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FLEXIBLE ELECTRONIC SKIN

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ABSTRACT

Inspired by Human skin an Electronic Skin is created by artificial means used for autonomous intelligent robots and biometric prosthetics, among other applications. The development of electronic networks comprised of flexible, stretchable, and robust devices that are compatible with large-area implementation and integrated with multiple functionalities is a testament to the progress in developing an electronic skin to human skin. Human skin is an important organ. It consists of an integrated, stretchable network of sensors that relay information about tactile and thermal stimuli to the brain, allowing us to move the organs within our environment safely and effectively. E-skins are already capable of providing augmented performance over their organic counterpart, both in superior spatial resolution and thermal sensitivity. They could be further improved through the incorporation of additional functionalities Chemical and biological sensing and desired properties e.g., biodegradability and self-powering Continued rapid progress in this area is promising for the development of a fully integrated E-skin in the near future.

I. INTRODUCTION

Electronic skin refers to flexible, stretchable and self-healing electronics that are able to mimic functionalities of human or animal skin. The broad class of materials often contain sensing abilities that are intended to reproduce the capabilities of human skin to respond to environmental factors such as changes in heat and pressure. Advances in electronic skin research focuses on designing materials that are stretchy, robust, and flexible. Research in monitoring. Self-healing, or re-healable, the electronic skin is often achieved through a polymer-based material or a hybrid material and the individual fields of flexible electronics and tactile sensing has progressed greatly; however, electronic skin design attempts to bring together advances in many areas of materials research without sacrificing individual benefits from each field. The successful combination of flexible and stretchable mechanical properties with sensors and the ability to self-heal would open the door to many possible applications including soft robotics, prosthetics, artificial intelligence and health monitoring.

Electronics plays a very important role in developing simple devices used for any purpose. In every field electronic equipment's are required. The best achievement as well as future example of integrated electronics in medical field is artificial Skin. It is ultrathin electronics device attaches to the skin like a sick on tattoo which can measure electrical activity of heart, brain waves & other vital signals. Evolution in robotics is demanding increased perception of the environment. Human skin provides sensory perception of temperature, touch/pressure, and air flow. Goal is to develop sensors on flexible substrates that are compliant to curved surfaces. Researcher's objective is for making an artificial skin is to make a revolutionary change in robotics, in medical field, in flexible electronics. Skin is large organ in human body so artificial skin replaces it according to our need. Main objective of artificial skin is to sense heat, pressure, touch, airflow and whatever which human skin sense. It is replacement for prosthetic limbs and robotic arms.

The skin is one of the main organs of the human body and it implements many different and relevant functions. Due to its complexity, the development of artificial, or better, electronic skin (e-skin) is a challenging goal that involves many different and complementary research areas. Electronic skin refers to flexible, stretchable and self-healing electronics that are able to mimic functionalities of human or animal skin. Advances in electronic skin research focus on designing materials that are stretchy, robust, and flexible. The successful combination of flexible and stretchable mechanical properties with sensors and the ability to self-heal would open door to many possible applications including soft robotics, prosthetics, artificial intelligence, and health monitoring. Self-healing, or re-healable, the electronic skin is often achieved through a polymer-based material or a hybrid material.

