFeed PSA, starring Jordan Peele impersonating President Barak Obama while using AI video to deliver message about media manipulation:
<https://www.youtube.com/watch?v=cQ54GDm1eL0>

Ken: Let's talk about the center a little bit then, Catalin. How was it conceived and you've been in this field for quite some time now. Talk about kind of the progression of it and how this center at CU Denver was created.

Catalin: The National Center for Media Forensic started in 2008. It was DOJ, the Department of Justice grant to set up such a center. Like our Center of Excellency to teach the new generations to create new experts in this very dynamic field.

Catalin: And starting by 2010 we had the very first students. And now we can speak about almost nine generations or cohorts of students, graduates, that are all over the U.S. and even Australia, UK, Saudi Arabia. So we are proud from this point of view to speak about international students, or students that left the U.S. and be hired by some other organizations, respectable organizations from all over the world.

Ken: And we'll talk a little bit more about your students in a moment. But the center's also working with the Defense Advanced Research Project's Agency, DARPA, which is part of the U.S. Department of Defense, and you're working to create some deepfakes so you can examine them and take them apart. Tell us about that.

Catalin: Yes, we have a grant and we work for DARPA to create, from a forensic point of view now, these kind of deepfakes or to manipulate videos and audios. I have mentioned that deepfake is just one technique to counterfeit or to manipulate people. Counterfeit evidence and manipulate people.

Ken: So some of the audio forensics that you've talked about you've done for law enforcement and you've gotten some important results from that. Tell us more about that the confession you captured, the "I did it" confession from ... you worked with the Denver police in 2012.

Catalin: Yes, it was one of the, I would say, cold cases when some part of the evidence are just left in a cabinet, in a drawer because of their low quality. And just by chance a few years later when

somebody came back on this case and found the audio, it was just after a few days we had a meeting with the DPD and we told them we apply science on audio and videos and we told them what can be done. We mentioned cold cases, they said, "Okay, let us see what we have."

Catalin: Later, they came to us with this recording and it was about a room with two people sitting like for an interview, it was the police and the police left. And the microphone was switched on and picked up a brief discussion between them when one of the people, the suspects, confessed to the other. One whispers, "I did it."

Catalin: This dialogue was covered, messed by noise, heavy noise. And just apply the science, we analyze the recording, we identified the type of noise, some distortion as well. We fix the distortions, we clear the noise and came with that very clear discussion between them.

Ken: And that person was convicted?

Catalin: As I'm aware yes.

Cole: Kind of the thing about the scientific stance of this stuff is that we're not necessarily there to chase an outcome, to come up with a particular outcome. That's the exact opposite of what we're there to do. We're there to look at the footage, see the stuff, look at it for what it is, and present what our findings are and then whoever we're presenting them to, the Department of Justice, the lawyers, the civil cases, whatever, are then gonna take that and do kind of what they will with it, which is hopefully presented in as true a way as we can but that's what we're there to do.

Cole: It doesn't matter what side we're on, we're not taking side. We're not taking any kind of conclusions. We're there to kind of present this. So, a lot of times when we deal with this stuff, we don't necessarily think about or really kind of care what the overall outcome will be or what kind of happens from that kind of work.

Cole: Not in necessarily a callous way, and we're not just saying, "No, no, we're just here to look at the numbers and you guys put away whoever you want to put away or whatever." But, that's not our overall goal. So it's easier for us to kind of just step back and to stay away from that side of stuff to make sure that we're not tainting or biasing our opinions, our point of views, that sort of stuff, so.

Catalin: Exactly. Just continuing what Cole said, our duty is to stay unbiased first of all. And to know the limits of our science. As forensic experts, we are never ashamed or afraid to speak free about the limits of the yard.

Ken: What are some of the other cases where audio or video forensics have helped solve crimes?

Catalin: We can speak about both national and international cases like for instance, the very famous case of the Malaysian airplane shot down in Ukraine.

Ken: Yes.

