BIONIC CONTACT LENS

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Abstract

Have you ever wished that you could see the world around in front of your eyes as seen by protagonist in science fiction movies like Terminator and Robocop? This is now possible using Bionic contact lens.

Keywords - Contact lens, Virtual display, Fresnel lens, Micro fabrication technique, Miniature cameras, Bio-Sensing

I. INTRODUCTION

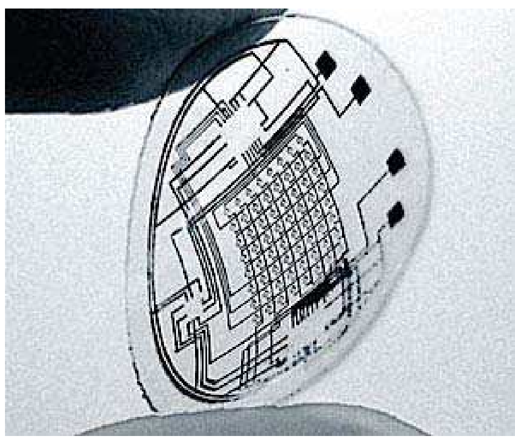

Fig 1: Bionic Contact Lens

From desktops to laptops, iphones, computers have shrunk to sizes unimaginable by their original creators. Now researchers have established one of the smallest device but yet a computer that could give a new meaning to the phrase "*The eye of the beholder*" In next 20 years internet will be on our contact lens, we would simply 'BLINK' and we will be online. It's already more science then fiction. Bionic contact lens could be the beginning of the Computer Human Interface of the future. Your smart lens would tell you what is relevant and what to ignore. Bionic contact lenses are being developed to provide a virtual display that could have a variety of uses from assisting the visually impaired to the video game industry. The lens will eventually have functional electronic circuits and infrared lights to create a virtual display. If someone speaks in Chinese no problem Bionic contact lens will translate Chinese into English subtitles underneath your picture

II. DEVELOPMENT

Students and researchers at the University of Washington lead by Dr Babak Parviz (Associate Professor, University of Washington) that can do a lot more than just help you see better. They are trying to convert pieces of plastic and polymer to a functional system that resemble a kind of complexity in cellular form. Antenna picks up radio frequency energy that is transmitted by an antenna elsewhere. While chip harvests the energy and transforms it into voltage that can power the LED. Electrical engineers are working to display directly display on the lens that would transmit information directly on the lens.

Fig 2: Virtual Display Image

III. TECHNOLOGY

- Researchers built the circuits from layers of metal only a few nanometers thick, about one thousandth the width of a human hair, and constructed light-emitting diodes one third of a millimeter across. This contact lens is embedded with light-emitting diodes; electronic circuits control circuits, communication circuits, and miniature antennas into the lens using custom-built optoelectronic components. Those components will eventually include hundreds of LEDs and much of the hardware is semitransparent. Array of LED pixels is used in lens to form an active display. They then sprinkled the grayish powder of electrical components onto a sheet of flexible plastic. The shape of each tiny component dictates which piece it can attach to, a micro fabrication technique known as self-assembly. Capillary forces – the same type of forces that make water move up a plant's roots, and that cause the edge of a glass of water to curve upward – pull the pieces into position. A kind of actuated mirror would scan the beams from a red, a green, and a blue laser to generate an image. The resolution of the image would be limited primarily by the narrowness of the beams, and the lasers would obviously have to be extremely small.
- LED's- Form images in front of the eye, such as words, charts, and photographs. The LED chips they built so far are 300 µm in diameter, and the light-emitting zone on each chip is a

60-µm-wide ring with a radius of 112 µm. They are trying to reduce that by an order of magnitude. The goal of reseacherers is to make an array of 3600 10-µm-wide pixels spaced 10 µm apart..

- Antenna-Antenna picks up radio frequency energy that is transmitted by an antenna elsewhere
- Chip-The chip harvests the energy and transforms it into voltage that can power the LED
- All these components could be positioned on the lenses outside of the transparent part of the eye. Information will appear in front of the user as if it is suspended in the air.
- Display-The display can be turned on and off. For the display to be worked its pixels must be shrunk arranged and focused and then balanced to give a study image on constantly moving eyeball.
- Image quality- Researchers could overcome that obstacle by precisely adjusting the angle of incoming light emitted by diodes on the contact lens.
- Energy- Antenna picks up radio frequency waves and turn them into energy that is transmitted by an antenna elsewhere while chip harvests the energy and transforms it into voltage that can power the LED also very small lasers can be used to ensure that the image is in focus at all times and eliminate the need for micro lenses.
- Circuit binding-To bind circuits with the lens, the researchers constructed a multiple receptor sites that attracted a different component by mimicking capillary forces that plants used to push water up thought their roots.
- Virtual display technology- A virtual retinal display (VRD), also known as a retinal scan display (RSD) or retinal projector (RP), is a display technology that draws a raster display (like a television) directly onto the retina of the eye. In bionic lens the display is floating in front of the user using virtual display technology. However, the portion of the visual area where imagery appears must still intersect with optical elements of the display system. It is not possible to display an image over a solid angle from a point source unless the projection system can bypass the lenses within the eye.
- Micro fabrication technique- Micro fabrication technique is used for image formation where thousands of free floating pixels are sand witch on a circuit board between two pieces of glass when they pour the liquid into the sand witch the pixels stick to the matter on the circuit board. One of the obstacles for the team was resolving the fundamental incompatibility between the fabrication process for microchips and light-emitting diodes and the types of polymers used for contact lenses. To get around the issue, the researchers first constructed electronic circuits from ultra-thin metal layers — each only one-thousandth the width of a human hair — and fashioned diodes so small that nearly 100 could fit within an inch. On the lens itself, the researchers created multiple receptor sites that each attracted a separate component by exploiting the same capillary forces that push water up through a plant's roots.

