A Novel Method for Robots to Provide First Aid to Injured People Inside the Mines Using GIS Technology

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Abstract
The artificial intelligence of robot is the weakness of digital intelligence of a person who able to train, self-realize and to develop competences, creative, professional and behavioral skills. A new methodology proposed for managing robots inside the mines using an electronic system designed for driving robots to injured people in seas, mines or wells who can not be reached by human force. This paper also explains the concept of managing and remote-controlling the process of searching and helping the injured. The user controls the robot through an application that receives all the reports that the robot sends from the injured person. The robot's tasks are to take a sample of the blood of the injured person, examine it, and measure the percentage of oxygen underground and send it to the user who directs the robot to pump a specific percentage of oxygen to the injured person. The user can also communicate with the person The patient and determine his condition through the camera connected to the robot equipped with headphones to communicate with the injured and the user can direct the camera of the robot and take x-rays from the injured.

Keywords:
artificial intelligence, robots, Geographic Information Systems (GIS), Remote Sensing (RS), First Aid.

1. Introduction

Artificial intelligence describes machines work process that requires intelligence if performed by humans, thus the term 'artificial intelligence' means "investigating intelligent problem-solving behavior and creating intelligent computer systems." There are two types of artificial intelligence; that are weak artificial intelligence and strong artificial intelligence [1].

Robotics is an economic system that uses robots, artificial intelligence, and (service) automation technologies as factors of production instead of human labor. There are many arguments make a company prefer using RAIA to produce goods and services instead of human employees [2].

Robots can solve different practical problems. Medicine, banking service, industry, education, hotel business and even entertainment are the main areas where robots used [3]. No doubt, technology has a significant impact on the geographical world.

Despite a great deal of media attention, the field of sponsored run robotics is still quite young. There is no strategic approach attempted to consider the robots deployment in care services. At present there are only a limited number of probable applications that robots can implement within home and residential care settings due to technological limitations, but it seems they will increase in the near future. The largest current application area of robotics technology facilitates social interaction [4]. In 2003, the University of Maryland Medical Center (UMMC) began a pilot program to determine the logistical capability and functional utility of robotic technology in delivering drugs from satellite pharmacies to patient care units [5]. Three affiliated pharmacies currently use the automated system. Five data sources (electronic robot activation records, records, interviews, surveys, and observations) were used to assess five key aspects of automated delivery: robot use, reliability, timeliness, cost reduction, and acceptability.

Although system companies that use artificial intelligence provide services, there are many problems, including those facing injured people underground, such as those stuck in wells or mines. The problem is represented in some questions, namely: Are the people stuck or searching underground

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exposed to health troubles there and how they can be contacted? How to provide them with healthcare? How to ensure their health? This can be achieved by designing an electronic system that controls a robot supported by sensor technology providing first aid to those stuk underground. The application remotely follows up and controls the robot that lights the place for the injured and directs him as it is the intermediary to talk with the system supervisor outside and sends all information as reports to the supervisor and then the system controls the robot stage by stage.
The system supervisor directs the robot through the application that is entered into narrow places such as mines or wells. The robot measures the underground oxygen level and soil moisture and reads all measurements and sends them to the application. The robot is equipped with a camera that takes x-rays for the injured, with a blood test device and a device to shed light into the place. The robot is also equipped with a device that regulates oxygen for the injured people underground. All information is saved in the system.The main objective of this research is to design an electronic system connected to a robot that provides health aid to the injured stuck underground in mines and wells. This paper is proposed to achieve the following objectives:

- Make x-ray for the injured to ensure his health condition.
- Provide the injured with first aid.
- Follow up the case through a digital camera.
- Measure the soil temperature and moisture underground.
- Pump the appropriate oxygen level to the injured.
- Take a blood sample from the injured.

In order to achieve these objectives, an electronic application sensory connected to a robot that provides first aid to the injured should be designed. The system allows the user to control and review reports by connecting a device to robot that operates on sensor technology. The robot is equipped with a camera to take x-rays for the injured, a blood test device, and a liquid oxygen device. It is also equipped with a video camera to enable the system supervisor to talk with the injured. The robot sends reports as data based on which the services provided to the injured can be controlled.

