Future Generation of Communication and Internet of Things (FGCIOT)

Journal homepage: http://fgciot.semnaniau.ac.ir/

Short paper

Healthcare Internet of Things Technology: Getting to Know the Basics

Mahdieh Rafatnejad[1], Seyed Ebrahim Heydariyeh[1] , Ali Jamali Nazari[2*]

[1]*Department of Engineering, Shahrood Branch, Islamic Azad University, Semnan, Iran*

[2]*Department of Engineering, Shahrood Branch, Islamic Azad University, Shahrood, Iran*

Article Info

Article History:
Received: May 11, 2023
Revised: June 28, 2023
Accepted: August 29, 2023

Keywords:
biomedical engineers, MEMS sensors, IOT, Arduino

*Corresponding Author's Email Address: alijnazari@gmail.com

Abstract

Humans have always needed health care and these cares are mostly done in a laboratory or clinic, but nowadays, due to the high cost and unavailability of medical equipment, biomedical engineers are looking for suitable solutions to personalize medical care. One of the suggested solutions is the use of IOT (Internet of Things) technology. In this article, an attempt has been made to describe the tools needed by biomedical engineers to advance medical IOT technologies.

Introduction

IoT is also called the Internet of Things. Sensors, software, and connectivity enable physical things, devices, automobiles, structures, and other items to amass and exchange data over the Internet.[1] This interconnection of devices can then be used to develop various applications and services. Increasing automation, efficiency, and convenience are all potential benefits of IoT.[2]

The Internet of Things (IoT), in particular Remote Patient Monitoring, has significantly impacted the area of medicine.[3] Patients' vital signs and health indicators can be continuously monitored by IoT devices like wearable fitness trackers and medical sensors. Healthcare providers can receive this data in real time, allowing for the early identification of problems and prompt intervention.[4]

Protection of patient information and safe transfer of medical data are among the challenges of healthcare Internet of Things, and it is hoped that appropriate solutions will be found for them with the advancement of technology An overview of the gear and software required by biomedical engineers to become familiar with the Internet of Things technology is given in this article.[5]

MEMS sensors

Micro-electro-mechanical systems are a class of Small devices and Systems made up of micromachining Processes.[6] MEMS devices can be used independently or in a mixture with other devices to make effects of gage. Some benefits of MEMS devices include small size, lightweight, cheap cost, little power consumption, and great functionality Compared to conventional devices.[7]

MEMS (Micro-Electro-Mechanical Systems) sensors play a crucial role in medical IOT (Internet of Things) applications. They enable the collection of real-time data and provide valuable insights for healthcare providers, improve patient monitoring, and enhance overall healthcare management [8].

ASIC

ASIC (Applications - Integrated Circuits) are Computer chips that combine some dissimilar circuits all on one chip- allowing it to be traditionally programmed by custom to combine some related purposes that together carry out exact overall tasks and cannot be

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reprogrammed, so they are suitable for devices that do not need to be changed during their lifetime.[9,10]

ASICs can reduce cost, size, and energy needs by developing a circuit, particularly for the required task [11].

FPGA

FPGA attitudes for Field-Programmable Gate Array. It is a combined circuit that can be programmed afterward manufacturing to perform specific logic functions.[12] FPGAs consist of a grid of programmable logic blocks and interconnections that allow users to create custom digital circuits.[13]

FPGAs are widely used in medical imaging and signal processing. In medical IOT applications, where devices need to adapt to evolving standards, protocols, and computational requirements, FPGAs have the flexibility and reprogramming ability to make them an ideal solution.[14]

CPU

Central Processing Unit, or CPU. It is frequently described as a computer or electrical device's "brain".[15] The majority of calculations and instructions that make a computer work are executed by the CPU. It executes fundamental mathematical, logical, control, and input/output (I/O) functions as instructed by computer programs.[16]

The CPU is not able to do tasks at the same time and performs the tasks sequentially. Unlike FPGA, the CPU only can manage digital signals. For this purpose, ADC or DAC converters are used to convert the analog signal to a digital signal or vice versa.[17]

MCU

An embedded system's microcontroller is a miniature integrated circuit that controls a single process.[18]

.A usual microprocessor comprises a CPU, memory, and input/output accessories on a signal chip, these pins permit the device to direct or accept both analog and digital info from sensors. MCUs are cheap and available.[19]

Microcontrollers bring intelligence and connectivity to medical IOT devices, enabling real-time data analysis, remote monitoring, and better overall healthcare outcomes.[20] They provide the necessary processing power, low-power operation, and communication capabilities required for these applications.[21]

