2020 IEEE International Women in Engineering (WIE) Conference on Electrical and Computer Engineering (WIECON-ECE) | 978-1-6654-1917-8/20/$31.00 ©2020 IEEE | DOI: 10.1109/WIECON-ECE52138.2020.9397958

Design and Implementation of an IoT Based Medical Assistant Robot (Aido-Bot)

Md. Anowar Hossain*, Md Ebrahim Hossain†, Md. Jashim Uddin Qureshi§, Md. Abu Sayeed¶,
Md. Azim Uddin††, Umme Afifa Jinan‡, Md. Azad Hossain‡
*‡Department of Electronics and Telecommunication Engineering, §†¶††Department of Electrical and Electronics Engineering,
‡Department of Information and Communication Engineering
*‡ Chittagong University of Engineering and Technology, §†¶ ††Port City International University,
‡Noakhali Science and Technology University
Chattogram, Bangladesh
Email: *anowarhossain.cuet@gmail.com, †engr.ebrahim_rifat@yahoo.com, §j.jqureshi@yahoo.com, ¶sayeedrikhal357@gmail.com,
††mejorazim@gmail.com, ‡afifajinanict@gmail.com, ‡azad@cuet.ac.bd

Abstract— **This paper discusses in detail a proposed IoT-Based Medical Assistant Robot (Aido-Bot) that will be designed and implemented for the disabled and the patients in need. Such a robot's prime utilization is to minimize person-to-person contact and ensure proper cleaning, sterilization and support in hospitals. The paper explains the background of the study and will also explore some previous related works to find a collaboration of other relevant devices/systems so that a better device can be developed. Then the main algorithm, architecture and the controlling system are explained in detail. According to the proposed method, an IoT-Based Medicine Reminding and Medicine Providing System, Automatic Hand Sanitizer and IoT-Based Physiological parameters observing system (Body Temperature, Pulse rate, and Oxygen saturation level) are developed including a direct one-to-one server-based communication method and an end user android app maintaining system. Though the achievements defined in the paper look fruitful and superior, shortcomings still exist.**

Keywords— Medical Assistant Robot, IoT, LFR, Heartbeat, SpO_2, Medicine Reminder, Pulse Oximeter, Aido-Bot, Communicable, Digital Thermometer, Patient Monitoring System, Automatic Sanitizer, IR Sensor, IP Camera, LCD, OLED, Android App.

I. INTRODUCTION

Nowadays, superior Mechanism are all over the region. Humans are encircled by innovation in every aspect of existence. Without innovation, men are not capable of living a superior lifestyle with complete contentment. Concurrently, our dependency on machines has increased in a manner which is enabling technologists to discover and explore more to make our lives more comfortable. To enhance that experience, we are replacing our rationale, frameworks, philosophy, and everything. However, because of the ever increasing populations globally, doctors and medical assistants cannot look after the patients perfectly and as they want.

According to the WHO member status report [1], we have less than one physician per one thousand people for providing proper assistance in medical health issues in the world. If a crisis like the current corona pandemic occurs, this insufficiency will significantly be more observable. As a result, doctors, nurses and medical assistants are forced to serve more people and end up being more vulnerable to their own families and themselves. This, in turn, is increasing the rate of contact with affected people more and more. Furthermore, poverty has emerged to be an enormous trouble in the developing countries. More people need more medical caregivers for checkups and this increases the level of expenditure in the health sector. In such situations, a robot may retrieve records of some vital bodily parameters (such as body Temperature, pulse rate, blood oxygen Saturation level) of the patient without the doctor or nurse's direct contact with them. It can considerably lessen the patients' hassels.

On the other hand, matters like round-check of the patient, getting medicine as per the prescription, having to talk directly and getting in direct contact with the doctor can be overcome by the developed Aido-Bot. Aido-Bot can largely reduce the shortage of medical staffs and doctors. Besides, this robotic assistant will drastically reduce the fee of recurring checkups and unnecessary hospital bills .Thus, the patient can receive secured and quality healthcare service at comparatively lower costs.