Figure (1): Shows the components; the Geographic Information System (GIS) consists of:

- Network: It is defined as a means of connecting a number of devices (may be two or more) for the purpose of information and data exchange (for example, the Internet).
- Physical devices: through which the user logs into the system (such as laptop computer and mobile phone).
- A robot that takes x-rays, tests blood, supplies oxygen to the injured and adjusts the soil temperature.

Software: Software that run GIS devices using Arc GIS for desktop and HTML to design pages.

- Personnel: They are responsible for design, programming, results, data validation and information dissemination.
- Procedures: A set of administrative procedures related to control, supervision and regulation.

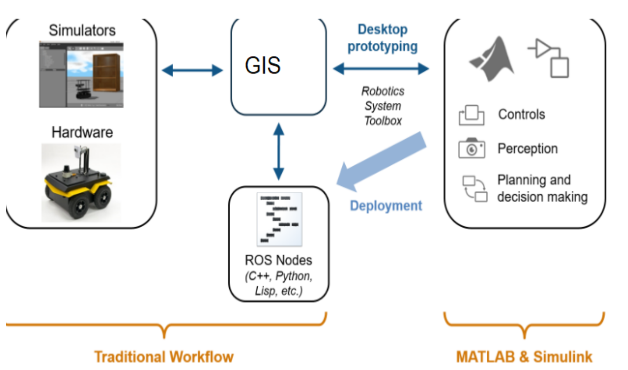

Figure 1. Illustrates robot System Components Using GIS

2. Literature Review

Robotics technology has been rapidly expanding into additional domains in recent years as a result of increased scientific advancement. The majority of them have been originally absolutely reliant on human operators [1]. Robotics is being deployed in nearly every single industry accessible. There are fully autonomous mobile robots that can assist people, provide support accessories, and perform other autonomous tasks [2]. By incorporating mobile robots into industries, healthcare, and households, the robotic industry is steadily growing. Service robots that can travel from one location to another are used in a variety of industrial sectors to automate data logging tasks [3]. The majority of existing industrial mobile robots are based on variations in the surrounding environment that can be adjusted to provide artificial benchmarks for autonomous navigation of mobile robot from one location to another [4]. According to the WHO members progress report [5] there is fewer than one specialist per thousand people who can provide sufficient medical health assistance for most of the countries. Chronic illnesses are affecting an increasing number of individuals. Healthcare services are becoming more reliant on medical staff, necessitating the need of modernization in medical personnel process flow. This problem becomes much more apparent in an emergency, such as the corona outbreak. As a consequence, doctors, nurses, and medical assistants are compelled to provide assistance to everyone, making them a source of illness for their families and themselves. As a result, individuals who are affected by various diseases are more likely to spread the disease to more people. In such situation, a mobile robot can potentially obtain some preliminary information about the patient (such as BPM, Body Temperature, ECG and Oxygen Saturation Level) while not requiring direct interaction with the health care professional, which would considerably minimize the disease spreading concerns. Poverty has also become a major concern in third-world nations [6]. More people need more healthcare professionals for check-ups, resulting in an upsurge in healthcare costs.

Since due to significant technological advances, hospitals are allowing mobile robots to participate and be a part of workforce. These robots can function and engage in a variety of environments [7]. Healthcare facilities have a massive market for such automated mobile robot units especially in current scenario of global pandemic. The adoption of robotic units results in a consistent increase in work productivity and a decrease in yearly costs, according to statistics [8]. Several studies have been conducted to examine the demand for mobile robots and their implementation methods in the healthcare sector but their demand in remote areas is scarce. For instance, a study demonstrated how automated transportation can improve hospital logistics performance, achieve better administration, and reduce costs [9].

Telepresence is among the most cutting-edge telemedicine systems. Although when connecting patients to doctors at health centres which are not in the same physical area, regional constraints are often encountered [10]. Telemedicine's live video transmission features [11] can aid health workers, medical advisors, and experts in providing health care to patients in distant places. For health-care applications, a number of telepresence efforts have been established. The therapeutic and instructional effects of a remotely tele-consultative service through a two-way audio-visual connection appeared to be better than using simply telephone connection [12]. A mobile robotic mechanism with live audio-visual communication capabilities [13] is used to achieve this functionality. Given the high prevalence of severe poverty in developing countries, most of the existing methods to address this problem are too expensive to implement in this field. Furthermore, the instability of the electricity grid in rural regions, where the majority of towns are not even linked, will ultimately compromise the system's long-term viability.