Arduino

An open-source electronics platform named Arduino is made on humble hardware and software directing a set of commands to the board's microprocessor will instruct your board what to do.[22] You use the Arduino software (IDE), which is founded on processing, and the Arduino programming language .[23]

Programming Arduino boards require the C/C++-like Arduino programming language. The IDE of the Arduino (Integrated Development Environment), which is also used for compilation and uploading, is where code for the Arduino board is written. However, different programming environments, such as Atmel Studio, are also compatible with Arduino.[24]

Arduino and their derivative microcontroller were designed very easy to use and It is a positive point.[25]

CLOUD CONNECTIVITY

Many IOT platforms use cloud connectivity to collect, store, and analyze data and there are more than 600 IOT platforms.[26] These platforms are usually focused on providing a web-based dashboard and a database to assemble and display data. You have to pay money to use some of these platforms.[27] Sometimes in IOT, we need a large amount of storage which may require a lot of bandwidth. For this reason, we should get to know cloud platforms and their costs before doing anything.[28]

Communication PROTOCOLS

(HTTP) and (MQTT) two of the most general communication protocols in IOT platforms. MQTT is an info-conduction procedure.[29] IBM advanced it in 1999 for conveying data between low-power sensors. It is founded on the print /subscribe model. HTTP is a named procedure. So, the HTTP procedure lets us post information to a server, which any other client can also request.[30] MQTT is Among the top messaging technologies to install for your IOT network, It is cheap, quick, lightweight, and scalable.[31]

Serial PROCESSING

MCU has to read info from the sensor, transform an analog to digital, and save that data in it.[32] When enough information is calm in memory, the MCU has to direct the information to the cloud.[33] A signal-core MCU cannot execute the next instruction until the previous instruction has been completed, which is why multi-core MCUs or systems that syndicate FPGAs with MCUs are used.[34].

CONCLUSION

As it is known, IOT in health care is a multidisciplinary technology, which is why it is necessary for biomedical

engineers to be familiar with the basic principles of IOT technology so that they can find a better understanding of the application of this technology in medicine and tools with a lower cost and design higher efficiency.

References

[1] J. F. Fuller, E. F. Fuchs, K. J. Roesler, "Influence of harmonics on power distribution system protection," IEEE Trans. Power Delivery, 3(2): 549-557, 1988.

[2] Gokhale, P., Bhat, O., & Bhat, S. (2018). Introduction to IOT. International Advanced Research Journal in Science, Engineering and Technology, 5(1), 41-44.

[3] Aledhari, Mohammed, et al. "Biomedical IoT: enabling technologies, architectural elements, challenges, and future directions." IEEE Access 10 (2022): 31306-31339.

[4] Khan, M. A. (2021). Challenges facing the application of IoT in medicine and healthcare. International Journal of Computations, Information and Manufacturing (IJCIM), 1(1).

[5] Lu, D., & Liu, T. (2011, December). The application of IOT in medical system. In 2011 IEEE International Symposium on IT in Medicine and Education (Vol. 1, pp. 272-275). IEEE.

[6] Farahani, B., Firouzi, F., Chang, V., Badaroglu, M., Constant, N., & Mankodiya, K. (2018). Towards fog-driven IoT eHealth: Promises and challenges of IoT in medicine and healthcare. Future generation computer systems, 78, 659-676.

[7] Tadigadapa, S. A. K. M., & Mateti, K. (2009). Piezoelectric MEMS sensors: state-of-the-art and perspectives. Measurement Science and technology, 20(9), 092001.

[8] Aborujilah, Abdulaziz, Abubaker-Eseddig Fathi Mahmoud Elsebaie, and Shamsul Anuar Mokhtar. "IoT MEMS: IoT-based paradigm for medical equipment management systems of ICUs in light of COVID-19 outbreak." Ieee Access 9 (2021): 131120-131133.

[9] Moise, Madalin Vasile, Mihaela Pantazica, and Marian Otoiu. "IoT Portable Patient Health Monitoring System using MEMS Sensors." 2023 46th International Spring Seminar on Electronics Technology (ISSE). IEEE, 2023

[10] Samir, Nagham, et al. "ASIC and FPGA comparative study for IoT lightweight hardware security algorithms." Journal of Circuits, Systems and Computers 28.12 (2019): 1930009.

[11] Ballabriga, R., Campbell, M., & Llopart, X. (2018). Asic developments for radiation imaging applications: The medipix and timepix family. Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 878, 10-23.

[12] Magaki, I., Khazraee, M., Gutierrez, L. V., & Taylor, M. B. (2016). Asic clouds: Specializing the datacenter. ACM SIGARCH Computer Architecture News, 44(3), 178-190.