In recent years, numerous researches have been conducted in the medical healthcare arena specifically. We went through a number of works on medical assistance [2] autonomous robots [3]. The majority of medical personnel wanted to manipulate their assistant robot over the internet [4]. Any paramedic can use some methods like FASTele – A tele-echography transportable robotic system for an emergency reason [5]. There were some techniques introduced at the PMS (patient monitoring System) [6], advanced healthcare [7], non-touch infrared thermometer [8], a pulse oximeter layout primarily based on Raspberry Pi [9] and temperature-humidity measurement device [10] and all these have already been mentioned in our work. We considered using a unique robotics utilization and prescribed medication care [11] for the healthcare digitalization sector. Inside the controlling portion, a few number of researches are primarily based on route-locating self-sufficient movement [12], and some are based on android app associated user-end manual controlling [13].

As we type out these studies and summarize this, we endorse a bundle solution by defining three parameters. We have

concluded that an entire solution can be reached out to by combining those three factors. These are (i) Mobility- motion and Transportation characteristic from one area to some other; (ii) Physiological monitoring- to assess the physiological conditions of sufferers and display their health status remotely; and (iii) Assistance with day-to-day activities for supporting activities associated with self-care. Thus, this paper aims to represent Aido-Bot, a biomedical based humanoid self-reliant robot, through maintaining those three parameters. In particular, we refer Aido-Bot to hospitals to lessen direct workload of nurses' and medical assistants. A proof-of-idea and the model are introduced in this work. Test results show experiences that this Aido-Bot can be utilized as a clinical assistant.

II. Methodology

A. System Overview

The three parameters are stated as follows: (i) Mobility and motion, (ii) Physiological parameters monitoring, (iii) Assistance with day-to-day activities. The complete system includes the following components: an IP digital camera, sensors, microcontroller unit, Wi-Fimodule, GSM module, RTC module, Liquid Crystal Display, OLED display, automated sanitizer unit, motor driver and motors. A block diagram of the proposed system is presented in Fig. 1.

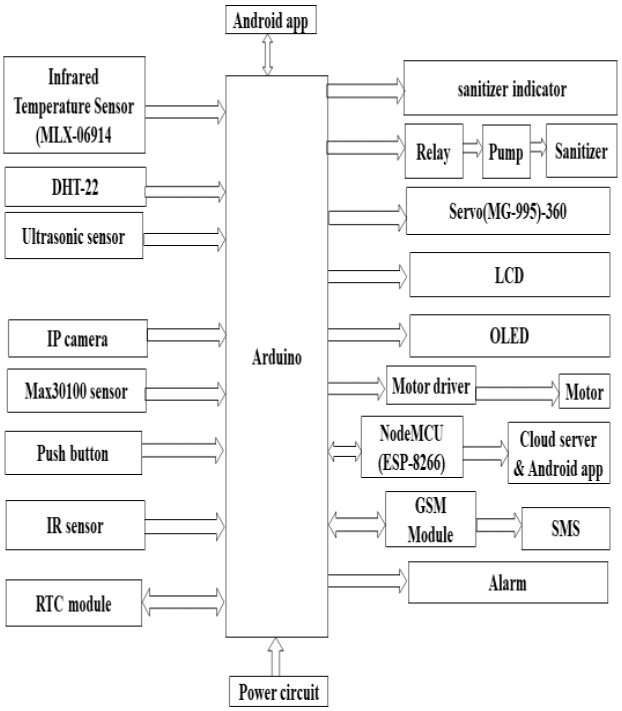

Fig. 1: Block diagram of the proposed system including-mobility and movement, physiological parameters monitoring, and assistance with daily activities.

B. System Architecture

We have represented the physiological observing system in Fig. 2.

Fig. 2: Body temperature, pulse rate and oxygen saturation level shown in LCD.

The flow chart explaining the function of the physiological parameters monitoring system in detail is illustrated in Fig. 3.

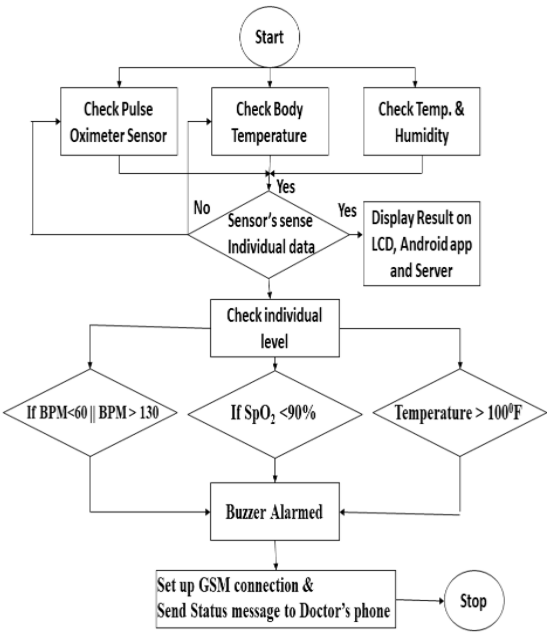

Fig. 3: Flow chart of the physiological parameters monitoring system (body temperature, pulse rate, oxygen saturation level, room temperature and humidity monitoring system).

