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Design And Development Of Smart Healthcare Assistant Robot Patients Monitoring

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ABSTRACT

The main objective of this project is to present the development of an "Smart Robot for Health Assistance". Most countries, particularly first world countries, are faced with an increasingly higher percentage of people in need of healthcare assistance, either due to old age or some disabilities or impairments, requiring prolonged care, constant examination, and following up the patients very closely. This pressure, both in number of and time dedicated to the patients, will put a strain on the current healthcare and social systems all over the world. Solving this problem, however, is not a simple matter, not just due to the lack of professionals but also due to the increasing costs of maintaining these services. The implementation of such a system would not only remove some of the workload from the medical professional, but also be more reliable in the long run, not suffering from attention, exhaustion or other issues that often affect us. With this system we intend to show the possibility of using robot platform in this context, paving the way for further development and implementation of such platform in hospitals and other healthcare facilities.

Keywords: Healthcare, Patients, Robots.

I. INTRODUCTION

The project aims to provide a contactless testing method to the doctors in hospitals to conduct initial health check-ups like measuring the body temperature of the patients, their heart rate, pulse rate and oxygen levels. This project can be used when the doctors have to be in contact with the patients in order to test and treat them, thereby increasing the risk of a community spread. There is a strong requirement of contactless technology for the testing of patients to prevent spread of highly contagious disease like the novel coronavirus. Healthcare robots offer benefits beyond task automation.

They can enhance patient engagement, provide personalized care, and alleviate the burden on healthcare staff, allowing them to focus on more complex and critical aspects of patient care. Additionally, in the context of aging populations and increasing healthcare demands, robots have the potential to fill gaps in care delivery, especially in areas facing shortages of medical professionals. The robot contains sensors like Oximeter MAX 30105 to measure the blood oxygen saturation and heart rate of the patients as a preliminary test criteria.

This paper was conceived as a result of the observations made during the ongoing pandemic of COVID-19, where in the doctors are having to be in contact with the patients in order to test and treat them, thereby increasing the risk of a community spread.

II. LITERATURE REVIEW

A few research papers related to medical robots have been reviewed and the following references show influence on the design of the smart medical assistant robot. Marcin Zukowski et al have developed a humanoid medical assistant and companion robot dedicated to children hospitals. They have focused on the robot being able to express emotions and communicate with the children by recognizing their faces and using pictures and text on the chest display to tell stories and present educational videos. The 'Bobot' autonomously navigates through hospital rooms and performs simple medical tests like measuring patient's body temperature or heart rate and sends live video feed to the doctors and nurses. The robot is run using ODROID XU and XU4 with Ubuntu 14.04 operating system and has a dedicated Raspberry Pi 2 computer to animate the robot's eyes.

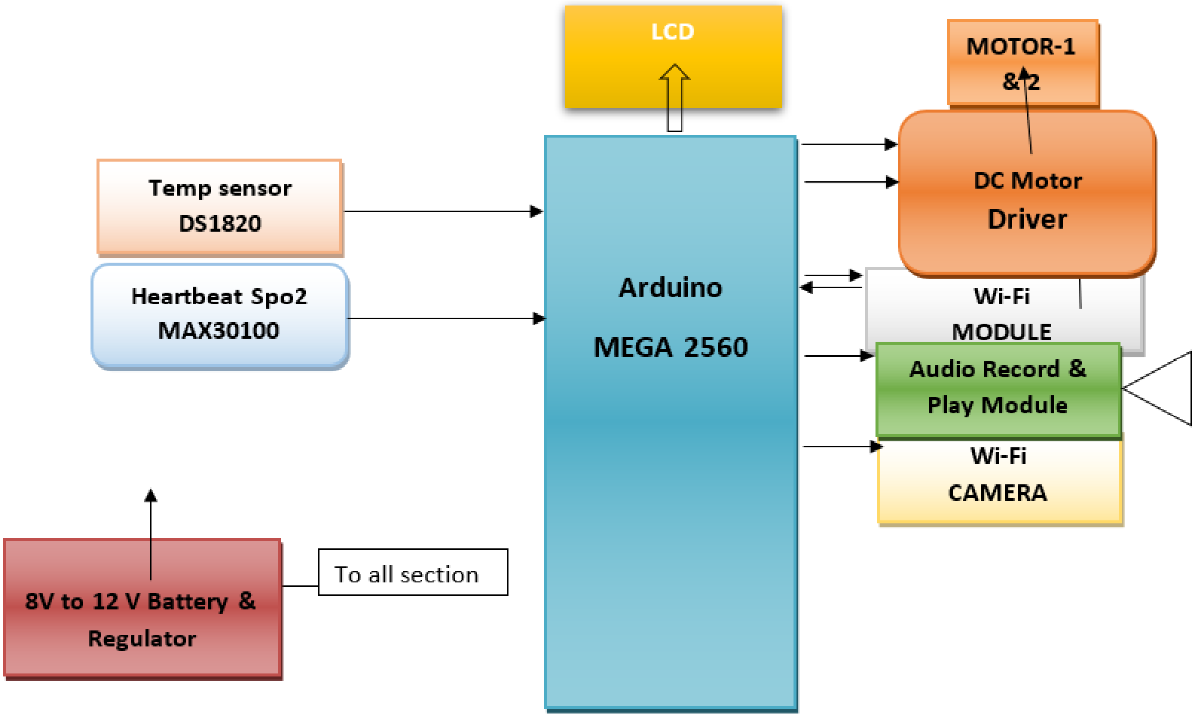
Marcin Zukowski et al presented the implementation of patients temperature measurement system for the medical robotic assistant. They have experimented with MLX90614 infrared thermometer and FLIR Lepton thermal camera and found out that the MLX90614 infrared thermometer cannot be used as the only input source of the system and to get more accurate results, robot would need to come as close as less than 0.3 metres to a patient's face. To overcome this they created a hybrid system having infrared thermometer along with thermal camera to provide ambient temperature and approximate skin temperature that can be used to detect presence of humans in front of the robot.