[13] Iida, M. (2018). What is an FPGA?. Principles and Structures of FPGAs, 23-45.

[14] Yang, H. G., Sun, J. B., & Wang, W. (2010). An overview to FPGA device design technologies. 电子与信息学报, 32(3), 714-727.

[15] Hill, B., Smith, J., Srinivasa, G., Sonmez, K., Sirasao, A., Gupta, A., & Mukherjee, M. (2017, August). Precision medicine and FPGA technology: Challenges and opportunities. In 2017 IEEE 60th International Midwest Symposium on Circuits and Systems (MWSCAS) (pp. 655-658). IEEE.

[16] Rutkowska, J. (2007). Beyond the CPU: Defeating hardware based RAM acquisition. Proceedings of BlackHat DC, 2007

[17] Rutkowska, J. (2007). Beyond the CPU: Defeating hardware based RAM acquisition. Proceedings of BlackHat DC, 2007.

[18] Maheshwarappa, M. R., Bowyer, M. D., & Bridges, C. P. (2017). Improvements in CPU & FPGA performance for small satellite SDR applications. IEEE Transactions on Aerospace and Electronic Systems, 53(1), 310-322.

[19] Baughman, J. M., Perocchi, F., Girgis, H. S., Plovanich, M., Belcher-Timme, C. A., Sancak, Y., ... & Mootha, V. K. (2011). Integrative genomics identifies MCU as an essential component of the mitochondrial calcium uniporter. Nature, 476(7360), 341-345.

[20] Cernigliaro, G., Martos, M., Montagud, M., Ansari, A., & Fernandez, S. (2020, June). PC-MCU: Point cloud multipoint control unit for multi-user holoconferencing systems. In Proceedings of the 30th ACM Workshop on Network and Operating Systems Support for Digital Audio and Video (pp. 47-53).

[21] Zhang, X., Jiang, H., Zhu, B., Chen, X., Zhang, C., & Wang, Z. (2010, December). A low-power remotely-programmable MCU for implantable medical devices. In 2010 IEEE Asia Pacific Conference on Circuits and Systems (pp. 28-31). IEEE.

[22] Rghioui, Amine, et al. "An IoT based diabetic patient monitoring system using machine learning and node MCU." Journal of Physics: Conference Series. Vol. 1743. No. 1. IOP Publishing, 2021.

[23] Galadima, A. A. (2014, September). Arduino as a learning tool. In 2014 11th International Conference on Electronics, Computer and Computation (ICECCO) (pp. 1-4). IEEE.

[24] Badamasi, Y. A. (2014, September). The working principle of an Arduino. In 2014 11th international conference on electronics, computer and computation (ICECCO) (pp. 1-4). IEEE.

[25] Varshney, Heena, Ali S. Allahloh, and Mohammad Sarfraz. "Iot based ehealth management system using arduino and google cloud firestore." 2019 International Conference on Electrical, Electronics and Computer Engineering (UPCON). IEEE, 2019.

[26] Louis, L. (2016). working principle of Arduino and u sing it. International Journal of Control, Automation, Communication and Systems (IJCACS), 1(2), 21-29.

[27] Pereira, P. P., Eliasson, J., Kyusakov, R., Delsing, J., Raayatinezhad, A., & Johansson, M. (2013, March). Enabling cloud connectivity for mobile internet of things applications. In 2013 IEEE seventh international symposium on service-oriented system engineering (pp. 518-526). IEEE.

[28] Zolotová, I., Bundzel, M., & Lojka, T. (2015). Industry IoT gateway for cloud connectivity. In Advances in Production Management Systems: Innovative Production Management Towards Sustainable Growth: IFIP WG 5.7 International Conference, APMS 2015, Tokyo, Japan, September 7-9, 2015, Proceedings, Part II 0 (pp. 59-66). Springer International Publishing.

[29] Arulanthu, Pramila, and Eswaran Perumal. "An intelligent IoT with cloud centric medical decision support system for chronic kidney disease prediction." International Journal of Imaging Systems and Technology 30.3 (2020): 815-827.

[30] Al-Sarawi, S., Anbar, M., Alieyan, K., & Alzubaidi, M. (2017, May). Internet of Things (IoT) communication protocols. In 2017 8th International conference on information technology (ICIT) (pp. 685-690). IEEE.

[31] Çorak, B. H., Okay, F. Y., Güzel, M., Murt, Ş., & Ozdemir, S. (2018, June). Comparative analysis of IoT communication protocols. In 2018 International symposium on networks, computers and communications (ISNCC) (pp. 1-6). IEEE.

[32] Kassem, Ihab, and Azzam Sleit. "Elapsed time of IoT applicatio