Investigation into feasibility of lens with miniaturization of materials and power supply

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ABSTRACT

The concept of connected lenses has been presented in recent literature. As their operation requires energy, activation of the lenses could simply rely on eye movements. The energy produced by the movement of the eye could power these lenses. They would even have the ability to recharge in the blink of an eye. Another possibility could be to use the salinity of tears to recharge a micro battery. Features could theoretically be integrated such as assisting the visually impaired or displaying a signal by connecting the system to an external sensor, as recent developments already exist for the design of preliminary prototypes;

Keywords: lens, eye, energy, optics.

1. INTRODUCTION

Contact lenses were invented by Adolf Gaston Eugen Fick in 1888 [1]. The concept of connected lenses has been presented in recent literature [2, 3].

As their operation requires energy, activation of the lenses could simply rely on eye movements. The energy produced by the movement of the eye could power these lenses. They would even have the ability to recharge in the blink of an eye.

Another possibility could be to use the salinity of tears to recharge a micro battery [4 – 6]. Features could theoretically be integrated such as assisting the visually impaired or displaying a signal by connecting the system to an external sensor, as recent developments already exist for the design of preliminary prototypes.

Based on some of our experience with fabrication of lenses and optical resonators [7, 8], we propose to discuss the possibility to feasibility of developing smart lenses. First to check the state-of-the-art, then to propose some way to supply energy for a prototype of lens.

This paper does not aim to present results but rather to provide a state of the art in the field in order to provide the means to know what assets are necessary to investigate this type of lens.

In this short paper, we will first present a recent review of the state of the art.

We will then address the issue of energy sources to power a potential so-called smart system.

Finally, after reviewing our expertise in lenses and optics, we will conclude.

2. RECENT REVIEWS

The eye potentially contains a lot of physiological information. It could enable noninvasive disease monitoring via smart contact lens sensors. Research efforts are still in the early stages of their use as a smart wearable sensing platform for surveillance. A review was recently presented [9]. The choice of the material is important and latest advances in smart contact lenses with biosensors that diagnose diseases were reviewed [10] as well as tear exchange and contact lenses [11].

Fig. 1. As an illustration, a lens on the finger

Fig. 1 shows the dimension of a human lens regarding the finger. We see that the problem of making a simple lens smart will require the implementation of a certain number of new technologies.

3. ENERGY SOURCES

Commonly proposed ideas are using the salinity of tears for an electrochemical source [5], or simply flicking the eyelids over the eyes for a mechanical energy source, it could be for instance a hybrid power generation unit composed of a flexible silicon solar cell and an eye-blink activated Mg–O2 air-metal collector [12].

Thanks to the development of new technologies, particularly artificial intelligence, optical innovations are becoming increasingly numerous. The latest in development comes from Singapore and consists of contact lenses that can be recharged using tears. Find out what smart contact lenses are and what you need to know about this new generation model [13].

Optical experts predict an explosion in smart contact lenses by 2030. These new types of lenses aim to do much more than just correct vision. Indeed, by allowing the user to view an integrated screen, smart contact lenses will enable numerous functionalities.

For example, they would allow access to augmented reality without having to wear a dedicated headset. These new-generation lenses are primarily intended for medical purposes because they would allow access to health data. In the blink of an eye, a person could, for example, monitor their blood sugar levels. Smart contact lenses also aim to enable early detection of eye diseases. Finally, in a more lightweight way, they will allow you to watch movies or your computer screen.

To understand how it works to recharge with our tears, we can see reference [13].

In Singapore, researchers have developed next-generation smart contact lenses that recharge with tears.

There could be an incredible revolution in the technologies of smart contact lenses.

Fig. 2. Image to illustrate the possible revolution in the technologies of smart contact lenses

These smart lenses will have a very thin battery, approximately 0.2 millimeters, as thin as the cornea. To be placed directly on the surface of the eye, they will be made of biocompatible materials and coated with glucose. These ultra-thin batteries will be able to recharge using tear fluid, composed of water and salts. The battery of the smart contact lens will react to the sodium and potassium ions contained in this saline fluid. By supplying energy to the battery, tears will allow it to last up to thirteen hours instead of twelve for other lenses. However, these smart contact lenses can also be recharged in more conventional ways. Contact lenses that can be recharged using our tears are currently at the prototype stage and have just been patented.

4. KNOWLEDGE IN LENSES AND OPTICS

The skills developed for example in the knowledge of the limitations related to the use of glasses with low refractive index dispersion in optics [14] are useful for considering the base material for lenses. A good asset is also experience in material manufacturing, in particular having studied the interfaces between some materials and deposits intended to constitute either antennas or means of communicating or transferring information between the smart lens and a computer application [15 – 18].

It is also important to check that patents [19, 20] have been filed in order to mark out this rapidly developing disciplinary field. Patents allow the delimitation of a field of research while allowing funding for this research.

Another point is to have required systems to analyze signals and deliver frequencies [21,22].

It is also necessary to have an expertise in terms of evaluation of uncertainties [23 – 25].

4. CONCLUSION

It is still science fiction to imagine that contact lenses could really improve night vision, allow

blind people to "see", or even with the integration of photovoltaic cells, or microcircuits and sensors, to correct in real time, to display an augmented reality, and possibly increase clarity in night vision.

Recent advances allow us to imagine that in a few years we will be able to have optical lenses that allow different functions aimed at improving everyday life.

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