Application of IoT and Industry 4.0 Components in Textile and Fashion Research

Research · May 2020

DOI: 10.13140/RG.2.2.34663.68000

2 authors, including:

Gurumurthy B Ramaiah
Ethiopian Technical University
28 PUBLICATIONS **144** CITATIONS

International Journal of Advanced Science and Technology
Vol. 29, No. 7, (2020), pp. 4281-4287

Application of IoT and Industry 4.0 Components in Textile and Fashion Research

[1]Gurumurthy.B.Ramaiah, [2] Gurumurthy.Kargal.Satyanarayana rao

[1] Associate Professor, Expatriate Faculty – Textile Technology, FTVET Institute, Addis Ababa, Ethiopia,

[2] Retired Professor, Department of Computer Science and Engineering, UVCE, Bangalore University,

[1]voguru1@gmail.com [2]drksgurumurthy@gmail.com

Abstract.

IoT and Industry 4.0 components are changing the way the information is communicated with men and machines in textile and fashion activities. The prime objective of this research paper is to identify the recent developments and options available for faculty in universities to develop research projects in textile and fashion technology streams. The Industry 4.0 revolution ideas and concepts and components are discussed in this paper. These include application of new technologies like IoT (Internet of Things) for design and development of devices, artificial intelligence, smart manufacturing, cloud computing, cyber physical system study and implementing these concepts for Textile and Fashion Technology applications. Overall, IoT and Industry 4.0 revolution throws up many challenges for professionals in the way to develop textile and fashion projects.

KEYWORDS*— Internet of things: cloud computing: artificial intelligence: cyber physical systems: smart manufacturing.*

I. INTRODUCTION

In the recent years there has been few changes in the professional approach to solve problems which is fueled by Industry 4.0 revolution happening rapidly in the world today. There is an absolute need to look into the different aspects of research approach, coupled with teaching and evaluation methods employed in Indian Universities. Foreign Universities have already started orienting their research activities in textiles and fashion by incorporating many elements of Industry 4.0 revolutions [1] like Internet of Things (IoT), Artificial Intelligence (AI), Smart Manufacturing, Cloud computing and Cyber Physical System (CPS). In view of these developments in textiles and fashion industry, this research focusses mainly to address the issues, problems and discuss the working model of Industry 4.0 revolution elements [2], keeping Textile 4.0 revolution as an example. Even though, this is an emerging technological challenge for many universities and Institutes in India, some research on development and implementation of these technology is been carried out by many researchers in textile and fashion area to address very few problems. However, there are still many pending issues which is required to be addressed by technologists. The prime objective of this research paper is to identify the recent developments and research options available for faculty in universities and in turn converting research ideas into a research project [3]. In this paper we explore new methods of recent research developments like usage of IoT (Internet of Things) for design and development of devices, Artificial Intelligence for research studies, Smart manufacturing like clothing on demand for integrating technologies in manufacturing and

cloud computing for running and solving. real time problems, cyber physical systems and its importance with examples from Textile and fashion area, analysis and evaluation methodology followed by focusing on the working model

and discuss their components involved to develop newer technology and methods of research employed in Universities offering textile and fashion as major project areas. The present study provides many opportunities to solve the real time problems and will certainly gear up the stakeholders of universities and institutes offering textile and fashion education to face challenges posed by Industry 4.0 revolution. Finally, the examined Industry 4.0 technology components would enhance the research progress and methods employed in universities.

II. INTERNET OF THINGS (IOT)

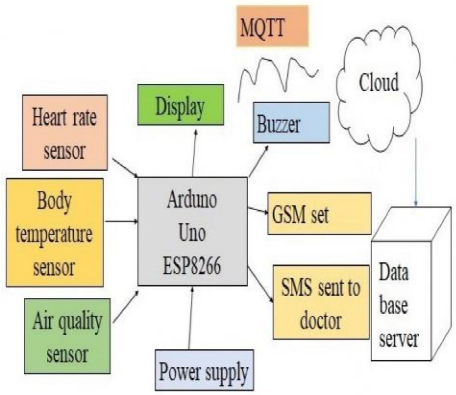


Fig 1. Internet of Things enabled devices

Internet of things is the process of interrelating all or few of the connecting devices, machines, digital objects and other relevant objects using an identifier. This enables data transfer over a specified network service achieving the functional objective without a human involvement in handling he machines.

