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Emerging Applications of Face Biometrics and Its Deception

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Abstract-Biometrics has nowadays been of universal interest and has been developed and used for many purposes such as for the detection of criminals and undesirables, identification and access control. Faces are of essential importance for human social life. They provide valuable information about the identity, expression, gaze, health, and age of a person. Many security systems depend upon face recognizers to identify a person. Many of these systems are passive and are deployed at places such as airline terminals. However, face recognizers are sensitive to deception attacks. Previous studies suggest that hair regions are very crucial in face recognition and the success of a recognizer depends on the success of a pre-segmentation stage which extracts the face region from the hair and the background. Deception attacks which would change the hairstyle, apply make-up or occluding objects to the face would cause many systems to fail. The face is equipped to lie the most and leak the most, and thus can be a very confusing source of information during deception. A person can get away with and best perpetrate deception through his face. This paper presents in brief about the deception that can be identified in face and emerging applications of Face recognition technologies.

Keywords: Behaviour, Cognition, Deception, Detection, Emotion, Judgment, Lying

I. INTRODUCTION

Facial recognition technology (FRT) has emerged as an attractive solution to address many contemporary needs for identification and the verification of identity claims. It brings together the promise of other biometric systems, which attempt to tie identity to individually distinctive features of the body, and the more familiar functionality of visual surveillance systems. Terrorism at its core is a human endeavour. Human beings cultivate what they hate, plan, and then execute terrorist attacks. Thus, any information that can aid the intelligence or security officer to weigh the veracity of the information he or she obtains from suspected terrorists or those harbouring them would help prevent attacks. This would then not only add another layer to force protection but would facilitate future intelligence gathering. Yet the face-to-face gathering of information through suspected terrorists, informants, or witnesses is replete with obstacles that affect its accuracy such as the well-documented shortcomings of human memory, honest differences of opinion, as well as what is the focus of this article—outright deception [1].

The evidence suggests that in day-to-day life most lies are betrayed by factors or circumstances surrounding the lie, and not by behaviour [2]. However, there are times when demeanour is all a Homeland security agent has at his or her disposal to detect someone who is lying about his or her current actions or future intent. Because a lie involves a deliberate, conscious behaviour, we can speculate that this effort may leave some trace, sign, or signal that may betray that lie. What interests the scientist, as well as society at large, is (i) are there clues perceptible to the unaided eye that can reliably discriminate between liars and truth tellers; (ii) do these clues consistently predict deception across time, types of lies, different situations, and cultures?; and if (i) and (ii) are true, then (iii) How well can our counter-terrorism professionals make these judgments, and can they do this in real time, with or without technological assistance?

II. CURRENT AND FUTURE USES OF FACIAL RECOGNITION TECHNOLOGY

A. E-ID - Officials Race To Secure The Olympic Games With Face And Finger Recognition

More than 10,000 Olympic athletes and their coaches are having fingerprints and face-scans taken by UK officials around the world to prevent the London Olympic Games being targeted by illegal immigrants or terrorists. The UK Border Agency (UKBA) is reported to have begun taking biometric details of around 10,000 individuals. Officials will visit international sporting events to collect data. Each profile contains a facial image scan and 10 finger scans, kept in a single digital record. The UK government has also announced plans to expand its biometric identity scheme by doubling the number of people who need to hold biometric proof that they are legally permitted to work in the country. The system will allow employers and public authorities in particular to access biometric residence permits through an online service to help run checks on individuals. 400,000 people will be expected to hold biometric residence permits, which hold personal data including fingerprints and a photograph.

B. LAW ENFORCEMENT- Facial Recognition Identifies New York Bus Drivers With Multiple Licences

Authorities in New York, US, have used facial recognition technology to identify and arrest 14 bus drivers who used aliases to obtain driver licences.

C. MOBILE -Ice Cream Sandwich Feeds Face Recognition Debate

Google has teamed up with Samsung to unveil Face Unlock on the Galaxy Nexus. The smart-phone is the first with Ice Cream Sandwich, a new version of Google's Android mobile operating system. Face Unlock lets users unlock the

phone by showing it their face. Hot on the heels of the launch came widespread reports that the system could be breached by presenting it with a photo of the user when he or she was not present .

German authorities have gone a step further, that it is preparing legal action against Facebook for the company's use of automatic facial recognition features. Face tagging is moving to the mobile device, however, and it looks likely that Facebook will be just one way people can use facial recognition to tag people. A new iPhone application, Tagg, uses offline facial recognition to detect the faces of friends in photos, so users can tag them and upload them to Facebook or post them to Twitter.