- Catalin: It's a few years ago when Malaysian airplane was shot down in Ukraine and there has been a lot of recordings between the cockpit and the towers. Also between some other people in Ukraine about the disaster. And the recordings made immediately after the event.
- Catalin: Different types of recordings, some of them noises, so it was necessary to enhance them. So in these kind of cases we speak about forensic audio enhancement. And in some other cases it's about speaker recognition, meaning to identify the speaker. Like fingerprint or DNA or to recognize it and be able to say, like with ratios, who the speakers are.
- Catalin: We can also speak about the Texas explosion from a few years ago, the chemical plant. We've been involved and we analyzed the footage.
- Ken: Yeah, how would you describe that technique just in simple terms?
- Catalin: The techniques that we use, mean scientific validated methods. Meaning methods that are published, so anybody can read and verify them. They are peer reviewed meaning that before publishing such a paper, it is like a blind peer review so a commission, we are not aware who the members are, reviews our manuscripts and decide if they are good before publishing or not.
- Catalin: And we only speak about scientific validated papers and methods published in these kind of peer reviewed papers. And one of the beauties in these kind of forensic analysis is that we stay with the science and we are fully transparent. And we know that one of the most powerful weapons for a forensic expert is transparency. Always play if we are allowed to make a joke, like with the cards on the table. No scam. No cheat, nothing like this.
- Ken: I'd imagine in a field where fakes are the coin of the realm, that being transparent is a necessary.
- Catalin: Absolutely. And there are many other famous cases like the Iranian missiles. Anybody can just Google and find them. We can speak about smoke on Beirut and these pretty impressive least famous cases.
- Cole: Yeah, I think the case with the chemical explosion, specifically what that was, was basically a whole bunch of different sources of footage. There was cellphones, I don't know if there was any CCTV or anything like that but there was a lot of different angles, all had different timestamps, all had started recording at different times and stopped recording at different times.
- Cole: So in that particular case it was a matter of syncing things up. Finding ways to actually match timestamps, match footage, match what was going on at the time to actually build a much more kind of conclusive and involved idea of what actually happened of when certain things happened, when certain parts of the explosion happened. Where they happened. How it was located.
- Cole: Some of the footage was a mile away, some of the footage was a lot closer so having different perspectives was really important for figuring out how it actually happened and what actually happened.

Catalin: Whenever we speak about these kind of huge buildings or plants, their CCTV systems or cameras are oriented inside usually or outside. But we see the parking, so the around area.

Catalin: In these kind of disasters, it's extremely important to understand that the internal and internal cameras do not depict the entire event. So this is why people that are far away, as Cole said, like one mile away, but around the plant, using their mobile phones to visually record the flames, the fire, the explosion, and it is necessarily to synchronize to bring all this.

Ken: Is that more difficult or easier?

Catalin: It's hard work to be done. It's hard work, it's time consuming work and it's a huge responsibility. And we can speak about frames. So we go at frame level when we understand about synchronizations. We use automatic techniques but they always have to be verified.

Catalin: Like we also like we say, we never leave a computer to decide if somebody's guilty or not. Even if the computers are smart and fast enough, we always have to go back and verify the results.

Cole: Yeah, trust but verify.

Catalin: Exactly. And in the end, coming back to these kind of plans. It's very important for the investigators later, to identify precisely the point or the area, the region of interest. The area of the explosion came from and how the fire evolved later. We speak about the dynamic of fire and it's extremely important for the investigators to understand the event. But based on top quality enhanced and synchronized evidence.

Cole: Right.

Ken: Do you testify in court?

Catalin: Yes. Yes I do.

Cole: Yeah, one of our colleagues that's not here is the associate director, is that right?

Catalin: Yes.

Cole: Yeah, it's called. Jeff Smith testifies at least two or three times a year.

Catalin: Exactly.

Cole: I feel like you are at least once or twice as well?

Catalin: Exactly, like once or twice.

Cole: Yeah, it's kind of rare when the science is strong, and the math, everything the science behind it kind of backs everything up and that science is strong, it's rare that you would end up getting called in the case in to testify stuff because usually the only reason you would have to be

called to testify is if the other side has an expert that's saying something different than what you were saying.

