**FLEXIBILE ELECTRONIC SKIN**

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**ABSTARCT**

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. 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 (E-skin) to human skin. 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 (e.g., 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.

# **1. INTRODUCTION**

The 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. Artificial skin is skin grown in a laboratory. There are various names of artificial skin in biomedical field it is called as artificial skin, in our electronics field it is called as electronic skin, some scientist it called as sensitive skin, in other way it also called as synthetic skin, some people say that it is fake skin. Such different names are available but application is same it is skin replacement for people who have suffered skin trauma, such as severe burns or skin diseases, or robotic applications & so on. An artificial skin has also been recently demonstrated at the University of Cincinnati for in-vitro sweat simulation and testing, capable of skin-like texture, wetting, sweat pore density, and sweat rates.



FIG 1.1: ARTIFICIAL SKIN

-This latest advance is an example of the progress made in the field of microfluidic stretchable radio frequency electronics (μFSRFE), which have demonstrated the possibility of combining established stiff electronic components with channels of elastomers filled with fluid metal. This design means it is possible to build systems that can return to their original form after major mechanical deformation. Ongoing research projects that promoting the virtues of ‘E-skin’ could, in the future, be deployed in the field of healthcare. This E-skin could be used for a vast array of applications such as medical instruments that need to make controlled incision. Likewise, bandages could be equipped with sensors to ensure they are applied with the proper tightness [2].

**2 . EVOLUTION**

Electronic skin or e-skin is a thin material designed to mimic human skin by recognising pressure and temperature. In September 2010, Javey and the University of California, Berkeley developed a method of attaching nanowire transistors and pressure sensors to a sticky plastic film. In August 2011, Massachusetts-based MC10 created an electronic patch for monitoring patient's vital health signs which was described as 'electric skin'. The 'tattoos' were created by embedding sensors in a thin film. During tests, the device stayed in place for 24 hours and was flexible enough to move with the skin it was placed on. Javey's latest electronic skin lights up when touched. Pressure triggers a reaction that lights up blue, green, red, and yellow LEDs and as pressure increases the lights get brighter. Artificial skin identified by different name in a same way it is developed in different laboratories such as in MIT (Massachusetts institute of technology), in Tokyo led by Takao Someya, The Fraunhofer Institute for Interfacial Engineering and Biotechnology, and so on. In this report we see the different methods of manufacturing of artificial skin of different scientist & its application with its future scope. Another form of artificial skin [2].

It has been created out of flexible semiconductor materials that can sense touch for those with prosthetic limbs. The artificial skin is anticipated to augment robotics in conducting rudimentary jobs that would be considered delicate and require sensitive ―touch. Scientists found that by applying a layer of rubber with two parallel electrodes that stored electrical charges inside of the artificial skin, tiny amounts of pressure could be detected. When pressure is exerted, the electrical charge in the rubber is changed and the change is detected by the electrodes.

However, the film is so small that when pressure is applied to the skin, the molecules have nowhere to move and become entangled. The molecules also fail to return to their original shape when the pressure is removed. Sensitive skin, also known as sensate skin, is an electronic sensing skin placed on the surface of a machine such as a robotic arm. The goal of the skin is to sense important environmental parameters—such as proximity to objects, heat, moisture, and direct touch sensations. Examples of a sensitive skin have been made by a group in Tokyo led by Takao Someya [3].

1. **LITERATURE SURVEY**

**Paper 1**

Title : "Epidermal Electronics: Flexible Electronics for Biomedical Application,"

Authors : R. S. Dahiya

Published on : 19 September 2021

Description : This paper reviews recent There have been giant leaps not just in the manner in which technology is being used to treat patients, but also in the way the electronics and sensors have diffused into society and resulted in paradigm shifts in health monitoring. Electronic microsystems can now be ingested (e.g. swallowable capsules) to explore the gastrointestinal tract and can transmit the acquired information to a base station.

**Paper 2**

**Title** : "Directions Towards Effective Utilization of Tactile Skin -- A Review

**Authors** : P. Middendorf, M. Valle.

**Published on** : 25 Jan 2022.

**Description** : This paper provides a comprehensive review of A wide variety of tactile (touch) sensors exist today for robotics and related applications. They make use of various transduction methods, smart materials and engineered structures, complex electronics, and sophisticated data processing. While highly useful in themselves, effective utilization of tactile sensors in robotics applications has been slow to come and largely remains elusive today. This paper surveys the state of the art and the research issues in this area, with the emphasis on effective utilization of tactile sensors in robotic systems. One specific with the use of tactile sensing in robotics is that the sensors have to be spread along the robot body, the way the human skin is-thus dictating varied 3-D spatio-temporal requirements, decentralized and distributed control, and handling of multiple simultaneous tactile contacts.