III. Implementation

A. Physiological Monitoring System

In the physiological observing system, we have incorporated different types of sensors. We have used the (MLX-06914) sensor to measure body temperature. This sensor senses the affected person's body temperature by using infrared rays and shifts the information to the Arduino (Mega 2560). After that, the Arduino processes all this information and indicates it on the LCD and android app step by step. This process is presented in Fig. 3. When the suspect's temperature crosses the 100oF stage, the system will ring an alarm and the Aido-Bot will send an SMS to authorized people through GSM module. The suspect can take a look at his/her pulse rate through the Aido-Bot as well. When the suspect's pulse is active, the BPM value will appear on the display and also on the android application. If the BPM rate is higher than 130 or lower than 60, the alarm will be ON and the Aido-Bot will send an SMS to authorized people. Next, suspects can test the oxygen saturation level via this Aido-Bot. If blood flow is present, the SpO2value will appear as shown in Fig. 3 and android application as shown in Fig. 4. At the same time, if the SpO2 level is much less than 90%, the alarm will be ON. The microcontroller will also transfer the data to the server

through a Wi-Fi module. For communication among the suspect & authorized people through video conference, we implanted/placed an IP camera on the Aido-Bot. The IP camera will display all the information at the android application and additionally on the cloud server. All the processed data sent to the server and referred here has been delivered through the IoT system as presented in Fig 5.

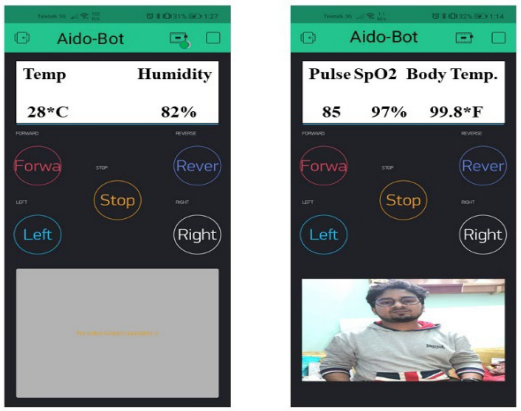

Fig. 4: Displaying data of the physiological monitoring system in the android app.

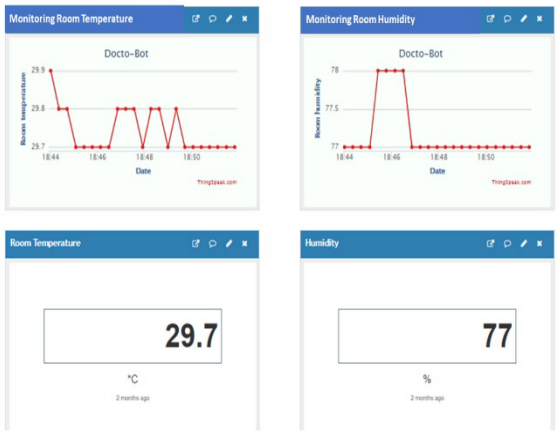

Fig. 5: All the processed data sent to the cloud server through the IoT system.

B. *Assistance with daily activities*

To remind the medication time and medicinal drug name, Aido-Bot has a medication reminder system. This system gives drugs as well. We used RTC module in this system to keep the Remote Time Clock. The device has six boxes. Those are for-before breakfast, after breakfast, before lunch, after lunch, before dinner and after dinner medications. By using push buttons, the drugs reminding timer may be set for every box. Then the device will check the drugs reminding time for each package deal. If the time is matched, the system will ring an alarm, blink LED on the particular box and automatically open with the help of a servo motor as displayed in Fig. 6. Besides, an SMS will be sent to the patient and caregiver including the drugs name and medication taken time. Here, all the data is processed through the Arduino.

Fig. 6: Medicine reminder and medicine providing system for assistance with daily activities.

For measuring the room temperature and humidity, DHT-22 sensor has been used. The microcontroller collects the sensor's data and shows the information in the LCD, cloud server, android app after processing those data.