If that science is rock solid, and there is a foundation and it's there, you're not just spouting off random opinions, you rarely get called in. There are some experts that do testify dozens of times a year for exactly that kind of reasons, but when cases come through these guys' hands it's rare that they'll be called in to testify and it's usually just to kind of explain to the courtroom or explain to the jurors or something like that. It's not more of something is being contested, it's more of like, "Well, this is a really technical thing and we need someone to come and explain it." Sort of a thing, yeah.

Catalin: Continuing with what Cole said, yes, tying back to that case with "I did it." This is the kind of case where we didn't go in the courtroom to testify. So, using the science that was described in the report, providing the courtroom very good quality enhanced versions of the conversation, it was not necessary in fact.

Ken: So you hope that your work is so good you don't need to appear in person?

Cole: Yes, ultimately.

Catalin: Well, we don't, yes. We don't say that we don't help or we help, we are just doing our scientific job and that is up to the courtroom, to the other side, to ask for us or not. In most of the cases, they do not ask.

Ken: Audio manipulation is what the recording industry basically does in the creation of music, or it's a big part in the creation of music. And so, there is recently a case where a Michael Jackson album was released after his death that was called into question whether this was really the voice.

Catalin: Like in handwriting, we speak about normal handwriting or normal speech with normal phonation analogies. It's harder or even impossible and we don't have the science to analyze whispers or falsetto and to identify the speaker's based on whispers or falsetto. Or by singing.

Catalin: When people sing, they stretch their vocal cords and their normal pitch and all the other frequencies, they're completely different varies than normal speech.

Cole: It's like singing is a mask.

Catalin: Exactly.

Cole: You're not just using your voice, now you're putting a mask on and you're doing something totally different. That's why accents disappear when people sing, all that kind of stuff.

Catalin: Exactly. And also singing, from a forensic point of view, we can speak that are kind of distortion. People distort their normal voices. I don't say like they are trying to cheat or distort the voices.

Cole: Or fake it or anything.

Catalin: Exactly. No, it's just the artistic way they have to go. Like Opera singers. If you have a chance to listen to some of the singing and then talking and pay attention to his voice you'll be surprised to see that there are big differences.

Cole: Oh yeah.

Ken: Let's talk a little bit more about your students. Who are the students in the program?

Cole: That's an interesting one. They kind of come from all over the place. The Master's program was kind of born alongside with the recording arts program, out of the College of Arts and Media out of CAM.

Cole: So, technically the Master's is MSRAMF. So, Masters of Recording Arts with a Media Forensics on Specialists. So, actually a lot of our students, I'd say probably half of them, each cohort, come from the recording arts program. That's where I came from, that's what my undergrad was in, was in recording arts and then moved right into this.

Ken: So how did you get from there in recording arts to media forensics?

Cole: So me personally, I came back to school older than a lot of the other students that were around and I was kind of done with the studio world of stuff. And I just didn't want to be an intern again and then start kind of over somewhere else and I wanted something that was a little more lucrative, a little more focused and specialized, so.

Cole: But a lot of students, the reason why they're drawn to it is that media forensics, it's just media, it's not audio forensics or video forensics, it's media, it's all digital multimedia. So, it's audio, video, image, as well as computer forensics, mobile phone forensics, just kind of general digital forensics.

Cole: We have a lot of students that are already in the field. I believe this semester we have a student that has been, or this cohort that has been in the field for 20, 30 years almost. He works for the Department of Interior.

Cole: But we're the only Master's program that does this, that offers this kind of stuff. So it's seen as really valuable and obviously a lot of the employers are gonna see it as that way too that you have an actual degree once you're done. So even if you've been in the field for a long time it's still a valuable thing.

Cole: We have other students that are photographers that are other kinds of artists. We have students that are really just into mobile phones and that kind of digital world and into computers in general. We have other law enforcement students. I think most of our students that have come from overseas, I think the Saudi Arabia students were involved with law enforcement and stuff like that.

Ken: And where do they go to? What kind of jobs do they end up with?

Cole: The market that's for this, there's a couple different levels, you have the federal level, the kind of three letter organizations, FBI, CIA, DOJ, that type of stuff. But then there's kind of local law enforcement. You have all the police departments. That's probably the place where they need

the most help. But it's also the place where they have the least funding so it's kind of harder to get into those but they definitely need a lot more of that.