This micro fabrication technique allowed the tiny parts to self-assemble on the surface of the lens and bind themselves together to form the different devices. For the prototype, the group successfully integrated an antenna, tiny metal wires for an electronic circuit, and red light-emitting diodes onto the lens surface.

- Fresnel lenses-The researchers tackled the limitation of the minimum focal distance of the human eye by incorporating a set of Fresnel lenses into the device that correctly focus the projected image on the retina. The prototype lens consisted of an antenna to harvest power sent out by an external source and an integrated circuit to store this energy and transfer it to a transparent sapphire chip containing a single blue LED. It was fitted to a rabbit eye to evaluate the effects and safety of the lens on the cornea and the body.
- Image management-The researchers tackled the limitation of the minimum focal distance of the human eye by incorporating a set of Fresnel lenses which is less than 1 micrometer thick and placed it on the surface of the contact lens about 360 micrometers away from the LED
- Pixel Management-Of the high-tech miniature display, the researchers they have only one controllable pixel and they have provided the first proof-of-concept technology demonstrations for producing multipixel and in-focus images using a contact lens by producing multipixel micro-LED array chips on transparent substrates and micrometer-scale Fresnel lenses that can be integrated into a contact lens.

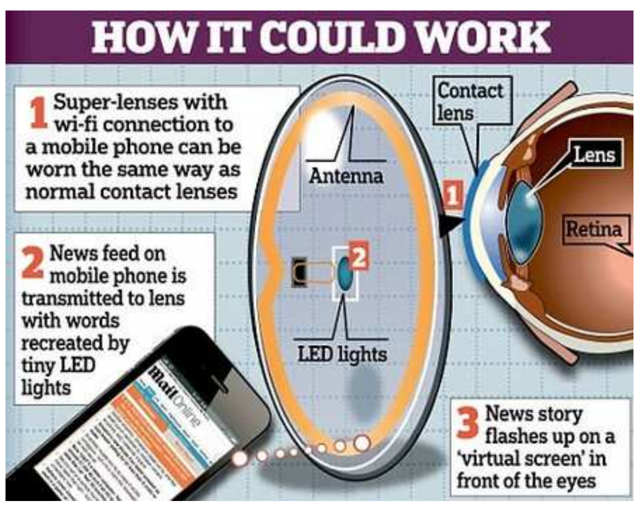

Fig 3: Working

IV. APPLICATIONS

According to the researchers, from the University of Washington, some of the possible applications include the following:

- Zooming in on and out of distant objects-Miniature cameras with adaptive lenses could be incorporated, able to zoom in on something far away or to look at something very close.

- Get useful facts to pop up in your field of view.
- Holographic driving panels.
- Surfing the Web- Using flexible display screen contact lenses.
- Visual aids for vision-impaired people.
- Immersive video games.
- Used by drivers and pilots-drivers and pilots could obtain route, weather, or vehicle status information and could see a vehicle's speed projected onto the windshield.
- Bio-sensing- on the surface of the contact lens there are a lot of biomarkers already present that are important for monitoring health care like transmit medical information like glucose , sodium, and potassium levels, blood-sugar levels directly to your doctor using internet
- Personalized wide-screen TV-The combination of contact lens with embedded optoelectronic and electronic devices could well be the beginning of the Computer Human Interface of the future.
- Recording images-with an array of lenses wirelessly connected to a wearable computer it is able to record images.
- Gaming- Video-game players could immerse themselves in a virtual world without restricting their range of motion.
- UW Contact Lens-to capture the imagination of the public is its promise of bionic vision.
- Tourism-It would offer the ability to see the ancient ruins, overlayed with what the buildings originally looked like and for buildings to be labeled in a real/virtual mixed tour.
- Sporting event-players might be labeled, the ball/puck tracked, distances marked.
- For military personnel on the battlefield.
- For disaster response teams in a crisis where saving time and doing things efficiently means saving lives.
- Direction- to orient and identify landmark on the map.

Fig 4: Computer Human Interface

V. LIMITATIONS

- First challenge is designing the surface of the lens so the electronics didn't block regular vision.
- The next problem is how to attach the electronic components thinner than a human hair to the delicate polymer of a contact lens.
- Building the lenses is a challenge because materials that are safe for use in the body, such as the flexible organic materials used in contact lenses, are delicate.
- Display circuitry couldn't be made small and light enough to be placed on a contact lens without a noticeable increase in the lens's weight.
- Micro fabrication Technique- Direct placement would probably damage the lens. So researchers built a separate, nano-size metal component and mixed them together so that they appeared like a fine powder. This powder was then placed in a vial of fluid and poured over a pitted lens surface. Each pit corresponded to a particular component.
- Another big obstacle which is resolved is the incompatibility between the fabrication process for microchips and light- emitting diodes and the types of polymers used for contact lenses.
- Focusing on image quality- Researchers overcomes this obstacle by precisely adjusting the angle of incoming light emitted by diodes on the contact lens.
- How to give power supply-Researchers are working on the issue of how to run displays or biosensors without the need of batteries. So far they have mounted antenna which collects radio frequency waves and turns them into useful.

VI. CONCLUSION

We conclude that even though blindness is a large problem in the world, there have been major advances that may one day lead to everyone having beyond perfect vision. From the medical procedure involving a lot of machinery and time bionic vision has come very far. A person can now record their entire life just by blinking or possibly connect their contact lenses with a wireless device.

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