C. *Control System*

The Aido-Bot has two control systems. These are self-sufficient control mode and manual control mode. To control the Aido-Bot in self-sufficient mode, an ultrasonic sensor, a servo motor, four 12V DC gear motors and five IR sensors have been used. The IR sensor detects the path by using Line Following Robotic [12] system and the Ultrasonic sensor detects the track's obstacle. To look at the barrier in all the direction of the place, we used a servo motor to rotate the ultrasonic sensor at 360^0 angles and the total system is operating according to the required programming.

Within the manual control system, an android app and a Wi-Fi module are used. The android app works as a transmitter and the microcontroller & Wi-Fi module works as a receiver. By using of the serial communication technique, we manipulated Aido-Bot from left, right, ahead, opposite positions and stop by usage of the android app. ("stopped it by using" if you mean you stopped it using the app).

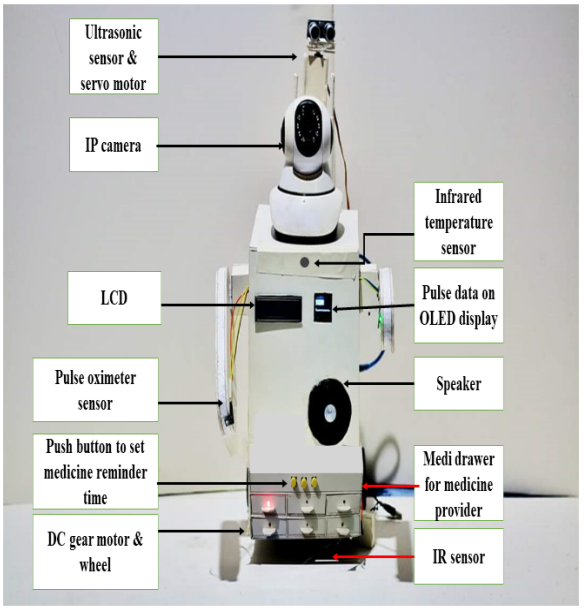

Fig. 7: Front view of Aido-Bot including a physiological monitoring system, automatic sanitizer, room temperature and humidity monitoring, two control system, IP camera, medicine reminder and provider system.

IV. Results and Discussion

We tested the body temperature of twenty patients with the developed system. The patients' data with the comparable data is given in TABLE I. Then we tested the pulse rate and oxygen saturation level of twenty patients and these data with

comparable data is given in TABLE II. All the data that have been taken here has been re-matched by the Mindray Medical Device [14] and is graphically shown in Fig. 8 with respect to the Aido-Bot's data.

TABLE I. AIDO-BOT MEASURED BODY TEMPERATURE DATA OF TWENTY PATIENTS OF DIFFERENT AGES

Patient No.	Gender	Age	Mindray Temperature©	Sensor Tempearature ©
Patient 1	Female	10	30	30
Patient 2	Female	19	32	31
Patient 3	Female	16	31	31
Patient 4	Male	25	36	37
Patient 5	Male	22	34	34
Patient 6	Male	32	40	40
Patient 7	Male	23	35	35
Patient 8	Male	22	37	36
Patient 9	Male	18	36	36
Patient 10	Male	19	39	39
Patient 11	Female	27	33	33
Patient 12	Female	23	29	29
Patient 13	Female	18	32	32
Patient 14	Male	16	39	39
Patient 15	Male	21	37	38
Patient 16	Female	29	35	35
Patient 17	Female	27	33	33
Patient 18	Female	28	30	30
Patient 19	Male	24	34	34
Patient 20	Male	22	36	35

TABLE II. AIDO-BOT MEASURED PULSE RATE AND OXYGEN SATURATION LEVEL DATA OF TWENTY PATIENTS OF DIFFERENT AGES

Mindray Pulse(BPM)	Sensor Pulse(BPM)	Mindray SpO2(%)	Sensor Spo2(%)
67	65	97%	97%
80	80	96%	96%
75	73	98%	98%
82	83	96%	95%
96	96	97%	97%
88	88	99%	98%
92	94	95%	96%
102	101	99%	98%
85	85	98%	98%
95	95	95%	96%
76	77	94%	97%
89	89	95%	95%
98	96	93%	93%
72	72	98%	98%
72	73	85%	86%
96	98	99%	98%
101	100	87%	87%
93	93	92%	92%
95	95	98%	98%
109	107	93%	93%