D. E-BORDERS

1. More Passengers Opt For Facial Recognition Gates At UK Borders

More passengers travelling to the UK via Manchester, Bristol, Gatwick, Birmingham, and East Midlands airports are opting to use facial recognition gates to clear border control, according to figures released by the UK Border Agency. Manchester was the first UK airport to see the automated border controls go live in 2008. In the last year 571,117 passengers at Manchester airport used the gates, an average of 47,593 passengers per month. So far this year (April to end of July) a further 254,387 passengers used the automated system, an average of 63,596 per month to date.

The gates, which may be used by anyone with a UK or European 'chipped' passport who is aged 18 or over, use facial recognition technology to compare the passenger's face to the digital image recorded in their passport. Their details are then automatically checked against Border Agency systems and watch lists. Once the checks are made, the gates open automatically to allow the passenger through the border. The facial recognition gates have been introduced at 15 UK airport terminals, and more than 17m biometric passports, which contain a facial image, have been issued in the UK since their introduction in 2006. The gates have now been extended to London's Heathrow and Gatwick airports.

The facial recognition technology comes from Aurora Computer Services, a UK-based company. BCC Research has examined the market for biometrics securing transportation. 'Security Technologies for Transportation Markets' finds that revenues from biometrics technology stood at $0.7bn in 2010. However, it finds that in this sector, the compound annual growth rate (CAGR) of biometrics is expected to lead the market with 33.2% for the period 2010 to 2015 and revenues from biometrics technology are expected to reach nearly $3bn by 2015.

2. AOptix Partners With IATA And Launches Simultaneous Face And Iris Capture

AOptix Technologies has set up strategic partnership with the International Air Transport Association (IATA). The partnership will explore how biometrics can be deployed as a part of IATA's Checkpoint of the Future, International Traveller Scheme, and other initiatives.

AOptix will bring its experience deploying at-a-distance iris recognition systems at border crossings and passenger terminal checkpoints to air transportation challenges including long wait times, intrusive searches, and overall automation and efficiency of the air travel process.

AOptix has also launched the InSight Duo biometric system with simultaneous ISO standards- compliant iris and face capture InSight Duo delivers iris and face capture within seconds from a distance of 2m.

III. SCIENTIFIC OVERVIEW—BEHAVIORAL SIGNS OF DECEPTION

To date no researcher has documented a "Pinocchio response"; that is, a behaviour or pattern of behaviours that in all people, across all situations, is specific to deception (e.g. [3]). All the behaviours identified and examined by researchers to date can occur for reasons unrelated to deception. Generally speaking, the research on detecting lies from behaviour suggests that two broad families of behavioural clues are likely to occur when someone is lying—clues related to liar's memory and thinking about what they are saying (cognitive clues), and clues related to liar's feelings and feelings about deception (emotional clues) [3–8].

A. Cognitive Clues

A lie conceals, fabricates, or distorts information; this involves additional mental effort. The liar must think harder than a truth teller to cover up, create events that have not happened, or to describe events in a way to allow multiple interpretations. Additional mental effort is not solely the domain of the outright liar; however, a person who must tell an uncomfortable truth to another will also engage in additional mental effort to come up with the proper phrasing while simultaneously reducing the potential negative emotional reaction of the other. This extra effort tends to manifest itself with longer speech latencies, increased speech disturbances, less plausible content, less verbal and vocal involvement, less talking time, more repeated words and phrases, and so forth [9]. Research has also shown that some nonverbal behaviours change as a result of this mental effort. For example, illustrators—hand or head movements that accompany speech, and are considered by many to be a part of speech (e.g. [10])—will decrease when lying compared to telling the truth [11, 12].

Another way in which cognition is involved in telling a lie is through identification of naturalistic memory characteristics. This means that experienced events have memory qualities that are apparent upon description that are different from events that have not been experienced (the "Undeutsch hypothesis" [13]). Events that were not actually experienced feature more ambivalence, have fewer details, a poorer logical structure, less plausibility, more negative statements, and are less embedded in context. Liars are also less likely to admit lack of memory and have less spontaneous corrections (reviewed by [8, 9]), and may use more negative emotion words and fewer self and other references [14]. Mental effort clues seem to occur more in the delivery of the lie, whereas memory recall clues tend to rest more in the content of the lie. Moreover, a clever liar can appear more persuasive if he or she substitutes an actual experienced event as their alibi rather than creating an entirely new event. This may be why a recent general review paper [9] found consistent non-homogeneous effect sizes for these mental effort and memory-based cues across the studies they reviewed, as the particular paradigms used

by researchers varied greatly in the extent to which the lies that were studied mentally taxed the liars.

