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Using conductive fibres embroidery to integrate electronic functions into clothing

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Abstract:

Wearable devices, technology and technology is a new term, and its business environment is expanding rapidly on a global basis with the emergence of new emerging markets and applications. Wearable electronic devices and technologies will be used in new application sectors using various technologies, including semiconductors, screens, sensors, textiles, the Internet of things, etc. Wearable technologies help and expand human capabilities in various spheres of life. Although the prototypes of wearable technology were bulky and lacked certain features required to be widely marketed, they are currently significantly improved thanks to recent improvements in electronic miniaturization, energy efficiency, connectivity and the ability to embed intelligence into electronic (and photonic) devices. In the future, we will see new developments in wearable technology and also will come with the Internet of things as the smart textile market grows with high potential globally. The high demand for smart textile products is causing the current market to expand, leading to new players entering the smart textile market. In emerging economies, the market share of smart textiles consumed is increasing compared to traditional textile products. The global smart textiles market is expected to reach us.5,369 million by 2022 from the US. 943 million in 2015, with a CAGR of 28.4% from 2016 to 2022. The global smart textiles market is booming and experiencing significant growth due to numerous applications in various industries.

The research problem is summarized in the following questions :

1. Can wearable technology be used to serve different life purposes?
2. Can wearable technology be used to achieve greater healthcare and care for certain groups?
3. Can conductive fibres be used in an innovative fashion design that combines the aesthetic and functional appearance and provides health care and further care for certain special categories?

The research aims to :

1. Utilizing wearable technology to serve different life purposes.
2. Innovative fashion designs with wearable technology combine aesthetic and functional appearance and deliver new health care .
3. The use of conductive fibres in an innovative fashion design that combines aesthetic and functional appearance with the provision of health care and further care for certain special groups.

Importance of research :

1. Identify wearable technology types, importance and uses.
2. Identify conductive fibres and their importance in the design of innovative fashion that combines the aesthetic and functional appearance and provide health care and further care for some special groups.
3. Enhancing the role of wearable technology in daily life uses especially medical.

The research aims to:

1. The concept of wearable technology, its types and the techniques used to make wearable devices.
2. Smart textiles, their classification, conductive materials, and techniques used to integrate electronic functionality into smart textiles.
3. The role of wearable technology in meeting the needs of its users and providing aesthetic and functional form.

Results :

1. The technique of embroidery with conductive threads constituted a good contemporary response to the link between human needs and modern technology, which contributed to employing different types of techniques.
2. The use of smart conductive fibres/threads is enough to develop great solutions to the challenges facing humanity in various fields, through its ability to achieve the functional purpose for which they are designed more accurately.
3. The merging of science and engineering with the technologies used in smart clothing will lead to the integration of clothing technologies such as embroidery, conductive threads, electronics, information and education, and will lead to tremendous development in all areas of industry in its various sectors, health, environment, energy and others, and improve the systems of auxiliary services for its users, so the development of knowledge and education will come from the use of conductive threads instead of ordinary knitting threads.
4. Some categories face some difficulties in dealing with any new technology and therefore their requirements for wearable

technology must be recognized and taken into account during the design .

Recommendations :

1. Support studies and research on wearable technology products in general, design for special groups in particular, and establish industrial research and development centres specialized in the manufacture of conductive fibres in all universities at the national level, while activating the role of these institutions in translating these research commercially.
2. Compilation and inventory of all research related to the manufacture of conductive fibres locally and globally, organizing them in databases, and publishing them through specialized networks.
3. Opening a new field of work for companies and factories within the framework of the revolution of protective clothing and those concerned with human health and the environment and linking different fields.
4. Directing researchers to conduct scientific research on conductive threads.
5. Take advantage of the conductive threads to improve the functional properties of smart clothes.
6. When considering the future and application of wearable technology, the increasing population growth of each category should be included during the product design process.

Keywords:

Embroidery , Conductive fibre, merge , Electronic job, Wearable clothes

References:

