Beyond Recognition: The Promise of Biometric Analytics

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In the near future, we might be able to use biometric analytics to help answer everyday questions such as: Is the speaker on TV being honest? How much money will I need for retirement? Will using this cosmetic really make me look younger?

In previous columns I have explored biometrics and its many modalities: I have examined cutting-edge algorithms that promise to identify people faster and more robustly, dispelled common myths about the technology, and discussed the use of biometric signals for purposes other than recognition. Here I explore the use of biometrics, in particular soft biometrics—human physiological and behavioral characteristics that don't explicitly identify individuals but can help differentiate them[1]—for novel applications through the lens of analytics.

Biometric analytics is the discovery of useful patterns within biometric signals to ascertain potentially interesting information about a person other than identity, such as emotional state or longevity. This emerging approach could one day dwarf the use of biometrics for identification in the commercial sphere given the public's heightened sensitivity to such applications. For example, Google has received extensive criticism from users, policymakers, and privacy advocates for its pursuit of face recognition technology, in connection with Google Glass,[2] as has Facebook.[3] Biometrics pioneer Joseph Atick declared that the unfettered proliferation of biometric identification for consumer devices and apps is "basically robbing everyone of their anonymity."[4]

BIOMETRIC ANALYTICS RESEARCH

Biometric signals are the starting point for all biometric systems. Signals associated with common biometric characteristics include 2D ridge-valley maps in fingerprints, audio recordings of the voice, near-infrared images of the iris, and video of gait motion. From these raw signals, biometric algorithms extract various features relevant to identification. Researchers continue to develop new ways to harness such signals' power—for example, using electrocardiography (ECG) waveforms to achieve aliveness detection and continuous authentication.[5]

In recent years, scientists have looked beyond recognition to analyze biometric signals for other types of information.

Kevin Bowyer and his colleagues at the University of Notre Dame have developed a system capable of determining ethnicity and, to a less accurate degree, gender from iris signals. Such demographic data could help reduce the search time of or act as an accuracy check on iris recognition systems, such as that used in India's Unique ID project.[6]

Researchers at the University of Southampton, UK, are exploring ways to improve recognition through gait analysis (www.southampton.ac.uk/research/southamptonstories/medhealthlife/walk_this_way.html), which thus far has largely been

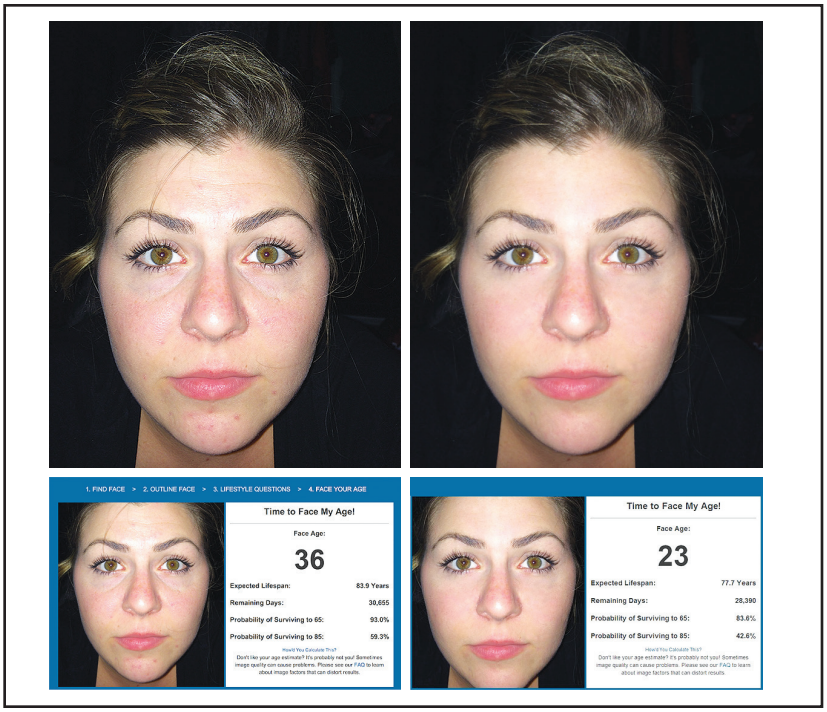

Figure 1. Face My Age is a Web application that estimates a person's age and longevity based on face features in an uploaded photo of a user and his or her responses to a series of questions. This example shows a female in her mid-twenties whose face exhibits noticeable aging effects, including forehead lines and bagging and discoloration under the eyes (top left). The system estimates her age to be 36 (bottom left). After simulated application of makeup and botox injections to the original image (top right), the system estimates her age to be 23 (bottom right).

limited to medical and sports science applications. The grainy video and upper-front view of traditional CCTV systems make it difficult for biometric algorithms to make a high-degree match of a person captured by such systems with an enrolled subject. Mark Nixon and his colleagues created a tunnel with eight digital cameras to record people's unique walking movements—which are based on physical attributes such as muscle strength and bone density—from every angle. Using this prototype system, the researchers are creating a gait database that can be matched to CCTV footage. In addition, the system could be integrated with existing access control systems at secure buildings and airports.