B. Emotional Clues

Lies can also generate emotions, ranging from the excitement and pleasure of "pulling the wool over someone's eyes" to fear of getting caught to feelings of guilt [4]. Darwin [15] first suggested that emotions tend to manifest themselves in the facial expressions, as well as in the voice tones, and that these could be reliable enough to accurately identify emotional states. Research has since shown that for some expressions—e.g. anger, contempt, disgust, fear, happiness, sadness/distress, or surprise—cultures throughout the planet recognize and express these emotions in both the face and voice similarly [16]. To the extent that a lie features higher stakes for getting caught, we would expect to see more of these signs of emotion in liars compared to truth tellers. If the lie is a polite lie that people tell often and effortlessly, there would be less emotion involved (e.g. [17]). Meta-analytic studies suggest that liars do appear more nervous than truth tellers, with less facial pleasantness, higher vocal tension, higher vocal pitch, greater pupil dilation, and fidgeting [9]. If the lie itself is about emotions—e.g. telling someone that one feels calm, when in fact one is nervous—the research shows that signs of the truly felt emotion appear in the face and voice despite attempts to conceal, although these signs are often subtle and brief [18, 19].

C. Measurement Issues

One issue in measuring lie signs is to make clear what is meant by the terms cognition and emotion. For example, in deception research, the term arousal is used interchangeably with emotion, but often refers to many different phenomena: an orienting response [20], an expression of fear [21], a more indeterminate affect somewhere between arousal and emotion ([22]; see also discussion by Waid and Orne [23]), as well as physiological states as different as stress, anxiety, embarrassment, and even anger [24].

A second issue in measuring lie signs is to clarify the level of detail of measurement as well as to specify why that level of detail may or may not correlate with lying [25]. Many meta-analyses of behavioural deception clues report insignificant effect sizes, but the variance among effect is not homogeneous (e.g. [3, 926–28]). For example, some studies investigated behaviour at the most elemental *physical* units of measurement such as counting the movements in the hands, feet, arms, legs, torso, eye movements, eye blinks, pupil dilation, lip pressing, brow lowering or raising, lip corner puller (smiling), fundamental frequency, amplitude, pauses, filled pauses, response latency, speech rate, length of response, connector words, unique words, self-references, and so forth. Other studies investigated behaviour at the most elemental *psychological meaning* units of measurement. Some of these included manipulators—which involve touching, rubbing, etc., of various body parts—which could be composed of a number of hand, finger, and arm movements, but which were scored for theoretical rather than merely descriptive reasons. Other psychologically meaningful units of measurement include illustrators, which accompany speech to help keep the rhythm of the speech, emphasize a word, show direction of thought, etc. or emblems, which are gestures that have a speech equivalent, such as a head nod meaning "yes", or a shrug meaning "I am not sure", or facial emblems such as winking. The psychological meaning units might also include vocal tension, speech disturbances, negative statements, contextual embedding, unusual details, logical structure, unexpected complications, superfluous details, self-doubt, and so forth. Finally, other studies investigated behaviour at the most *interpretative/ impressionistic* unit level, which are further unarticulated composites of the physical and the psychological meaning units described earlier. Some of these impressionistic variables of the behaviours include fidgeting, involvement, body animation, posture, facial pleasantness, expressiveness, vocal immediacy and involvement; and spoken uncertainty; plausibility; and cognitive complexity (see review by [9]).

D. Prognosis on Generalizability of Deception Findings Across Time, Lies, Situations, and Cultures

It is safe to conclude that although there are some clues that betray a lie at rates greater than chance, none of them are exclusive to deception. This conclusion applies to machine based physiological approaches as well. However, the origins of these signs—mental effort, memory, and emotion—are universal. This suggests that if the context in which the information is gathered is controlled, and designed to differentially affect liars and truth tellers, it would increase greatly the chances of being able to distinguish people with deceptive intent from those with truthful intent. Polygraph examination has done this by controlling their question style to improve hit rates, but to date this has not been done systematically in behavioural studies. Thus its effects are unknown, but we can speculate based upon what we know about normal, truthful human behaviour. If the lie is of no significance to the person, with no costs for getting caught, and involves a simple yes or no answer, odds are there will not be many clues to distinguish the liar from the truth teller. If the situation has significance to the person, there are consequences for getting caught, and the person is required to recount an event in an open ended question, then we would expect more clues to surface that would distinguish the liar from the truth teller. This may be a curvilinear relationship; a situation of extraordinary high mental effort and emotion—e.g. one in which a person is being beaten, screamed at, and threatened with execution—will generate all the "lie clues" described earlier, but equally in liar and truth teller. Nonetheless, information about mental effort, experienced memory, and emotion can be very useful clues to Homeland Security personnel to identify behavioural "hot spots" [4] that can provide information about issues of importance to the subject. A counter-terrorism Intelligence officer who knows when a subject is feeling an emotion or thinking hard can know what topics to pursue or avoid in an interview, whether the subject is fabricating, concealing information, or merely feeling uncomfortable with the topic, although truthful.

