VIEWPOINT

Protecting Nonverbal Data Tracked in Virtual Reality

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Technology companies are facing scrutiny over privacy concerns as the public and lawmakers realize that the free services they enjoyed for years come at a cost—access to personal data. Now, many of these same companies are selling virtual reality (VR) devices to consumers. As of 2018, there have been millions of systems sold in the United States.[1]

Mining Nonverbal Data With VR

With VR, in addition to recording personal data regarding people's location, social ties, verbal communication, search queries, and product preferences, technology companies will also collect nonverbal behavior—for example, users' posture, eye gaze, gestures, facial expressions, and interpersonal distance.

A recent news report compared the VR privacy agreements across the major technology companies.[2] At that time, some companies specifically acknowledged recording "physical movements and dimensions," while others used broader terms, such as "device events."

Virtual reality only works if the system measures body movements because the content responds accordingly. For example, in VR, people turn their physical head around to make eye contact with other virtual reality users, use their legs to walk in the physical room to get across a virtual room, and move their physical arms to grasp virtual objects. These tracking data can be recorded and stored for later examination.

In 2018, commercial systems typically track body movements 90 times per second to display the scene appropriately, and high-end systems record 18 types of movements across the head and hands. Consequently, spending 20 minutes in a VR simulation leaves just under 2 million unique recordings of body language. Psychologists have never, in the decades of studying nonverbal behavior, had data sets of this magnitude, given the labor involved in hand-coding movements from recorded video.

Mental States and Health Information Revealed Through Tracked Nonverbal Behavior

Nonverbal behavior is largely automatic. Although people can regulate what images and text they post via social media, very few people can consistently regulate subtle micromovements and gestures such as sidelong glances or genuine smiles. In this sense, nonverbal data are uniquely telling. This notion that "actions speak louder than words" is most often associated with the work of psychologist Paul Ekman.

Clinical researchers have used VR tracking data for assessment for more than a decade. Early on, Rizzo and colleagues[3] built a virtual classroom with fellow students, a teacher delivering a lesson, and distractions throughout the room. The amount of head, arm, and leg movements were higher for children who received a diagnosis of attention-deficit/hyperactivity disorder compared with those who did not. Using a similar assessment paradigm, Jarrold and colleagues[4] measured head movements and demonstrated that students who received a diagnosis of higher-functioning autism spectrum disorder looked less frequently toward virtual classmates during conversation compared with undiagnosed children.

Body language might also determine learning and classroom behavior. Won and colleagues[5] used a VR tracking system to gather nonverbal head and body movement data from face-to-face student-teacher interactions and used those data to estimate students' test scores. The body language of teachers and learners during instruction accurately determined the subsequent test score of the student. In other research, body posture measured with the use of a physical chair determined a person's emotion while that person was learning from a desktop computer.[6]

Some argue that the true value of online tracking data is its influence in setting parameters in predictive models. Most users are not worried about their role in contributing to "macro" models. In other words, if one person's movement data help to fuel an overall algorithm that can determine behavior from any person's body movement, then that person would likely trade the data for free technology. Indeed, the current business models of social media companies revolve around using tracking data to tailor advertisements. Nonverbal data will augment this strategy; a recent study showed that head movements measured in VR scenes can reveal how positively a viewer rates the content in the scene.[7]

But algorithms can also be tailored to individuals. Consider a study that used tracked facial movements to estimate mistakes.[8] In that study, participants sorted virtual objects using a hand-tracking device, while their facial movements were measured via computer vision. Researchers evaluated sorting task performance for participants and categorized each one as either high or low performers. With just a few minutes of facial tracking data—"a thin slice" of nonverbal behavior—it was possible for computer vision to determine whether a user was a high or low performer. A person's future quality of work overall could be pigeonholed by small amounts of nonverbal data.

Protecting Nonverbal Data

These algorithms will likely have value outside of VR because it is fairly simple, even using older technology, to capture and categorize body movements in the real

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world using computer vision.[9] In this sense, hours of personal use within VR systems will provide the training data for algorithms that pair body language with subsequent behavioral outcomes, but the value in estimating outcomes could extend to the real world. The science fiction notion of determining future behavior—whether about what people buy, if they are ill, whom they want to date, or even if they might commit a crime—becomes a possibility. One can imagine sponsored content that is designed for the sole purpose of determining future behavior. Instead of the typical strategy of product placement, sponsors could feature compelling VR experiences that are the equivalent of a Rorschach test, which elicit telling nonverbal patterns that they will later seek to detect in the physical world.

The most viable solutions for protecting consumers will likely come from a combination of government policy, self-regulation from companies, and the users themselves. Watchdog organizations should monitor changes in privacy policies. A different type of solution would be for consumers themselves to add hardware filters onto tracking systems that intentionally reduce data fidelity (ie, how often the position data are updated or to what degree of specificity the cameras isolate movement) or employ an algorithmic "mask" to their data by intentionally adding random noise to movement streams as the tracking data feed back into the simulation, which would thwart the power of their data to estimate outcomes. Of course, both of these solutions could degrade the VR experience itself, so they are not optimal.

Conclusions

Common Sense Media recently published a report on VR and children.[10] At the time of the survey, about 1 in 5 households with at least 1 child 17 years of age or younger owned a VR system. About half of those families used VR during the week prior to the survey. Even when one accounts for the probability of bias in the sample, it is likely that hundreds of thousands of people used VR that week, and those VR systems recorded billions of data points about body language.

Virtual reality provides incredible experiences, and I remain bullish on its successful integration into the media landscape given its role in communication, education, and training. But unless we solve the privacy issue early on, violations of our nonverbal privacy might trump these benefits.

ARTICLE INFORMATION

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