The Southampton researchers also developed a technique that extracts soft biometric features of subjects captured in CCTV video including height, stature, position/pose, and clothing type/color to help identify persons of interst.[7] Although designed primarily as law enforcement tool to ID criminals and terrorists (such information might have enabled the Boston Marathon bombings investigators to catch the perpetrators much earlier), this technology also has commercial applications—for example, retailers could use it to analyze the movement of customers throughout a space or to track buying patterns based on ethnicity and gender.

COMMERCIAL BIOMETRIC ANALYTICS SYSTEMS

Several companies have developed biometric systems that go beyond recognition to analyze voice recordings and face images.

Voice analytics

Voice recognition involves matching a query audio signal to an enrolled signal. Voice recognition systems have been proposed for access control of property as well as computing systems. The notion of voice recognition, and hence control, dates back to early science fiction and TV programs like *Star Trek*, in which characters spoke commands into a system that, after authenticating the speaker, executed those hands-free commands.

Systems are now being deployed that repurpose the voice recognition process to better understand the speaker's emotional state, honesty, concentration level, and other attributes that define a person's character and personality. This application of voice analytics made headlines during the 2012 US presidential campaign, when a political group used the technology—though with inconclusive results—to assess the candidates' truthfulness during the first debate.[8]

Beyond Verbal (beyondverbal.com) has created a voice analytics app called Moodies that can analyze a short audio clip of someone's voice to assess his or her mood, attitude, and other personality markers and share the results via social networks or email. *Digital Trends* demonstrated the app's impressive capability with analysis of audio from video clips of Edward Snowden's interview with *The Guardian* in Hong Kong, a press conference by President Obama addressing the NSA's surveillance programs, and various well-publicized celebrity apologies.[9]

In the near future, this technology might be integrated with speaker recognition systems, such as Apple's Siri, and automated customer service systems like those used by banks, utilities, and other companies to improve the user experience—for example, to detect your frustration with the system and send you to a human operator.

Face analytics

Numerous startups have developed software that analyzes face images for novel purposes. Founded by affective computing pioneer Rosalind Picard of MIT, Affectiva (www.affdex.com) aims to "digitize emotion, so it can enrich our technology, for work, play and life." Its signature tool, Affdex, captures facial expressions of everyday device users via webcam and uses cloud-based processing to extract and analyze emotional states such as surprise and dislike. The system provides media researchers with emotion metrics and scene-by-scene playback of data to reveal exactly when users smile or become confused, bored, or upset watching, say, a TV ad.

Another unique use of face analytics is age estimation. Perceived face age has long been associated with chronological age, and is the basis of judgments that people "look" older or younger than they are. Some age slower than the general population and are even said to have a "baby face," while others age faster as a result of genetic, medical, and sociological factors as well as lifestyle choices, and hence their faces appear older. A discrepancy between perceived face age and biological age can be an indicator of longevity; those who look prematurely older may be at higher risk for mortality. Scientifically verifiable age estimation would be particularly valuable to life insurance companies, but it would also have applications in the cosmetics and facial rejuvenation industries.

In conjunction with S. Jay Olshansky, a professor in the School of Public Health at the University of Illinois at Chicago and a research associate at the Center on Aging at the University of Chicago and at the London School of Hygiene and Tropical Medicine, I formed Lapetus Software with the goal of creating a face analytics system that quickly and accurately estimates a person's age and lifespan. The resulting app, Face My Age (www.facemyage.com), integrates cutting-edge computer vision, machine learning, and image processing techniques with the latest advances in actuarial science. Users can upload an image of their face to the site and, in about 90 seconds, the system estimates their age based on both face features—including shape/skin elasticity, forehead lines, wrinkles at the corners of the eyes (crow's feet), and lower-face laugh lines—and key data points such as date of birth, sex, race, marital status, education level, and smoking history. Figure 1 illustrates one use of the system: to simulate the effect of makeup and botox injections on perceived face age.

Face My Age was launched on 2 July 2014 and received 1.3 million views in the first five weeks. The system has been widely praised, and we continue working to improve its speed and reliability as well as to add other features.

Biometric analytics is an emerging subfield of biometrics that has huge promise in the commercial space. Applications such as Affdex and Face My Age are leading the way in efforts to leverage biometric signals, especially face images and voice recordings, for purposes other than recognition. In the near future, we might be able to use biometric analytics to help answer everyday questions such as: Is the speaker on TV being honest? How much money will I need for retirement? Will using this cosmetic really make me look younger? C

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