Dr Emre Ozan Polat

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A new generation of wearable devices for telemedicine

Research Objectives

Emre Ozan Polat works on multifunctional wearable devices and imaging technologies by combining nanoscale materials with traditional electronics.

Detail

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Bio
Dr Emre Ozan Polat is an Assistant Professor at the Mechatronics Engineering Department of Kadir Has University. His early carrier publications have received more than 1,700 citations so far. His research has been deemed worthy of several awards, including BAGEP 2021 Physics Awards (Bilim Akademisi), The Innovator of the Year 2017 in the Falling Walls Lab Competition at Barcelona, and supported by Marie Curie Actions Fellowships of the EU.

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Personal Response

What are the next steps for your research team?

" We have come a long way to demonstrate the active usage of nanomaterial based technologies in flexible and wearable applications. The next stage in our research is to empower our approach with new materials to measure multiple vital signs for complete medical information that is needed to diagnose through telemedicine networks. In addition to telehealth, integration methodologies that we develop for transparent and flexible nanomaterials will serve for wide range of optoelectronic applications from defence to energy harvesting. "

A new generation of wearable devices for telemedicine

Wearable gadgets such as smart watches, or wristbands, represent a user-friendly and cost-effective platform for the tracking of physiological parameters, such as heart rate and blood pulse oxygenation levels. However their rigid and opaque nature hinder the development of skin conformable sensors that provides continuous and accurate data for telemedicine. Dr Emre Ozan Polat and his team from Kadir Has University in Istanbul, Turkey, use the unique flexibility, strength, and transparency of graphene and related materials to design discreet wearable sensors that provide accurate, real-time monitoring of clinical data.

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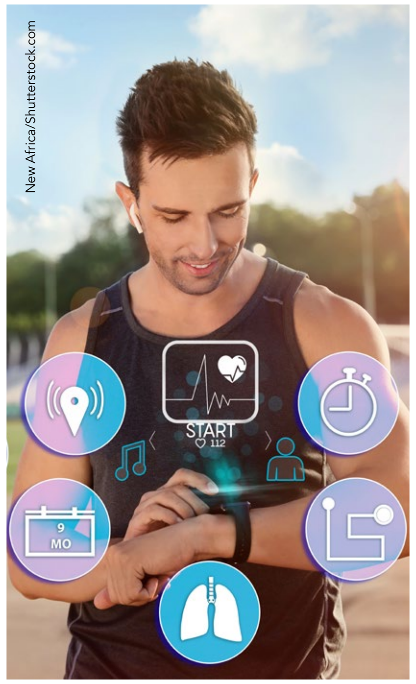
The latest generation of wearable gadgets are based on a technique known as photoplethysmography (PPG), which works by sending light through the skin to collect vital health information. Given that more than 40% of all countries have fewer than 10 doctors per 10,000 people (World Health Organization Global Reports), wearable devices in clinical settings are believed to bring telemedicine solutions to maintain a decent level in public health, especially in developing countries.

Human skin provides a unique interface for wearables to extract physiological parameters. The main aim of wearable technology has revolved around user-friendly operation; hence, some more invasive approaches including the use of implantable wearables have not gathered a large amount of user interest. A recent review by Dr Emre Ozan Polat, published in *Advanced Material Technologies*, reports the increasing usage of PPG methods in wearable devices due to its user friendly and non-invasive operation for continuous extraction of vital health parameters. In his recent work, Dr Polat covers the routes to the skin and garment integration of optoelectronic components and analyses the measurement sites for accurate extraction of heart rate (HR) and respiration rate (RR). The study highlights the key statistics on wearables, and it gives a complete outlook on skin-conformable devices that are still in the research and development phases.

Dr Polat and his team from the Kadir Has University, Istanbul, are currently working on the development of multifunctional wearable devices that combine the latest nano-material technologies with traditional electronics. Although wearable devices have been around for some time, their widespread use has so far been limited by the need for rigid materials that impact on the functionality of the gadgets and their aesthetic appeal. Dr Polat and his team work on novel approaches that combine the advanced sensing properties of graphene and related materials (GRM) within mechanically flexible device structures to realise discreet health and fitness trackers.

NON-INVASIVE AND CONTINUOUS MONITORING FOR PUBLIC HEALTH

PPG technology allows for non-invasive monitoring of vital signs by sending the light of specific wavelengths to the skin. Changes in light intensity due to absorption in blood vessels can be linked to changes in the HR, RR, blood pulse oxygenation (SpO_2), and related cardiovascular parameters. PPG devices typically use rigid semiconductor based light sources and light sensors to collect vital parameters from the skin. Current PPG wearables commonly employ green LEDs (540 nm) to measure HR, since this wavelength minimises signal interference from motion artifacts while providing enough tissue penetration depth (dermis and epidermis) to extract the vital signs. However, the presence of rigid components cannot provide continuous skin contact during the exercises and yields motion artefacts in the measurement. Although the data processing to cancel the motion artefacts has become an important part of the wearable market, additional hardware requirements limit the continuous and long term usage of the wearables and case specific motion artefact reduction algorithms remain insufficient under complex real-world conditions.



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Dr Polat develops multifunctional wearable devices that combine the latest nano-material technologies with traditional electronics.

The unique flexibility, strength, and transparency of graphene is used to design discreet wearable sensors that provide accurate, real-time monitoring of clinical data.

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Dr Polat and his Kadir Has University colleagues are working on the development of optimum device specifications to provide clinical grade data from wearable devices. The team currently investigates suitable GRMs as a sensing platform that can bypass the technological limitations of the rigid semiconductor based wearable sensors. In this way, Dr Polat aims to upgrade the feel and form factor of the currently available wearables while providing clinical accuracy for diagnosis through telemedicine networks.

Dr Polat's team investigates suitable graphene and related materials (GRM) as sensing platforms that can bypass the technological limitations of the rigid semiconductor based wearable sensors.

FLEXIBLE OPTOELECTRONICS FROM NICHE TO UBIQUITY

Graphene has emerged as a viable material for wearable optoelectronic sensors due to its key properties of transparency, conductivity, and flexibility. When combined with semi-transparent light absorber layers, graphene offers broad wavelength sensitive photodetectors (from 300 to 2,000 nm), that are mechanically robust.

Dr Polat and his colleagues from ICFO, The Institute of Photonic Sciences, have previously reported that flexible graphene photodetectors can operate at broad wavelength spectrum with operating speeds of less than a millisecond which are the key requirement in optical extraction of vital health parameters.

The team demonstrated the HR measurement by using flexible photodetectors in PPG and have found a strong correlation to the devices that are used in clinical settings. The HR measurements at multiple wavelengths (red and infrared) yielded the optical extraction of blood pulse oxygenation and the authors also reported the simultaneous extraction of the respiration rate, which holds a great importance in diagnosing respiratory problems.

Currently, Dr Polat is working on combining the GRM based light sensing technologies with new integration methodologies to enable ubiquitous light sensors for a wide application range from defence to health and energy harvesting. The research and development in flexible electronics has enabled the usage of unconventional substrates such as thin films and foils of polymers. Plant-based substrates, such as paper, are increasingly gathering attention as viable substrates due to their biocompatible and biodegradable properties. In this regard, Dr Polat has previously reported novel applications that use graphene as an optically reconfigurable medium on standard printing papers. Similarly, silk is currently considered to be used as a substrate for flexible and wearable optoelectronics. According to Dr Polat, the ability to develop humanitarian technologies on unconventional substrates would open up a plethora of opportunities from smart wearable technologies to new generation display technologies such as foldable electronic papers.


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