A medical assistant robot has been developed to assist patients in relocating essential medical equipment. The robot detects people using a Pixy image recognition sensor and avoids obstacles with an ultrasonic sensor [14]. Social robots are another form of robots that are capable of interacting and communicating with people as well as their surroundings. From pet-like toys (e.g., Paro) to humanoids, social robots have been created in a variety of forms (e.g., Sophia) [15]. Furthermore, overview of the existing and future uses of humanoid robots in healthcare settings has been published in literature [16]. Several specifications and criteria for humanoid robots in healthcare is provided which is required to perform medical tasks successfully, including the availability of a vision system, sensor operations, manoeuvrability, and actions in delicate control tasks [17]. These robots can substantially compensate the unavailability of doctors if either the doctor or patient due to the working condition does not get physically contacted immediately. Finally, this robot will lower the cost of regular checks per capita in the healthcare system by health facilities greatly. As a consequence, people especially labourer will benefit from low-cost healthcare. To improve the effectiveness of social robot interactions, many types of sensors and controllers may be integrated. For example, social robots resembling humans in appearance may converse and engage with humans while using integrated sensors to monitor their emotions, temperature, body language, and vital signs. Wearable technology such as augmented reality/virtual reality head-mounted displays are another example. This technology can be used to improve public health, assist medical practitioners, and create interactive interfaces for e-health and tele-robotics management [15]. Virtual reality and, to a lesser level, augmented reality are both publicly accessible consumer commodities. Virtual and augmented reality technology may be used by healthcare personnel to facilitate natural interaction for offsite diagnosis and treatment scheduling [18].

Most development in the navigation section for mobile robots is based on path planning automated motion [19], obstacle/collision avoidance [20], and other study in navigation is focused on android app associated with user-end manual controlling [21]. Medical assistance [22] and autonomous robot communication and control schemes [23] have received a lot of attention. The vast majority of medical workers according to literature requested internet management for autonomous robot [24]. To provide remote check-ups and improve current systems, the PMS (Patient Monitoring System) [25], digital thermometer [26], and non-contact infrared thermometer for observing body temperature [27] have all been suggested. In remote areas where life is at risk, the following equipment/methods are recognised for long distance health monitoring solutions: low-cost pulse oximeter using Arduino [28], and Raspberry-based pulse oximeter design [29], Temperature-Humidity measuring system for IoT Based Medical Assistant Robot [30], heartbeat monitoring using IoT [31], and IoT based device for detection of heart related problems [32].

3. Proposed Methodology

Various methods of using devices applications remotely are proposed in this field. In this paper, an additional model system is proposed including the development stage,

requirements and design stage up to the final stage. It is shown in Figure (2). The design stage is the test and implementation stage.
The paper basically aims to investigate the process of controlling robot that performs first aid for the injured underground. In order to apply this proposed methodology, to design, implement and test all components of the system, the programmer needs to develop a system that controls a robot connected to the sensor technology.

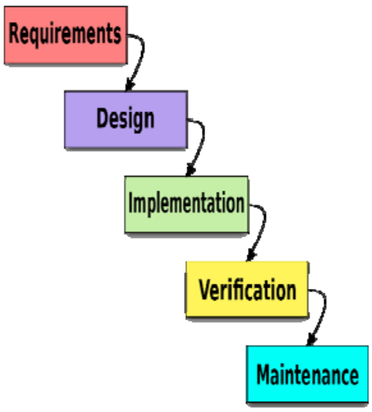

Figure 2. Schematic Representation of an Incremental Build Model

3.1 Use case

Figure (3) shows a use case diagram of the proposed system. In Figure (2), the first representative represents the system supervisor who reads reports and information sent by the robot and the way the robot is given commands. The second actor is the robot that takes x-rays for the injured, provides him with oxygen and tests his blood.

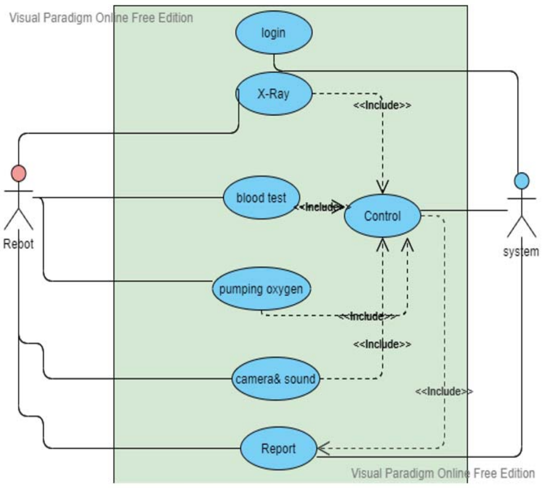

Figure 3. Use Case Diagram for the Proposed System

Figure (4): A screen shows how the supervisor enters into the system and controls the robot.