1. Byrne, C. (2000). Technical textiles market–an overview. Handbook of technical textiles, 12, 1.
2. Çelikel, D. C. (2020). Smart E-Textile Materials. In Advanced Functional Materials. IntechOpen.
3. .Wilson, S., & Laing, R. (2018). Wearable technologies: Present and future. In Paper presented at the 91st world conference of the textile institute, Leeds, UK.
4. Brophy, K., Davies, S., Olenik, S., Çotur, Y., Ming, D., Van Zalk, N., ... & Yetisen, A. K. (2021). The future of wearable technologies. future.
5. Fernández-Caramés, T. M., & Fraga-Lamas, P. (2018). Towards the Internet of smart clothing: A review on IoT wearables and garments for creating intelligent connected e-textiles. *Electronics*, *7*(12), 405.
6. Li, L., & Cheung, T. W. (2018). Sustainable development of smart textiles: A review of 'self-functioning'abilities which makes textiles alive. *Journal of Fashion Technology & Textile Engineering*, *4*(2), 151-156.
7. Hassan, S. H., Voon, L. H., Velayutham, T. S., Zhai, L., Kim, H. C., & Kim, J. (2018). Review of cellulose smart material: biomass conversion process and progress on cellulose-based electroactive paper. *Journal of Renewable Materials*, *6*(1), 1-25.
8. Cristian, I., Nauman, S., Cochrane, C., & Koncar, V. (2011). Electro-conductive sensors and heating elements based on conductive polymer composites in woven structures. In *Advances in modern woven fabrics technology*. IntechOpen.
9. Gehrke, I.; Tenner, V.; Lutz, V.; Schmelzeisen, D.; Gries, T. Smart Textiles Production. Overview of Materials, Sensor and Production Technologies for Industrial Smart Textiles; MDPI: Basel, Switzerland, 2019 .
10. Grancarić, A. M., Jerković, I., Koncar, V., Cochrane, C., Kelly, F. M., Soulat, D., & Legrand, X. (2018). Conductive polymers for smart textile applications. *Journal of Industrial Textiles*, *48*(3), 612-642
11. Butola, B. S. (Ed.). (2020). *Advances in Functional and Protective Textiles*. Woodhead Publishing.
12. Dang, T., & Zhao, M. (2021, February). The application of smart fibers and smart textiles. In *Journal of Physics: Conference Series* (Vol. 1790, No. 1, p. 012084). IOP Publishing.
13. Bar-Cohen, Y. (2005). Current and future developments in artificial muscles using electroactive polymers. *Expert review of medical devices*, *2*(6), 731-740.
14. Chatterjee, K., Tabor, J., & Ghosh, T. K. (2019). Electrically conductive coatings for fiber-based e-textiles. Fibers, 7(6), 51.
15. Al Faruque, M. A., Remadevi, R., Razal, J. M., & Naebe, M. (2020). Impact of the wet spinning parameters on the alpaca-based polyacrylonitrile composite fibers: Morphology and enhanced mechanical properties study. *Journal of Applied Polymer Science*, *137*(41), 49264.
16. Brackett-Rozinsky, N., Mondal, S., Fowler, K. R., & Jenkins, E. W. (2011). Analysis of model parameters for a polymer filtration simulator. *Modelling and Simulation in Engineering*, *2011*.
17. Tseghai, G. B., Malengier, B., Fante, K. A., Nigusse, A. B., & Van Langenhove, L. (2020). Integration of conductive materials with textile structures, an overview. *Sensors*, *20*(23), 6910.
18. Åkerfeldt, M., Strååt, M., & Walkenström, P. (2013). Electrically conductive textile coating with a PEDOT-PSS dispersion and a polyurethane binder. *Textile Research Journal*, *83*(6), 618-627.
19. Trindade, I. G., Matos, J., Lucas, J., Miguel, R., Pereira, M., & Silva, M. S. (2015). Synthesis of poly (3, 4-ethylenedioxythiophene) coating on textiles by the 333.vapor phase polymerization method. *Textile Research Journal*, *85*(3), 325-.
20. Hebeish, A., Farag, S., Sharaf, S., & Shaheen, T. I. (2014). Development of cellulose nanowhisker-polyacrylamide copolymer as a highly functional precursor in the synthesis of nanometal particles for conductive textiles. *Cellulose*, *21*(4), 3055-3071.

21. Stoppa, M., & Chiolerio, A. (2014). Wearable electronics and smart textiles: A critical review. *sensors*, *14*(7), 11957-11992

22. Locher, I., Kirstein, T., & Tröster, G. (2004). Routing methods adapted to e-textiles. *Wearable Computing Laboratory*.

23. Roh, J. S. (2018). Conductive Yarn Embroidered Circuits for System on Textiles. *Wearable Technol*.

24. Abouraddy, A.F.; Bayindir, M.; Benoit, G.; Hart, S.D.; Kuriki, K.; Orf, N.; Shapira, O.; Sorin, F.; Temelkuran, B.; Fink, Y. Towards multimaterial multifunctional fibres that see, hear, sense and communicate. Nat. Mater. 2007, 6, 336–347.

25. Müller, C.; Hamedi, M.; Karlsson, R.; Jansson, R.; Marcilla, R.; Hedhammar, M.; Inganäs, O. Woven electrochemical transistors on silk fibers. Adv. Mater. 2011, 6, 898–901.

26. Hamedi, M.; Forchheimer, R.; Inganäs, O. Towards woven logic from organic electronic fibres. Nature Mater. 2007, 6, 357–362.

27. Bhat, N. V., Seshadri, D. T., & Radhakrishnan, S. (2004). Preparation, characterization, and performance of conductive fabrics: Cotton+ PANi. *Textile research journal*, *74*(2), 155-166.

28. Eichhoff, J., Hehl, A., Jockenhoevel, S., & Gries, T. (2013). Textile fabrication technologies for embedding electronic functions into fibres, yarns and fabrics. In *Multidisciplinary Know-How for Smart-Textiles Developers* (pp. 191-226). Woodhead Publishing.

29. Roh, J. S. (2017). All-fabric interconnection and one-stop production process for electronic textile sensors. *Textile Research Journal*, *87*(12), 1445-1456.

30. Campbell, B. (2006). Varicose veins and their management. *Bmj*, *333*(7562), 287-292.

31. Herlan, A., Ottenbacher, J., Schneider, J., Riemann, D., & Feige, B. (2019). Electrodermal activity patterns in sleep stages and their utility for sleep versus wake classification. *Journal of sleep research*, *28*(2), e12694.

32. Mostafa, Ahmed Waheed. "Design for Special Classes, Ergonomic Design for the Elderly" Ergonomics Design Information Center. http://www.ergo-eg.com/32.php.(March 20, 2018)

33. World Health Organization. (2019). *Global status report on alcohol and health 2018*. World Health Organization.

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