**4.ARCHITECTURE OF E-SKIN**

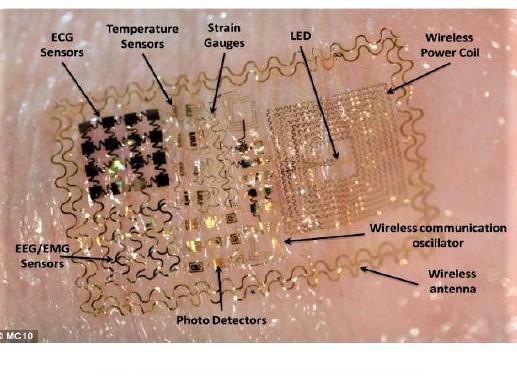
With the interactive e-skin, demonstration is takes place an elegant system on plastic that can be wrapped around different objects to enable a new form of HMI. Other companies, including Massachusetts-based engineering firm MC10, have created flexible electronic circuits that are attached to a wearer's skin using a rubber stamp. MC10 originally designed the tattoos, called Bio stamps, to help medical teams measure the health of their patients either remotely, or without the need for large expensive machinery [4]. Fig 2 shows the various parts that make up the MC10 electronic tattoo called the Bio stamp. It can be stuck to the body using a rubber stamp, and protected using spray-on bandages. The circuit can be worn for two weeks and Motorola believes this makes it perfect for authentication purposes. Bio stamp use high-performance silicon, can stretch up to 200 per cent and can monitor temperature, hydration and strain, among other medical statistics. Javey's study claims that while building sensors into networks isn't new, interactive displays; being able to recognize touch and pressure and have the flexible circuit respond to it is 'breakthrough'. His team is now working on a sample that could also register and respond to changes in temperature and light to make the skin even more lifelike [3 

FIG 4.1: ARCHITECTURE OF ELECTRONIC SKIN

An ultrasonic skin covering an entire robot body could work as a 360-degree proximity sensor, measuring the distance between the robot and external obstacles. This could prevent the robot from crashing into walls or allow it to handle our soft, fragile human bodies with more care. For humans, it could provide prosthetics or garments that are hyperaware of their surroundings. Besides adding multiple functions to e-skins, it’s also important to improve their electronic properties, such as the speed at which signals can be read from the sensors. For that, electron mobility is a fundamental limiting factor, so some researchers are seeking to create flexible materials that allow electrons to move very quickly. Ali Javey and his colleagues at the University of California, Berkeley, have had some success in that area. They figured out how to make flexible, large-area electronics by printing semiconducting nanowires onto plastics and paper [6]. Nanowires have excellent electron mobility, but they hadn’t been used in large-area electronics before. Materials like the ones Javey developed will also allow for fascinating new functions for e-skins.

**5.IMPLEMENTATION**

The next section demonstrates how E-skin is implemented.

Organic field-effect transistors: A field-effect transistor with an organic semiconductor in its channel is called an organic field-effect transistor (OFET). OFETs can be made by vacuum evaporating tiny molecules, solution casting polymers or small molecules, or mechanically applying a peeling single-crystalline organic layer on a substrate. Biodegradable electronics have been constructed using these devices [13]. Various device geometries have been used to construct OFETs.Using a combination of low-cost solution-processing and direct-write printing, all of the layers of an OFET may be deposited and patterned at room temperature, making them appropriate for realising low-cost, large-area electronic functionality on flexible substrates.

Flexible array sensors: Non-volatile memory arrays on flexible plastic substrates are created using organic transistors with a floating gate embedded in hybrid dielectrics that include a 2-nanometer-thick molecular self-assembled monolayer and a 4-nanometer-thick plasma generated metal oxide. The dielectrics' thinness enables for a non-volatile, reversible threshold voltage change. A sensor matrix that recognises the distribution of applied mechanical pressure and retains the analogue sensor input as a two-dimensional picture over lengthy periods of time is achieved by merging a flexible array of organic floating gate transistors with a pressure sensitive rubber sheet.

Nanowire arrays: Germanium and silicon nanowire arrays were used (semi-conductors). High performance, bendable transistors and sensors are made possible with semiconductor nanowires.[13].

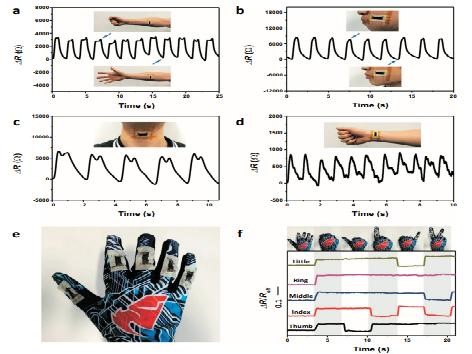


FIG 5.1: NANOWIRES E-SKIN

1. **APPLICATIONS**

1.When the skin has been seriously damaged through disease or burns then human skin is replaced by artificial skin

2.It is also used for robots. Robot senses the pressure, touch, moisture, temperature, proximity to object.

3.It can measure electrical activity of the heart, brain waves, muscle activity and other vital signals

4.By using interfacial stress sensor, we also measure normal stress & shear stress.

**7.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.Wearable

8.Twistable & stretchable

**8. 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 largearea, 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.

**9. FUTURE SCOPE**

* Bendable sensors and displays have made the tech rounds before.
* We can predict a patient of an oncoming heart attack hours in advance.
* In future even virtual screens may be placed on device for knowing our body functions.
* Used in car dashboard, interactive wallpapers, smart watches [2].

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