IV. THE FACE IN DECEPTION

Deception is ubiquitous among higher organisms, but one usually thinks of an intention to falsify, hide, embellish, or

otherwise alter the actual facts when abstracting the elements of human deception. Deception among humans is not necessarily a bad thing, but is widely condemned when it hurts or has potential to harm people. Innocuous deception is practiced by virtually everyone daily as a routine aspect of living. Managing the expressions of the face, disguising its features, and enhancing its attributes are important aspects of deception whenever people meet face-to-face. As deception is much fair under the rules of many competitive games, so too is it an acceptable part of human interactions that follow certain rules. Malevolent deceit may also be practiced by certain individuals to circumvent the rules. If one is fooled, given the ubiquity of deception and the possibilities of high stakes losses, it is not surprising that efforts to uncover deceit are also prodigious. The success of most people in detecting deception is, however, surprisingly poor.

A. The Clues to Deception

Observers usually are looking at the face of the person who deceives rather than their legs or arms, creating a dual dynamic for the process of deception and its detection. First, there is a pressure for the person to control the face in some way to ensure that it does not betray the deception or to improve its ability to give a false impression. Second, the rest of the body, which may not be as closely scrutinized by the other person or monitored as closely by the deceiver, is less subject to similar efforts at control. This difference has suggested to many psychologists that the clues for deception might be more apparent in the body than the face. Though the body has an important roll in nonverbal communication, how much it can reveal about deception is probably not as great as how much can be uncovered in the face. The face has a closer connection to many of the underlying processes connected to communication and deception so there is more that might be discovered there. Also, it is difficult to control all the aspects of the face entirely, so clues can still be gathered despite efforts to manage the face's behaviour or appearance.

Paul Ekman is a well known authority on deception, lying, and the face's role in deceit. He points out that deception covers a number of different scenarios. For the face, these techniques include masking or hiding one expression with another behavior, suppressing an expression that arises spontaneously, and faking an expression that is not genuine. He discusses many situations and motivations that underlie attempts by people to lie, and how other people can catch lies. He calls attention to the varying ability of people to lie, saying that it is very difficult, if not impossible, to tell whether some people are telling the truth or not, if they are skilled in deceptive interactions. Some occupations require such skills, whether for good or ill.

There is no one specific behaviour of the face that says "I'm lying." Instead, the person who wants to be a good lie detector must look for the clues to deception and put them together with many other facts to form an objective analysis. This analysis is often difficult to do in real time because the behaviours are difficult to see and occur in rapid sequence. They may occur only very briefly or together with other behaviours that obscure them. Most people also are not trained or naturally adept at seeing the elemental behaviours that one must perceive to break apart expressions and evaluate whether they are genuine or false. It is important to keep in mind how the facial behaviours correspond to the verbal production of the person, and any non-linguistic vocalizations or sound qualities that might betray the lie when matched with a particular facial behaviour. Psychological insights about the meanings of the verbalizations and their relation to personality, circumstances, and the story told, particularly conflicts, are also valuable in detecting deception. Catching a liar requires a lot of cognitive processing, and one increases the chances of success if the person's behaviours can be viewed repeatedly in slow motion.

V. CONCLUSION

Extensive efforts have been made over the past two decades in academia, industry, and government to discover more robust methods of assessing truthfulness, deception, and credibility during human interactions. The potential for Face recognition systems exists not just in the criminal investigative arena but equally in its ability to bolster investigation in national security, counterintelligence, and counterterrorism missions. Deception detection technologies such as Polygraphs are widely used for pre-employment screening and in criminal investigations in over 80 countries. Deception detection uses questioning techniques in conjunction with technologies to monitor a range of physiological functions. Newer technologies are exploring the potential uses of brain or facial imaging as the basis for monitoring responses.