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II. WORKING PRINCIPLE

ARCHITECTURE OF ELECTRONIC SKIN

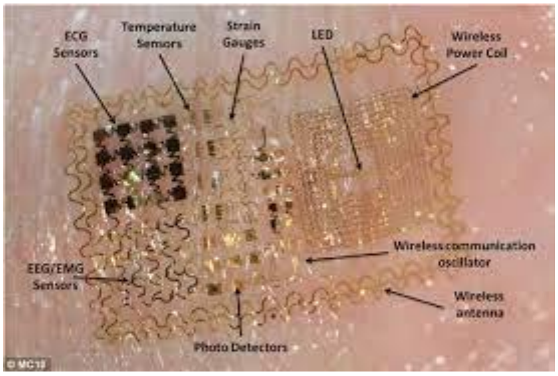

Fig 1: Architecture of E-skin

Multidisciplinary investigations have led to the development of artificial organs like the eyes, nose, and skin. When comparing all the artificial organs, the skin needs more sensors. E Skin finds its applications in a lot of places where it could be wrapped around objects to form a new form of Human Machine Interface. The ability to sense slight strain or temperature changes the E skin as an integral part of the body of a robot or an artificial limb. A lot of companies, in their own ways, applied the idea to form various circuits. MC10 created flexible electronics and attached them to the wearer's skin like a tattoo using a rubber stamp. They called these tattoos Bio stamps. Initially, they used these Bio stamps to monitor the health of patients remotely and economically. To protect these circuits, spray-on bandages would be used. The Bio stamp could be worn for a period of two weeks. Bio stamps could be stretched up to 200 percent and could monitor various medical statistics such as temperature, strain, and hydration. This was a breakthrough because, as Juvey's study claimed, although it wasn't very difficult to build sensors into networks, having a flexible circuit respond to touch and pressure, indeed, was a big deal. Ultrasonic sensors are used to measure distances and are often used in robots to avoid crashing. Proximity sensors, on the other hand, are used to detect nearby objects. Applying ultrasonic skin on a robot would give it an all-directional proximity sensor. This would allow robots to move around safely with accurate distance measurements and also allow the robots to handle soft and fragile humans with more care. Ultrasonic skin could also benefit humans as it could be used in prosthetics or as garments that had awareness of the surroundings. Although E Skin could find various applications and could hold various features, a problem that could be posed is the slow transmission of signals and reading of data from the sensors. The solution to this was found by Ali Juvey along with his colleagues at the University of California. They used nanowires that have excellent electron mobility and figured out how to make flexible large-area electronics. Another team developed electromagnetic coupling for E Skin which enabled wireless transmissions response speeds, that is, low response time, and high performance.

DESIGN AND FABRICATION

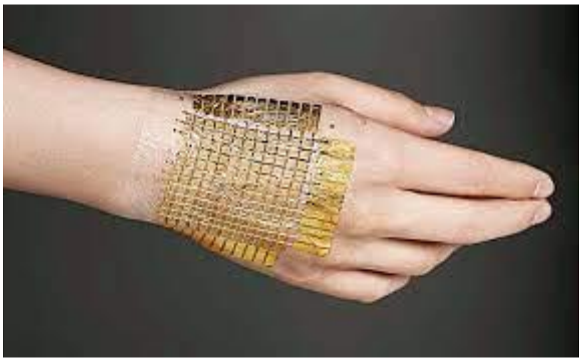

Fig 2: E Skin prototype

E Skin to function properly and to give the best, most precise, and accurate results and also to increase the range of fields of application of the E Skin, it needs to be flexible and stretchable. It is very significant for E Skin to have these properties as when it is applied to complex mechanical parts, the pressure sensing ability should be maintained. As most bodies practically are not a simple structure or a plane surface, not having flexibility would limit to very few objects. Besides, various bodies have slightly changed shapes in time to which the E Skin needs to adapt, thus, flexibility is also a very necessary feature. To achieve high amounts of flexibility, the thickness of the material must be very low, which can be achieved by using very thin and flexible substrates with high flexibilities. Depicts an E Skin prototype made using Zinc Oxide and vertical nanowires for stretchability, the method is a bit more complicated. To have stretchable E Skin, it needs to have a sophisticated island-bridge-like structure design. Also, the sensors used in E Skin will need to have high sensitivity, high resolution, very high Traditional electronics have always been fabricated on hard and rigid semiconductor wafers. In recent years, there has been a rapid increase in the field of stretchable and flexible electronics. The future seems to be full of possibilities and to make most of these come alive, it is necessary to have such technology to exist. Since E Skin poses a wide range of applications from Human Machine Interfaces (HMI) and robotics to prosthetics and microelectromechanical systems, it is even more reason to develop such technology at the earliest. Also, this technology seems to be the future of electronics rather than rigid electronics that are limiting the applications of electronics and are being used now. There have been demonstrations of multiple electronics with low thickness and with quite a bit of bendability, though, they're still very limited. Although it is very difficult and challenging to create stretchable and flexible E Skin, several strategies can be used to achieve this, such as, the use of thin conductive materials with very low Young's Moduli which is bonded to a flexible rubber or elastic substrate, and to enhance stretchability of electronics and then electronics and conductors can be assembled into devices that are flexible and constructed by a mix of conductive materials which will finally form an elastomeric matrix. For the best results of pressure mapping, it is necessary to use large scale pressure sensor arrays in E Skin. There are tactile sensors that are used in the fabrication of E Skin. These sensors measure information from physical interactions in the environment and convert them to use electronic signals. But, when using a large number of sensors, there is a problem of signal crosstalk among them. This is a huge challenge in the development of E Skin. There is, though, a method that can be used to reduce this crosstalk to a certain extent between the different pressure sensors by the use of transistors. E-Skin by using organic transistors developed by the Engineers at UC Berkeley consisting of a 16 by 16 array of transistors and is very thin with high sensitivity. The transistors have low power consumption and also have the capability to rapidly address because of their amplification and signal transduction properties. Thus, in such scenarios, instead of just using a pressure sensor array, a transistor array is also used.