IoT is rapidly progressing in Textile and Fashion Technology [4] with many applications and technologies like e-services for yarn, fabric and textile processing online evaluation of production and quality has resulted in an IoT enabled textile manufacturing plant controlled binterconnected computers directly. Recently Amazon and many other non-retail store companies has started developing a project on demand clothing concept, where the consumer can directly place his order and get the customized goods through IoT enabled supply chain and manufacturing line.

Basically, to start an IoT based process or to implement an IoT based concept in textiles or smart textiles [4], one should understand the big picture or specific problem that you are trying to solve. One should technically evaluate the requirement of technological inputs and computers that has to be designed and integrated into a tailored setup. The next step is to phase the project for proper implementation. Selection of sensors and communication devices is the key to proper collection of raw data enabling proper selection of devices. Building the IoT requires accurate network architecture to process data through selected devices. In Fig.1, a simple basic operating principle of IoT enabled device is demonstrated. In the example the IoT architecture utilizes a MQTT (Message

Queuing Telemetry Transport) device to communicate with the cloud server. An aurdino connecting to sensors measuring different parameters connects to the display and message service unit to enable instant communication of the measured data to the expert to take further action. These type of IoT architectures are fast and reliable way to address a problem associated with product performance and hence reduces wastage of data and time to an organization.

III. ARTIFICIAL INTELLIGENCE

Artificial Intelligence is the latest trend in research at universities and technology-based business today. Decisions are based on the way the computer suggests based on the training and learning algorithm employed in the software. In this working model, the computer identifies the problem, reads the process and operates a manufacturing process using computer-controlled robot or a software which can think intelligently, replacing the human factor involvement in the process.

take decision on a particular problem. This involves lot of experimental results and research on material properties to reach acceptable levels of accuracy.

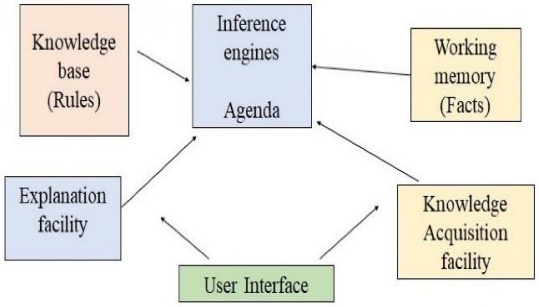


Fig 2. Artificial Intelligence working model

IV. SMART MANUFACTURING

Textile 4.0 Industry evolution has changed the way people started looking at textile manufacturing process today. Smart manufacturing is a new term associated with textile manufacturing. Smart manufacturing process is a fully integrated, collaborative manufacturing system that respond in real time to meet the changes of consumer demands

.

Artificial Intelligence applications in textiles and fashion technology are plenty [5]. Some of them are used to assist human stylists to handle fashion attributes and process data for predicting properties of fashion products and process. They also find application in designing and modeling. Where human models and their fit approvals are ascertained using predictive models. They are also used in visual garment display and analyze the garment properties based on customer requirements.

Artificial Intelligence in textiles find many high-end applications like searching images and predicting fabric drape, bending properties of fabrics, predicting yarn and fiber properties and many more applications [5]. Fig.2 shows the basic artificial intelligence working model, which utilizes a user interface connected to inference software or engines, which are trained based on the previous experimental or knowle

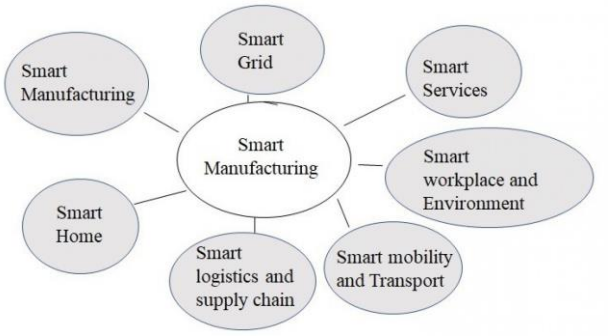


Fig 3. Working Model of Smart manufacturing

Fig. 3 shows the working model of a smart manufacturing plant. Components of a smart manufacturing plant includes efficient way to use computers and internet, integrated to manufacturing process. The manufacturing set up includes smart buildings, smart workplace and environment, smart mobility, smart grid for uninterrupted power supply, smart homes for the employees and services [5]. This approach has already started giving better results in the productivity and quality of products as well as customer satisfaction in developed countries. This is the reason why many universities have started investing in their labs, similar prototypes of smart laboratory, machines equipped with software and programmable user interface equipment's. CLOUD COMPUTING