Cole: But then you also have the private sectors. Target has a huge forensic lab. They work with law enforcement everywhere so there's a lot of work in there, there's kind of labs of works. Wal-Mart is a similar thing. And then there's like private consultation. A couple of our students have gone on to kind of start their own businesses.

Cole: Kind of a common thing that students will do is they'll graduate, they'll go work in a lab, they'll either internship with the FBI or something like that for a couple of years and then they'll kind of start their own business doing consultation for other companies. And then also just taking case works for not even just large things but just for civilians, for the civil cases.

Cole: And then you also have the academic side, which is really what I was drawn to, and that's why I really happy to be a part of the center doing this stuff, but there needs to be the science. There needs to be research done, there needs to be papers, there needs to be the legwork, the groundwork of building this. And that's kind of the thing about this field is it's a relatively young field in the world of science. Obviously digital stuff has been around for a couple of decades now. Computers are everywhere, cellphones are being more prolific, but the actual science, the foundation, the papers, the research, that really hasn't been there in a huge thing.

Cole: So you think of other FBI sciences, DNA, chemistry, all that kind of stuff, there's a lot of science that is the foundation for that. There isn't a ton of science to kind of backup what's been done. The just been the FBI and the local law enforcement has just been kind of flying by the seat of their pants. As something comes out they find a way to kind of detect it.

Cole: Law enforcement has not necessarily been the leader. It's really been the other side, the kind of underground that has been well ahead. And that's where we're at now is trying to build it up and try and grow it to that point.

Ken: It seems like a lot of those careers have rewarding aspects to them. I mean you're helping to solve crimes or you're helping to help truth emerge.

Cole: Yeah, exactly. Yeah, it's not just about convicting, it's not just about putting people away, it's also about exonerating people and helping ... just helping this science in general. And then that's kind of the standpoint that we always take is it's the science first. It is we're never gonna say that someone is guilty, that someone is this, that this is definitely a match or this is definitely not a match. It's like, "Well, it's likelihood, it's consistent with, it's ..." there's never a, "This is 100% guarantee, this is definitely what this is." So, it's all about that science first and it's not about trying to get an outcome it's about trying to make sure the science is there to back it up.

Ken: And Catalin, we talked before and you've been in this field since 1991 and I would imagine tremendous changes in that time. But do you find it's been a slow arc of change or has it been a series of big bang changes?

Catalin: I'll say it was like a smooth transition from one generation to the new generation of digital equipments, technologies. When I entered the field, for instance, the audio CDs were at the beginning. And I remember, I started talking, "If they resist or not on the market." And we still

remember when we have a look on some older scientific papers, the digital audiotapes for instance, which are also, we can speak about them as being obsolete.

Catalin: And we sought the advances of the new technologies in the images, in videos, in audios. And we can speak nowadays, for instance, about the mobile phone, like being a small computer that is mobile phone as well. However you want, it's the same. Being able not only to allow you to make phone calls but also to act like a digital camera, to videotape, to make audio recordings, and so many apps that you can install on it.

Catalin: And we noticed this soft evolution, which makes sense now when you look back. And if we pay attention to what happened in all these 20, 30 years we can be able to predict what it'll be like four or five years by now. It just makes sense. This is just the normal evolution.

Ken: Yeah, I was gonna ask you, I wouldn't ask you to look ahead 30 years but maybe if you look ahead five or 10 years, where do you see the field going?

Catalin: We will see smarter and smarter mobile phones. And in fact we will also start speaking about smarter and smarter networks. We can speak about mobile phones, people are probably familiar about the 5G generation, the 6G. It's the same in Europe when people also look and try to predict and to understand.

Catalin: When it is about the new techniques are technologies that are coming, some of them can be predictable or predicted. But some of them, we already know that will come in one, two years because we know what's in the lab, we know what's the in the industry, and we know what they are working on. We will we start speaking about faster internet for sure. We will start speaking about new services and apps.