III. MATERIALS AND METHODS

Traditional E Skin has a great value in many fields and has a lot of applications but it faces a lot of challenges in terms of response time and sensitivity. To solve this problem, one paper, High Sensitivity Flexible Electronic Skin Based on Graphene Film [3], discussed the use of a piezoresistive Graphene film. This would both increase the sensitivity and response times. This was based on the principle of the piezoresistive effect of the graphene film in which a micro pressure applied on the surface of the sensor would cause the stress to be collected evenly on the film. The stress would cause the carbon-carbon bond to fracture and thus cause a change in the resistivity of the film. This would thereby result in the easy measurement of the resistivity of the micro pressure by measuring the changed resistance of the graphene film with high sensitivity. The structure of the E Skin comprises a 4x4 sensor matrix in which the sensor has three layers - The lower substrate layer, the piezoresistive layer, and the PDMS bump in which the PDMS bump layer is the one with the ability to collect pressure. During the fabrication process, the lower substrate which is the flexible printed circuit board (or FPCB) is fabricated using standard MEMS technology. Then, the graphene films are obtained by the CVD method and transferred to a PET substrate and G/PET sensing units are tailored. Next, the sensing unit is attached to electrodes. Then, the upper PDMS bump is fabricated. Next, an adhesive PDMS solution is painted onto the middle of the PDMS bump and G/PDMS films and is cured for 4 hours and this way the PDMS bump is attached to the G/PET films, and the electronic skin is fabricated and obtained. The electronic skin thus obtained has 16 sensing units. Since the resistance of the sensing unit changes with the application of pressure, the resistances can be regarded as rheostats. Finally, based on the principle that the pressure on the E Skin causes the resistance to change, a measurement model is developed to sense and measure the application of the external pressure.

IV. ADVANTAGES

1. Reduces number of wires
2. Compact in size
3. Attachment and detachment is easy
4. More flexible
5. Light in weight
6. It replaces present system of ECG and EEG
7. It gives sense to a robot
8. Wearable
9. Ultrathin
10.Twistable & stretchable
11.Easy to handle

V. APPLICATIONS

Some applications are given below to know the depth and use of electronic skin:

- When the skin has been seriously damaged through disease or burns then human skin is replaced by artificial skin.
- It is also used for robots. Robot senses the pressure, touch, moisture, temperature, proximity to object.
- It can measure electrical activity of the heart, brain waves, muscle activity and other vital signals
- By using interfacial stress sensor, we also measure normal stress & shear stress.
- Localized electrical stimulation: This is a —smart bandage. Temperature is changes across a wound.

VI. CONCLUSION

In the past decade, the pace of e-skin development has accelerated dramatically owing to the availability of new materials and processes. As a result of this progress, the capabilities of e-skin are rapidly converging. Interest in e-skin has been driven by its potential to:

1. enable highly the development of interactive and versatile robots that are capable of performing complex tasks in less structured environments.

2. facilitate conformable displays and optics. and

3. revolutionize healthcare by providing biometric prostheses, constant health monitoring technologies, and unprecedented diagnostic and treatment proficiency.

Sensors and circuits have already exceeded the properties of biological skin in many respects. Electronic devices have been fabricated that stretch many times further than skin, flexible tactile sensors have been demonstrated that possess vastly superior spatial resolution to human skin, and tactile and temperature sensors are available with enhanced sensitivity over their natural counterpart. Despite rapid progress, there is a continuing need for further development before the goal of integrating multiple functionalities into large-area, low-cost sensor arrays is realized. From a design standpoint, e-skin requires active circuitry to address large numbers of devices with minimal wiring complexity and fast scan rates. Furthermore, the ability to mimic the mechanical properties of human skin (e.g., flexibility and stretchability) is critical in order to accommodate the various movements of the user. This can be accomplished through the use of intrinsically stretchable materials or rigid device islands tethered together through flexible interconnects. While the latter leverages the extensive optimization of rigid devices, the former may have advantages in terms of cost and robustness.

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