REFERENCES

[1]. Haugaard, J. J., and Repucci, N. D. (1992). Children and the truth. In *Cognitive and Social Factors in Early Deception*, S. J. Ceci, M. DeSimone-Leichtman, and M. E. Putnick, Eds. Erlbaum, Hillsdale, NJ.

[2]. Park, H. S., Levine, T. R., McCornack, S. A., Morrison, K., and Ferrar, M. (2002). How people really detect lies. *Commun. Monogr*. **69**, 144–157.

[3]. Zuckerman, M., DePaulo, B. M., and Rosenthal, R. (1981). Verbal and nonverbal communication of deception. In *Advances in Experimental Social Psychology*, L. Berkowitz, Ed. Academic Press, San Diego, CA, Vol. **14**, pp. 1–59.

[4]. Ekman, P. (1985/2001). *Telling Lies*. W. W. Norton, New York.

[5]. Ekman, P., and Frank, M. G. (1993). Lies that fail. In *Lying and Deception in Everyday Life*, M. Lewis, and C. Saarni, Eds. Guilford Press, New York, pp. 184–200.

[6]. Hocking, J. E., and Leathers, D. G. (1980). Nonverbal indicators of deception: A new theoretical perspective. *Commun. Monogr*. **47**, 119–131.

[7]. Knapp, M. L., and Comadena, M. E. (1979). Telling it like it isn't: A review of theory and research on deceptive communication. *Hum. Commun. Res.* **5**, 270–285.

[8]. Yuille, J. C., Ed. (1989). *Credibility Assessment* . Kluwer Academic Publishers, Dordrecht.

[9]. DePaulo, B. M., Lindsay, J. J., Malone, B. E., Muhlenbruck, L., Charlton, K., and Cooper, H. (2003). Cues to deception. *Psychol. Bull*. **129**, 74–112.

[10]. McNeill, D. (1992). *Hand and Mind. What Gestures Reveal about Thought*. Chicago of University Press, Chicago.

[11]. Ekman, P., and Friesen, W. V. (1972). Hand movements. *J. Commun*. **22**, 353–374.

[12]. Vrij, A. (1995). Behavioral correlates of deception in a simulated police interview. *J. Psychol*. **129**, 15–28.

[13]. Undeutsch, U. (1967). Beurteilung der glaubhaftigkeit von aussagen. In *Handbuch derPsychologie. Bd. II: Forensische Psychologie*, U. Undeutsch, Ed. Verlag fur Psychologie, Goettingen, pp. 26–181.

[14]. Newman, M. L., Pennebaker, J. W., Berry, D. S., and Richards, J. M. (2003). Lying words: predicting deception from linguistic styles. *Pers. Soc. Psychol. Bull.* **29**, 665–675.
[15]. Darwin, C. (1872/1998). *The Expression of the Emotions in Man and Animals*, 3rd ed. (w/ commentaries by Paul Ekman). Oxford University Press, New York.
[16]. Ekman, P. (2003). *Emotions Revealed*. Henry Holt, New York.
[17]. DePaulo, B. M., Kashy, D. A., Kirkendol, S. E., Wyer, M. M., and Epstein, J. A. (1996).
Lying in everyday life. *J. Pers. Soc. Psychol.* **70**, 979–995.
[18]. Ekman, P., Friesen, W. V., and O'Sullivan, M. (1988). Smiles when lying. *J. Pers. Soc.Psychol.* **54**, 414–420.
[19]. Ekman, P., O'Sullivan, M., Friesen, W. V., and Scherer, K. (1991). Invited article: face, voice, and body in detecting deceit. *J. Nonverbal Behav*. **15**, 125–135.
[20]. deTurck, M. A., and Miller, G. R. (1985). Deception and arousal: isolating the behavioural correlates of deception. *Hum. Commun. Res.* **12**, 181–201.
[21]. Frank, M. G. (1989). *Human Lie Detection Ability as a Function of the Liar's Motivation*, Unpublished doctoral dissertation, Cornell University, Ithaca.
[22]. Burgoon, J. E., and Buller, D. B. (1994). Interpersonal deception: III. Effects of deceit on perceived communication and nonverbal behavior dynamics. *J. Nonverbal Behav.* **18**, 155–184.
[23]. Waid, W. M., and Orne, M. T. (1982). The physiological detection of deception. *Am. Sci.* **70**, 402–409.
[24]. Steinbrook, R. (1992). The polygraph test: a flawed diagnostic method. *N. Engl. J. Med.* **327**, 122–123.