Cole: If you're looking for kind of whether it's an arc, whether it's a bunch of bursts, it's definitely been an arc. But I think everybody has this view of computers in general. Computers kind of showed up, they were what they were for a long time and then they got better and then they started getting better and better and better and it's gotten faster and faster and faster, that's really where all this is.

Cole: I think if you were to look at the kind of forensic side and just the technology side, they would definitely correlate with just the proliferation of computers in general. And I think cell phones fit right into that. Cell phones are just computers and they're a natural part of ... You used to have a room, gigantic room full of one megabyte of hard drive space, of tape space and stuff like that and then it gets smaller and smaller, it gets bigger and bigger, faster and faster and it's just we're in that natural evolution. So it's much more like a lot of logarithmic, sharp curve as opposed just a long evolution.

Cole: But with that, that also means though that not only does the technology kind of do that, but then that means our use of it and the way that people kind of get used to things and the way that people are just kind of assuming that, "Well, things have just kind of always been like this." It kind of gets more and more like that too.

Cole: And I think that's the stuff that we can see what's in the lab, we can see what's coming and we kind of know the next couple years of that type of stuff. Like deepfakes feel like they just kind

of came out of nowhere but it was a natural evolution of a lot of different tools, a lot of different things that have kind of been there.

Ken: And given all that, what are the implications for the National Center for Media Forensics here at CU Denver? Where do you see it heading in the next few years?

Catalin: Our plan is to keep going with the scientific research because aside the fact we teach our students, we also learn forensic analysis cases and also research. Meaning that we try to provide, to create new methods, to improve old methods, and to always stay on top. And as Cole mentioned, the deepfakes for instance, for us it wasn't a surprise because we've been familiar with the previous techniques.

Catalin: And I remember when we discussed, "Okay, if you're able now to manipulate half of the face, it's about months are years and you'll be able to do it for the entire face." When you do scientific research and you read the papers published by others, you understand the gaps in science and you try to fulfill them with new techniques to fix the problems in the science.

Catalin: And when you do these kinds of things, then yes you are able to predict or understand like where the market is going and to be one step ahead sometimes. We are not ashamed to just mention it on some of the techniques like deepfake. When deepfake came, for instance, we already had the solutions. The solution to detect them quickly.

Catalin: And this is why, we noticed what happened in the media. And it was one of our very first reactions, like trying to recommend people, be aware of these deepfakes but not afraid. And try to understand and notice that some of the news are fake news. From deepfakes we add to fake news. They can be very painful for the victims. They can be very dangerous for the society. And it's just a matter of time from the moment we load, let's say the evidence, into the computer and we get the results. And it can last like one, two, three hours depending by the video, until we are able to come to certain conclusion and make it clear that no, this video is inconsistent with the original and contains local traces of manipulation.

Ken: There's a lot of discussion, you touched on, about fake news. And we have this technique of deepfakes and they can be closely connected. What do you see as the role of media forensics or is there a role for media forensics to inform that discussion?

Cole: I've long had this personal belief or just kind of idea, science is, when it's used in a term and people just say "Science in general, science discovers this," or, "Science develops this," that sort of thing. That scientists are really good at looking at the numbers, looking at the backside of it, looking at the facts, finding these things out.

Cole: But then they're not very good at disseminating that information then to the public in general. So, we can say we're not worried about deepfakes. We can see deepfakes, we can understand fakes, we can find deepfakes. So far nothing has been developed that we can't necessarily detect, that we can't find traces of. But the damage is often times already done.

Cole: The public, the society in general, just needs to be better educated about what it means to be fake, what it means to have fake news, what it means to be served an ad when you don't even realize it's an ad. And that's a big part of not necessarily like our direct goal as the National Center for Media Forensics, obviously we're trying to teach forensic experts, but that's kind of

the hope of this in general, that our students and everybody that we're involved with, the community that we're involved with, the training that we do kind of helps to spread that word, to get that information out and get that education out that it can then hopefully spread throughout the world.

Ken: We appreciate having you gentlemen here today and this episode of CU On the Air will not try to manipulate too much.

Cole: We'll come back with our rebuttal to everything after they're done.

Ken: Okay, we'll give you equal time.