Cloud computing is an Internet based computing process which utilizes mainly Information Technology based services, servers, storage devices and appliances, Cloud computing servers can be classified as Private Cloud (one platform application for a company), Community Cloud (cloud services provided to a particular community), Public Cloud (Cloud services provided to B2C type of business, Hybrid cloud (useful for both B2B and B2C customers).High end research is also initiated at many universities to develop software and services to assist consumers who wish to run their regular activities through cloud computing[6 – 8]

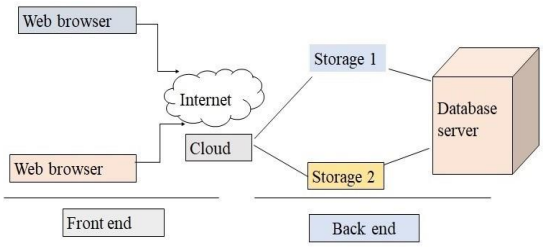


Fig 4. Cloud computing working model

V. CYBER PHYSICAL SYSTEM

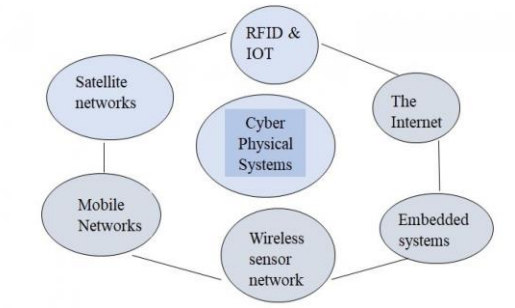


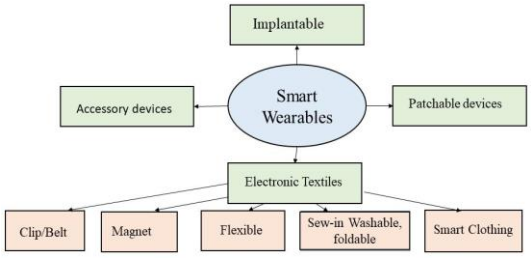
Fig 5. Working model of cyber physical systems

Cyber physical systems (CPS) involves the due integration of computer and physical facilities of an organization monitored by computer-based algorithm, tightly integrated with internet and its utility services. Robotic systems, Process control systems, medical monitoring system are few examples of cyber physical systems. Computer physical systems works through the process of computers, networks, and physical facilities [9-10]. Fig.5 gives a clear picture of cyber physical system working model.

VII SMART WEARABLES AND CLOTHING

Smart wearables are made by embedding low power sensors and devices that can adapt to the human body. Examples of smart wearables and clothing includes smart watches, healthmonitoring gadgets, etc. The integration process happens through the application of flexible fabric which classify as functional textile systems. These customized fabrics interact with the surroundings and adapt or respond to impulses

Fig 6. Smart wearables and clothing



received from the environment. Some may include patchable devices or implantable wearables. These wearables may be included near to the body or on the body, in some cases they are implanted into the body. Fig 6. Illustrates the classification of smart wearables and applications.

VIII. IMPLEMENTING IOT IN TEXTILES

IoT implementation in textiles in different scales of applications is making wave today. #IoT is the reference used to identify IoT in Textiles. The concept of implementing IoT encapsulates a growing interconnectivity of devices, vehicles and applications. In the implementation of IoT many softwares and devices coupled with sensors of different classes need to be connected in order to optimize the process control activity using an IoT enabled computer.

In Fig 7, the weaving machine which is used to weave a high quality fabric is controlled using IoT devices. The sensors for warp tension control, product quality monitoring device, setting the positon of warp stop motion is being optimized using the design data obtained from a set-up design computer. The design quality and output is controlled using the pre-setup
Simulation monitor online. These are a few applications of IoT in textiles which is vastly expanding and changing the way textiles are manufactured.