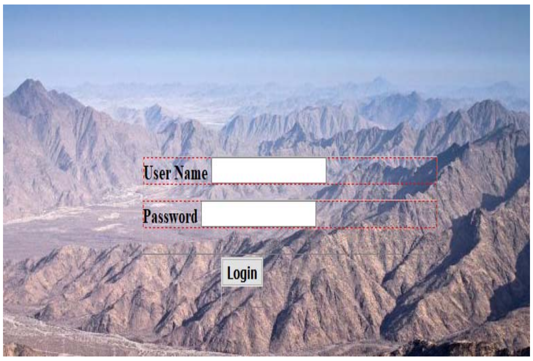

Figure 4. System login screen

Figure (5): A screen shows how the robot determines the place and makes x-rays for the injured. The screen contains the button (direction) and the button (capture).

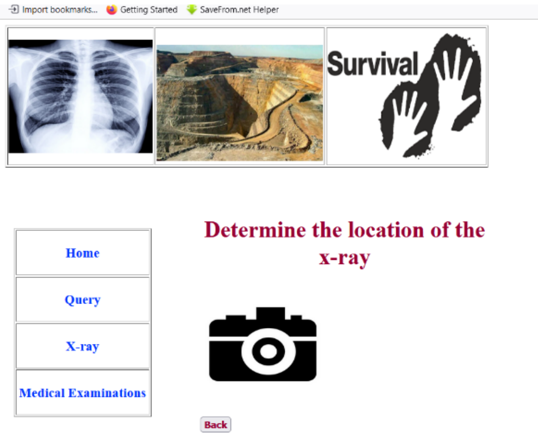

Figure 5. Screen showing x-rays taken from the patient

Figure (6): A screen shows the oxygen level report in the ground sent by the robot and the amount suggested to provide the injured with.

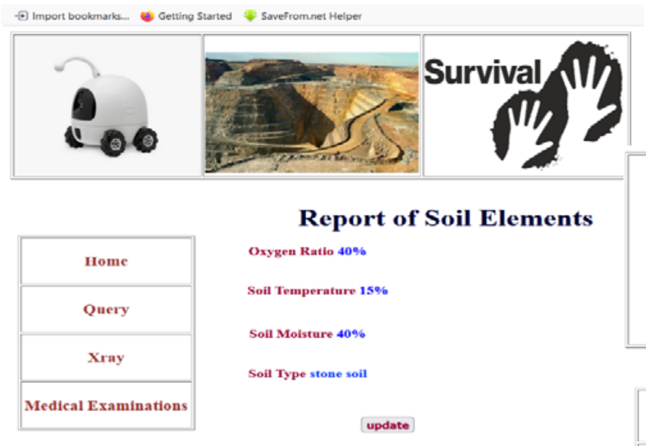

Figure 6. Robot reading screen soil elements

Figure (7): A screen shows how the supervisor pumping oxygen.

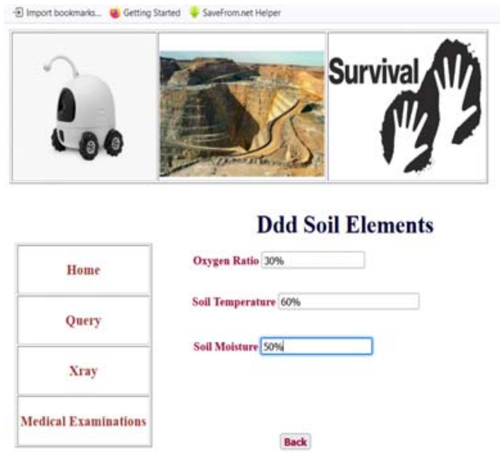

Figure 7. A Main Prescription Inquiring Interface

Figure (8): A screen shows the process of controlling the robot collecting blood sample from the injured and driving it to the right part of body through watching a camera installed in the robot. The screen contains an icon (test).

