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EDITORIAL

Technological Advances in Electronics and Computing for Elderly Healthcare

Avanços Tecnológicos em Eletrônica e Informática para Saúde do Idoso

Avances Tecnológicos en Electrónica y Computación para la Salud del Anciano

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The World Health Organization (WHO)[1] states five critical facts about aging and health: (i) the proportion of the world's population aged over 60 will almost double from 12% to 22% between 2015 and 2050; (ii) the number of people aged 60 years already exceeds the number of children under five years of age; (iii) the aging rate of the world population is increasing; (iv) about 80% of the elderly will live in low- and middle-income countries by 2050; and (v) Countries face significant challenges in providing social and health systems that respect this demographic change. Additionally, aging comes from accumulating a wide variety of cellular damage throughout life, gradually decreasing physical and mental capacity and increasing the risks of diseases of various natures. Therefore, it is not possible to ignore that the world population is aging, nor the need to face the fact that healthy aging requires care that must be treated in an assertive and mature way.

Technological advances in several areas, especially electronics and computing, have gradually allowed mitigating diseases, sometimes monitoring, controlling, and even healing them. A unified source of the first electronic equipment used for medicinal purposes is unknown. Nevertheless, some examples date over 100 years, such as the electrocardiogram developed by Willem Einthoven[2] and implemented in 1887 by the physiologist Augustus Waller and the X-ray development in 1895 by the physicist Wilhelm Roentgen, allowing to reach internal images of a human body.[3]

Electronics are an additional driving force for medicine, mitigating human error, increasing analysis accuracy, and reaching information beyond human sensory capacity. However, the accelerated growth of the electronic potential targeting medicine came with the integration of logical and mathematical sciences, which enabled the creation of computer systems composed of hardware and software. Computing emerged

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as a tool analogous to the knowledge stored in the human brain that controls the actions of the electronic system – analogous to the human body. This model gave the computer system several potentialities to act in numerous areas with critical operation requirements, such as high reliability, precision, accuracy, real-time response, security, and availability as in the medical area. Nowadays, even low-complexity equipment is composed of hardware and software, and the range of computer systems aimed at health is enormous, varying from the most diverse complexities, costs, and areas of operation, ranging from a digital thermometer to a surgical robot remotely assisted by physicians.[4,5] Additionally, it is common for these systems to be built with requirements to meet specific market segments, such as newborn children or older people.

According to Wang et al.,[6] most seniors prefer to age in their own homes, and technologies such as the Internet of Things (IoT), Ambient/Active Assisted Living (AAL) robots, and Artificial Intelligence (AI) be of great importance in promoting independent living, improving mental and physical health, and increasing quality of life. In addition, these technologies provide a certain degree of monitoring and control so that the family ecosystem of the elderly can have a certain degree of interaction and follow-up, bringing freedom and tranquility. This fact was even more pressing in highly complex global health situations, such as the one that recently occurred in the face of the COVID-19 pandemic, where countless people had to isolate themselves in their homes, requiring online monitoring.[7,8]

Electronic and computing technologies have significantly advanced with increasingly smaller and more integrated devices. Commercial equipment, such as smartphones, provides several sensors to collect data on physical activities and dietary information, giving an overview of an older person's lifestyle.[9] Additionally, wearable medical devices, subject to regulatory controls, may provide more specific health data such as blood pressure and oximetry. AI technologies targeting healthcare can rely on this information to achieve knowledge beyond collecting and tracking data. These technologies can learn, adapt, control, and even predict the health status of an older person to anticipate risk situations, taking countermeasures to maintain the elderly's well-being.[10]

Machine learning (ML) is a subset of AI technology that, employing statistical techniques based on previously collected data, enables computer programs to make predictions and take decisions. Additionally, ML allows programs to perform tasks progressively better through experiences that can sometimes be user-iterative.[11] These optimization algorithms continuously collect and analyze vast amounts of data, identifying and categorizing patterns, using predictive analytics to assess the risk level and make behavioral or medical care recommendations. Applying ML for image analysis can, for example, detect situations of skin aging and even analyze a region susceptible to having a severe skin disease, such as melanoma.

Wearable devices that add some degree of AI provide freedom to the elderly, with low-invasive and highly effective monitoring, also helping to predict health risks.[12] Standard sensors include heart rate, pulmonary respiration, blood oxygenation, and blood pressure, but technologies collect other specific information such as stress and anxiety levels. This sensory information, together with data collected by devices such as accelerometers, magnetometers, and barometers, enables the detection of daily situations of the elderly, such as brushing teeth, taking a shower, or going downstairs. By aggregating the various technologies, AI tools can, for example, detect a fall situation or go further, such as predicting a sudden illness, thus, anticipating the elderly care system.[13]

ML technologies enable an even greater degree of adaptability. Scientists can employ statistical data to train a wearable to recognize behavioral patterns common in humans and, more specifically, in older people.[14] However, it is not practical for the wearable to come from the factory with the knowledge of the specific human that it will be used. In this sense, ML systems can relearn new human-specific behaviors, making more assertive decisions. For example, during the use, an accelerometer-type sensor positioned on the wearable can infer that the user has Parkinson's and, in this way, tailor-make a fall risk situation.

Conclusion

There are countless possibilities that technologies must help the elderly have a healthier and more careful life, promoting greater autonomy and well-being. The current technological stage and the analysis of the technological advances of the last 100 years provide evidence that the well-being technologies for the elderly will become increasingly ubiquitous and imperceptible, bringing comfort and security to the elderly without affecting their independence and privacy, which are indispensable requirements for achieving a harmonious and happy life.

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