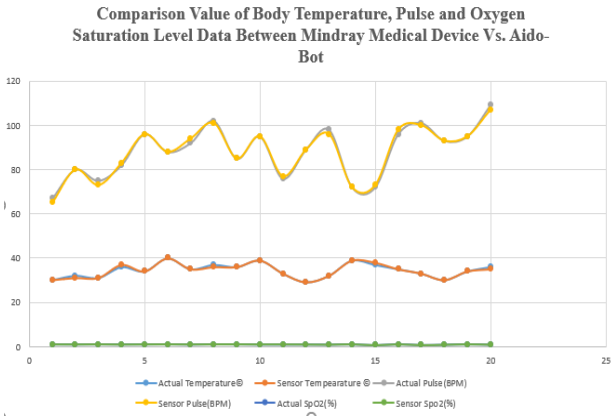

Fig. 8: Comparison Value of Body Temperature, Pulse and Oxygn Saturation Level Data measured by Mindray Medical Device Vs. Aido-Bot.

V. CONCLUSION

In this paper, we have worked on designing and implementing an IoT-Based medical assistant robot (Aido-Bot). As the result has shown some promising and advanced support for assisting the disabled and patients in need, we believe this robot will go a long way in alleviating the lack of adequate doctors in medical services around the world. Anyone who has primary operating knowledge can use Aido-Bot as a medical assistant for his family. However, we could not add any angular movement in the control system. Machine learning and AI techniques will be used to carry out future work.

REFERENCES

[1] WHO status report shows doctor-patient ratio worldwide: https://www.who.int/gho/health_workforce/physicians_density/en/J.

[2] Kevin Mugoye, Henry Okoyo, Sylvester Mcoyowo," Smart-bot Technology: Conversational Agents Role in Material Healthcare Support" 2019 IST-Africa Week Conference (IST-Africa).

[3] Ryosuke Murai, Tatsuo Sakai, Hajime Kawano, Yoshihiko Matsukawa, Yukihiko Kitano, Yukio Honda, Kenneth C. Campbell, "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).

[4] Chin-Liang Hung, "The research of factors influencing advanced medical robot use," Springer Nature B.V. 2020.

[5] Keiichiro Ito, Shigeki Sugano, and Hiroyasu Iwata, *Member, IEEE,* "Portable and Attachable Tele-Echography Robot system: FASTele", 32nd Annual International Conference of the IEEE EMBS, Buenos Aires, Argentina, August 31 - September 4, 2010.

[6] Mai Ali; Asma Asim Ali; Abd-Elhamid Taha; Imed Ben Dhaou; Tuan Nguyen Gia," Intelligent Autonomous Elderly Patient Home Monitoring System" ICC 2019 - 2019 IEEE International Conference on Communications (ICC).

[7] Nina S. Godbole, John Lamb, "Research into Making Healthcare Green with Cloud, Green IT, and Data Science to Reduce Healthcare Costs and Combat Climate Change." 2018 9th IEEE Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON).

[8] Zaiqin Zhang, Hang Zhang, Tonghai Liu, "Study on body temperature detection of pig based infrared technology: A review." Artificial Intelligence in Agriculture, Volume 1, March 2019, Pages 14-26.

[9] S Bakhri, E Rosiana, R C Saputra, "Design of low cost pulse oximetry based on Raspberry Pi." Journal of Physics: Conference Series, Volume 1501, International Conference on Science & Technology (ICoST 2019) November 2019, Yogyakarta, Indonesia.

[10] Ms. Munni Verma, Dr. Vivek Kumar, Mr. Sandeep, "Implementation of an IoT based Real Time Signal Acquisition System over the Cloud using ThingSpeak Platform for Multi-Zonal Temperature & Humidity Measurement." DOI:10.23883/IJRTER.2020.6046.TPDXM.

[11] Amy H. Huang, Benjamin H. Kaffenberger, Adam Reich, Jacek C. Szepietowski, Sonja Stander and Shawn G. Kwatra, "Pruritus Associated with Commonly Prescribed Medications in a Tertiary Care Center".Medicines 2019.

[12] Lan Anh Trinh; Mikael Ekström; Baran Cürüklü, "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).

[13] Ravi Kant Jain; Baskar Joyti Saikia; Nitant Pilmo Rai; Partha Pratim Ray, "Development of Web-based Application for Mobile Robot using IoT Platform." 2020 11th International Conference on Computing, Communication and Networking Technologies (ICCCNT).

[14] Mindray Medical Device: https://www.mindray.com