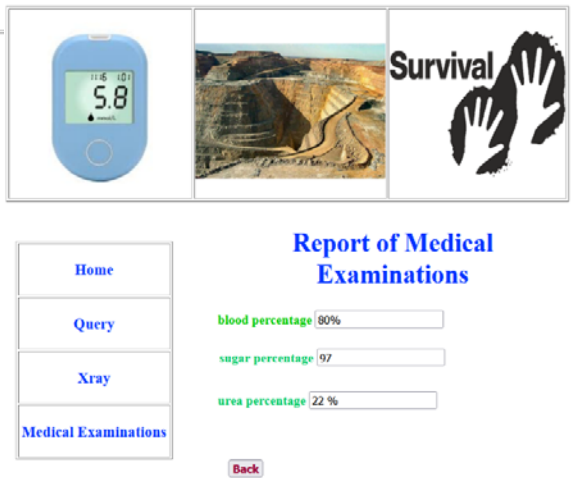

Figure 8. User add chemical elements screen

4. Conclusion and Future Enhancements:

The main objective of using robots is that; they are not affected by environmental factors and able to adapt light, to condition air or protect from noise, they are more accurate and faster than humans, they can access narrow or dangerous places, they also operate in locations that are not safe for humans such as nuclear or chemical industries and they keep reports. In the coming years, no doubt robots will be used in healthcare delivery as it will become a basic requirement; though robots widely used in mines and wells they do not provide healthcare or make medical tests for the injured inside those places. In this paper, a new methodology has been proposed to identify a person's information using robots; electronic applications have been integrated with artificial intelligence systems (robots), which helps in the process of controlling robots that send x-rays report, medical tests, humidity ratio and oxygen level from underground to the system, accordingly the system supervisor controls pumping the appropriate amount of carbon dioxide, talking to the injured through the robot.

4. References

[1] Mihret, Estifanos Tilahun. "*Robotics and artificial intelligence*." International Journal of Artificial Intelligence and Machine Learning (IJAIML) 10.2(2020):57-78 , doi10.4018/IJAIML.2020070104.

[2] Ivanov, Stanislav Hristov and Ivanov, " Stanislav Hristov, *Robonomics - Principles, Benefits, Challenges, Solutions*" Yearbook of Varna University of Management, Vol. 10, p. 283-293, 2017, Available at SSRN: https://ssrn.com/abstract=2995365." (2017).

[3] Evgeniy Bryndin. "*Robots with Artificial Intelligence and Spectroscopic Sight in Hi-Tech Labor Market* ". International Journal of Systems Science and Applied Mathematics. Vol. 4, No. 3, 2019, pp. 31-37. doi: 10.11648/j.ijssam.20190403.112019).

[4] Dickinson, Helen, et al. "*Robots and the delivery of care services*." (2018) DOI: 10.13140/RG.2.2.34652.03201

[5] Marc R. Summerfield, M.S., F. Jacob Seagull, Ph.D., Neelesh Vaidya, Pharm.D., Yan Xiao, Ph.D., Use of pharmacy delivery robots in intensive care units, *American Journal of Health-System Pharmacy*, Volume 68, Issue 1, 1 January 2011, Pages 77–83, https://doi.org/10.2146/ajhp100012

[6] K. S. Harikrishnan and D. G. Stephen, "Hospital/Home Medical Assistant Robot," *MS&E*, vol. 912, no. 6, p. 062015, Sep. 2020, doi: 10.1088/1757-899X/912/6/062015.

[7] J. Almeida Bessa, D. Almeida Barroso, A. Rego Da Rocha Neto, and A. Ripardo De Alexandria, "Global location of mobile robots using Artificial Neural Networks in omnidirectional images," *IEEE Latin America Transactions*, vol. 13, no. 10, pp. 3405–3414, Oct. 2015, doi: 10.1109/TLA.2015.7387248.

[8] E. Digiampaolo and F. Martinelli, "A Robotic System for Localization of Passive UHF-RFID Tagged Objects on Shelves," *IEEE Sensors Journal*, vol. 18, no. 20, pp. 8558–8568, 2018, doi: 10.1109/JSEN.2018.2865339.

[9] B. Lu and V. C. Gungor, "Online and remote motor energy monitoring and fault diagnostics using wireless sensor networks," *IEEE Transactions on Industrial Electronics*, vol. 56, no. 11, pp. 4651–4659, 2009, doi: 10.1109/TIE.2009.2028349.