Polyglot (multiple languages) are used to inter-relate computing devices which possess its identity and can transfer data through network. The selection of the language depends on the application of the device, type of cloud server used and gateways employed. Some of the popular programs of IoT are based on Java,C,C++,python,etc., Desirable features of an IoT program are scalability, concurrency, co-ordination, heterogeneity, fault tolerance, light footprint, support for latency and sensitivity. More research is to be carried out on the application and Implementation of IoT programs for textile and fashion devices

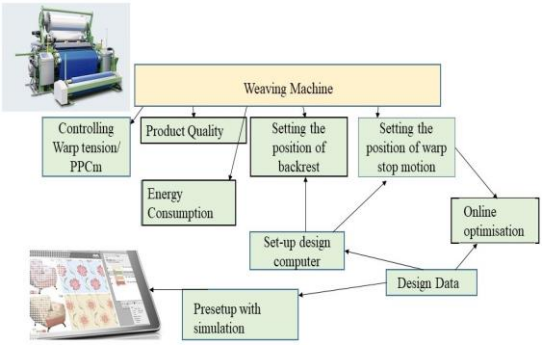


Fig 7. Implementation of IOT on a Textile weaving machine

IX. CONCLUSION

In this research paper a complete look into the recent trends and review on the use of latest technology and methods like Internet of things (IoT), Artificial Intelligence, Smart manufacturing, Cloud computing and cyber physical system working models are analyzed and certain areas of application and uses in textile and fashion technology areas is explored. The discussion on smart clothing and its technologies has immense potential to innovate using many IoT programs and make user friendly gadgets for the benefit of mankind. Practical implementation of IoT is the new research area where there is lot of problems available to be solved by IoT programs and devices. The overall output of textile 4.0 revolution seems to be very positive with respect to use of modern technologies available for researchers at Universities providing education in Textile and Fashion streams.

ACKNOWLEDGEMENT

The authors wish to acknowledge Department of Textile Technology, FTVET Institute/University for permitting to submit this research paper.

REFERENCES

[1] I. Bela, T. Peter, D. Peter, S. Robert, "New challenges for Quality Assurance of Manufacturing Processes in Industry 4.0", Solid State Phenomena, vol. 261, pp. 481-486, 2017.
[2] X. Min, M. D. Jeanne, H. K. Suk," The fourth Industrial revolution: Opportunities and Challenges", Int Journ of Finan Res, vol. 9 (2), pp. 90- 95, 2018.
[3] R .Vasja, M. Maja, K. Alojz, "A Complex view of Industry 4.0", Sage open Journ, vol. 1(11), pp. 1-10, 2016.
[4] Y. Zhe, Z. Qihao, L Lei, Z. Kan, X. Wei, "An IOT- cloud based wearable ECG Monitoring System for Smart Healthcare", Journal of Medical Systems, vol. 40 (286), pp. 01-11, 2016.
[5] J. P. Bullon, A. Gonzalez, E. Hernandez, A. Queiruga-Dios, "Manufacturing processes in the textile industry. Expert systems for fabrics production", Advances in Distributed Computing and Artificial Intelligence, vol. 6 (4), pp. 17-23, 2017.
[6] C. Min, M. Yujun, S. Jeungeun, L. Chen-Feng, H. Bin, "Smart clothing: Connecting Human with clouds and big data for sustainable health monitoring". Mobile Networks and Applications, vol. 21(5), pp. 825-845, 2016.
[7] A. K. Damodaram, K. Ravindranath, "Cloud computing for managing apparel and garment supply chains – an empirical study of Implementation frame work." International Journal of Computer Sciences, vol. 7(6), pp. 325-335, 2010.
[8] L. Chinyao, C. Yahsueh, W. Mingchang, "Understanding the determinants of cloud computing adoption." Industrial Management and Data Systems, vol. 111 (7), pp. 1006-1023, 2011.
[9] L. Insup, S., Oleg, C. Sanjian, H. John, J. Eunkyoung, G, K. Baek, , K. Andrew, M. F. Margaret, P. Soojin, R. Alexander, V. Krishna, "Challenges and Research directions in medical cyber- physical systems." In: Proceedings of the IEEE, vol. 100 (1), 75-90, 2012.
[10] A Banerjee, S. Gupta, "Analysis of smart mobile applications for healthcare under dynamic context changes". In: IEEE Trans. Mobile computing, vol. 14 (5), 904-919, 2015.