Of Molecules, Medicine, and Google Glass

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ABSTRACT A compelling area of use for Google Glass, a new computing and communication platform in the form of a network-connected head-worn system, is in laboratory experimentation and medicine. In the current issue of *ACS Nano*, Ozcan and colleagues describe how Google Glass can be used to automatically identify the results of immuno-assays. This and other recent pioneering works point toward the utility of the platform in aiding and augmenting the experience of laboratory scientists and physicians by enabling on-the-go access to information, seamless recording and documentation, live sharing of points of view, and eventually augmented reality.

Google Glass, a new computing and communication platform in the form of a head-worn connected system, has recently been released and used by thousands of developers to explore novel uses. One of the particularly compelling areas of usage is in laboratory experimentation and medicine. In the current issue of *ACS Nano*, Ozcan and colleagues describe an innovative use of Glass for reading test results.[1] They demonstrate how immunoassays can be automatically identified and read using the existing Glass hardware in conjunction with both on-device and server-side processing. In their implementation, a biochemical event occurs on the test strip. This event is imaged, and a combination of the images, QR codes, and image processing enables the translation of the molecular event to an understandable input for a computing device. Here, the bridge between the molecular and computing worlds is visible spectrum images. In future generations, as devices become more capable, the form of and the need for this type of information bridge will likely change.

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One can envision many areas of use that the unique form factor and functionality of Glass enable. Three are briefly discussed here related to receiving information on-the-go, sharing one's experience and point of view, and utilizing augmented reality.

Glass enables hands-free and immediate access to information. It allows the user to interact with the system with voice commands and receive both audio and visual data. In a laboratory setting, this on-the-go access to information would enable loading directions (*e.g.*, steps required to synthesize a compound) and then following the on-screen information as the experiment is performed step-by-step. Glass allows access to the Internet and custom databases, so that, as the need for new information arises during an experiment (*e.g.*, recalling the details of the molecular structure of a compound), Glass can be used to recall and to see the needed information rapidly. Glass is equipped with a camera and can record still images and video. This capability can be used to document an experiment with voice annotation so the exact details of how an experiment was performed can be recovered at a later date. In a clinical setting, Glass can be used to call up patient information during an office visit or to give a surgeon vital signs and other data during a surgical procedure. A number of companies have already started to explore these use cases with promising demonstrations.

Glass's camera has the same point of view as the user. It allows the view of the

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user—literally what is seen through the person's eyes—to be shared live with others. View sharing can be used to teleport an expert on demand into remote areas. For example, if the medical expertise of a physician is needed in a remote village, the view through the eyes of a technician on the ground can be shared live to allow the expert to participate in and to guide what is done in the procedure. View sharing is an intimate human experience and allows other viewers to see the world exactly as seen by the Glass user. This can be used for training purposes in medicine, as well, for example, allowing students to see what an expert surgeon is looking at as she goes through a surgical procedure. The ability of Glass to record first-person experiences enables natural and seamless recording and documentation of medical procedures so they can be retrieved at later dates, if needed.

Augmented reality is a field in computer science that deals with overlaying and registering computer-generated images onto what is normally seen in the real world, resulting in a composite, information-rich view. Glass is equipped with a see-through display that allows the user to see both the environment and what is rendered graphically by the system at once. Although in the current Explorer implementation Glass is not specifically designed and optimized for augmented reality, the use of the platform in overlaying computer-generated images onto the real world offers exciting opportunities in the future. Much of our intuition as scientists in the laboratory is based on careful observation of what we see during experiments. One can envision a system that in the future can overlay molecular information onto what we normally see (and cannot differentiate with the naked eye). Imagine seeing various colors in an organic chemistry lab according to the molecular composition rather than the omnipresent white as the color of most compounds. This type of experience will likely change how the next generation of chemists intuits, as they perceive the environment in their laboratory in an entirely new way. Another promising area for augmented reality is the superposition of medical imaging and molecular data onto a patient, which can help during surgical procedures. The possibilities are limitless.

We are still in the early days of Glass development as a computing and communication platform, but already there are indications that Glass may profoundly change how we access information and how we experience the world around us. Glass will likely affect how experiments are performed, how medical procedures are done, what scientists are expected to know and to memorize, and how scientific intuition is built.

Conflict of Interest: The authors declare no competing financial interest.

REFERENCES AND NOTES

1. Feng, S.; Caire, R.; Cortazar, B.; Turan, M.; Wong, A.; Ozcan, A. Immunochromatographic Diagnostic Test Analysis Using Google Glass. *ACS Nano* **2014**, DOI: 10.1021/nn500614k.