[10] Our World in Data, "Medical doctors per 1,000 people,"2022. https://ourworldindata.org/grapher/physicians-per-1000-people?tab=chart (accessed Feb. 26, 2022).

[11] J. Connell, "Third World," *International Encyclopedia of Human Geography*, pp. 237–246, Jan. 2009, doi: 10.1016/B978-008044910-4.00126-7.

[12] J. P. Carmo, P. M. Mendes, C. Couto, and J. H. Correia, "A 2.4-GHz CMOS Short-Range Wireless-Sensor-Network Interface for Automotive Applications," *IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS*, vol. 57, no. 5, pp. 1764–1771, 2010, doi: 10.1109/TIE.2009.2032207.

[13] E. Digiampaolo and F. Martinelli, "Mobile robot localization using the phase of passive UHF RFID signals," *IEEE Transactions on Industrial Electronics*, vol. 61, no. 1, pp. 365–376, 2014, doi: 10.1109/TIE.2013.2248333.

[14] A. G. Özkil, Z. Fan, S. Dwids, H. Aanaæs, J. K. Kristensen, and K. H. Christensen, "Service robots for hospitals: A case study of transportation tasks in a hospital," *Proceedings of the 2009 IEEE International Conference on Automation and Logistics, ICAL 2009*, pp. 289–294, 2009, doi: 10.1109/ICAL.2009.5262912.

[15] P. J. Heinzelmann, N. E. Lugn, and J. C. Kvedar, "Telemedicine in the future," *Journal of Telemedicine and Telecare*, vol. 11, no. 8, pp. 384–390, Dec. 2005, doi: 10.1177/1357633X0501100802.

[16] R. L. Craft, "Trends in technology and the future intensive care unit," *Critical care medicine*, vol. 29, no. 8 Suppl, 2001, doi: 10.1097/00003246-200108001-00003.

[17] H. H. Nguyen, A. Mehaoua, and J. W. K. Hong, "Secure medical tele-consultation based on voice authentication and realtime audio/video encryption," *2013 1st International Symposium on Future Information and Communication Technologies for Ubiquitous HealthCare, Ubi-HealthTech 2013*, 2013, doi: 10.1109/UBI-HEALTHTECH.2013.6708066.

[18] M. Becevic *et al.*, "Robotic Telepresence in a Medical Intensive Care Unit—Clinicians' Perceptions," *Perspectives in Health Information Management*, vol. 12, no. Summer, 2015, Accessed: Feb. 26, 2022. [Online]. Available: /pmc/articles/PMC4558480/

[19] S. Mahajan and C. M. Vidhyapathi, "Design of a medical assistant robot," *RTEICT 2017 - 2nd IEEE International Conference on Recent Trends in Electronics, Information and Communication Technology, Proceedings*, vol. 2018-January, pp. 877–881, Jul. 2017, doi: 10.1109/RTEICT.2017.8256723.

[20] M. Tavakoli, J. Carriere, and A. Torabi, "Robotics, Smart Wearable Technologies, and Autonomous Intelligent Systems for Healthcare During the COVID‐19 Pandemic: An Analysis of the State of the Art and Future Vision," *Advanced Intelligent Systems*, vol. 2, no. 7, p. 2000071, Jul. 2020, doi: 10.1002/AISY.202000071.

[21] S. Thale *et al.*, "Design of Smart Medical Assistant Robot for Contactless Preliminary Health Check Up of Patients," *International Research Journal of Engineering and Technology*, vol. 07, no. 08, Aug. 2020, Accessed: Feb. 26, 2022. [Online]. Available: www.irjet.net

[22] A. Joseph, B. Christian, A. A. Abiodun, and F. Oyawale, "A review on humanoid robotics in healthcare," *MATEC Web of Conferences*, vol. 153, no. 5, Feb. 2018, doi: 10.1051/MATECCONF/201815302004.

[23] C. Pensieri and M. Pennacchini, "Virtual Reality in Medicine," *Communication, sport and rehabilitation*, pp. 353–401, 2016, doi: 10.1007/978-3-319-22041-3_14.

[24] L. A. Trinh, M. Ekstrom, and B. Curuklu, "Multi-Path Planning for Autonomous Navigation of Multiple Robots in a Shared Workspace with Humans," *2020 6th International Conference on Control, Automation and Robotics, ICCAR 2020*, pp. 113–118, Apr. 2020, doi: 10.1109/ICCAR49639.2020.9108082.

[25] M. S. Aman, M. A. Mahmud, H. Jiang, A. Abdelgawad, and K. Yelamarthi, "A sensor fusion methodology for obstacle avoidance robot," *IEEE International Conference on Electro Information Technology*, vol. 2016-August, pp. 458–463, Aug. 2016, doi: 10.1109/EIT.2016.7535284.

[26] R. K. Jain, B. J. Saikia, N. P. Rai, and P. P. Ray, "Development of Web-based Application for Mobile Robot using IOT Platform," *2020 11th International Conference on Computing, Communication and Networking Technologies, ICCCNT 2020*, Jul. 2020, doi: 10.1109/ICCCNT49239.2020.9225467.

[27] S. Mahajan and C. M. Vidhyapathi, "Design of a medical assistant robot," *RTEICT 2017 - 2nd IEEE International Conference on Recent Trends in Electronics, Information and Communication Technology, Proceedings*, vol. 2018-January, pp. 877–881, Jul. 2017, doi: 10.1109/RTEICT.2017.8256723.

[28] R. Murai *et al.*, "A novel visible light communication system for enhanced control of autonomous delivery robots in a hospital," *2012 IEEE/SICE International Symposium on System Integration, SII 2012*, pp. 510–516, 2012, doi: 10.1109/SII.2012.6427311.

[29] C. L. Hung, "The research of factors influencing advanced medical robot use," *Quality & Quantity 2020 55:2*, vol. 55, no. 2, pp. 385–393, Jun. 2020, doi: 10.1007/S11135-020-01007-4.

[30] M. Ali, A. A. Ali, A. E. Taha, I. ben Dhaou, and T. N. Gia, "Intelligent Autonomous Elderly Patient Home Monitoring System," *IEEE International Conference on Communications*, vol. 2019-May, May 2019, doi: 10.1109/ICC.2019.8761204.

[31] K. Mahmud, M. S. Alam, and R. Ghosh, "Design of digital thermometer based on PIC16F77A single chip microcontroller," *2013 3rd International Conference on Consumer Electronics, Communications and Networks, CECNet 2013 - Proceedings*, pp. 246–249, 2013, doi: 10.1109/CECNET.2013.6703317.

[32] Z. Zhang, H. Zhang, and T. Liu, "Study on body temperature detection of pig based on infrared technology: A review," *Artificial Intelligence in Agriculture*, vol. 1, pp. 14–26, Mar. 2019, doi: 10.1016/J.AIIA.2019.02.002.

[33] A. A. C. Carcamo, M. G. M. Reyes, and S. M. S. Urbina, "Low cost Pulse Oximeter using Arduino," *IEEE CHILEAN Conference on Electrical, Electronics Engineering, Information and Communication Technologies, CHILECON 2019*, Nov. 2019, doi: 10.1109/CHILECON47746.2019.8988029.

[34] S. Bakhri, E. Rosiana, and R. C. Saputra, "Design of Low Cost Pulse Oximetry Based on Raspberry Pi," *Journal of Physics: Conference Series*, vol. 1501, no. 1, May 2020, doi: 10.1088/1742-6596/1501/1/012003.

[35] M. Verma, Dr. V. Kumar, and . S., "Implementation of an IoT based Real Time Signal Acquisition System over the Cloud using ThingSpeak Platform for Multi-Zonal Temperature & Humidity Measurement," *INTERNATIONAL JOURNAL OF RECENT TRENDS IN ENGINEERING & RESEARCH*, vol. 6, no. 7, pp. 1–7, Jul. 2020, doi: 10.23883/IJRTER.2020.6046.TPDXM.

[36] S. Banerjee, S. Paul, R. Sharma, and A. Brahma, "Heartbeat Monitoring Using IoT," *2018 IEEE 9th Annual Information Technology, Electronics and Mobile Communication Conference, IEMCON 2018*, pp. 894–900, Jan. 2019, doi: 10.1109/IEMCON.2018.8614921.

[37] L. Chuquimarca, D. Roca, W. Torres, L. Amaya, J. Orozco, and D. Sanchez, "Mobile IoT device for BPM monitoring people with heart problems," *2nd International Conference on Electrical, Communication and Computer Engineering, ICECCE 2020*, Jun. 2020, doi: 10.1109/ICECCE49384.2020.9179293.

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