Kaveh Bakhtiyari, Nils Beckmann and Jürgen Ziegler have proposed a non-invasive contactless Heart Rate Variability (HRV) measurement with Respiratory Sinus Arrhythmia (RSA) correction. They have incorporated Infrared and RGB cameras to measure the heart rate signal, and a 3D Depth sensor has been used to capture the human respiratory signal to correct the calculated HRV with RSA. They have performed correlation analysis by different methods and devices to find an appropriate method for HRV calculations based on the required accuracy and application. Contactless heart rate variability sensors can become an important part of sensors for preliminary health tests. Sachit Mahajan, Prof. Vidhyapathi C.M have designed a medical assistant robot which helps the patient to carry the necessary medical equipment along with them. They have created a person following robot assistant which provides support to the patients. The robot uses a Pixy image recognition sensor for person detection and ultrasonic sensor for obstacle avoidance.

Azeta Joseph et al have presented an overview of the current and potential applications of humanoid robotics in healthcare settings. Their paper describes various characteristics required in humanoid robots in healthcare such as presence of vision system, sensing behaviour, mobile platform and the ability to perform dexterous manipulation tasks. We explored similar human assistant robots available in various roles as helpers for the patients in hospitals.

The scope of the present study is to design a smart medical assistant robot by exploring various contactless less sensor technologies. The robot should be compact for efficient handling and incorporate a quick learning real time environment recognition technology for its locomotion in a crowded hospital.

III. IMPLEMENTATION AND METHODOLOGY



3.1 Working Principle

Upon entering the hospital premises, It instructs the patients to sanitize their hands using the sanitizer dispenser mounted on the back. The robot identifies and avoids obstacles using the ultrasonic sensor. Only after using the sanitizer, the patient is able to continue the process forward. This is done to prevent unnecessary spread of contagious viruses through the touch sensors present on the robot. The robot then reads the temperature of the patient using an DS1820 and asks the patient to place their finger on the Oximeter MAX30100 to collect important data regarding their heart rate, pulse rate and blood oxygen saturation level. Through the WiFi camera, the patients are then enquired about their travel history and present symptoms or allergy history. These data are collected using a voice & video recording camera module and are directly sent to the doctor. The doctors have live access to the patient and their data. An integrated storage compartment and tray are present on the robot for material handling and transfer of medicines or medical reports to the doctor or the patients. Figure 5 describes the working protocol of the medical assistant robot. Ultrasonic sensor is used for obstacle detection while robot in motion. If the obstacle range is less than2-3 feet, robot will stop to avoid collusion.

IV. ADVANTAGES, DISADVANTAGES AND APPLICATIONS

ADVANTAGES:

1. minimize the contact and the time of interaction between doctors and patients.
2. This system will minimize spreading of Novel coronavirus.
3. Two way voice and video communication so, patient can easily communicate with doctor.
4. Doctor can operate and monitor patient from remote using IoT cloud.
5. Easy to operate the system, no need special training to doctor.

DISADVANTAGE:

1. Battery backup is low due to continues use.

APPLICATIONS:

1. Hospital ward.
2. Personal care taker.
3. Commercial business complex.
4. Factories/industries.
5. Software companies.

V. CONCLUSION

The design of the smart medical assistant robot has been presented in this project. The internal structure of the robot has been tested for safety with a load of 1kg using Fusion 360. The outer casing of the robot was chosen to be made of medical grade plastics to maintain the global medical standards of sanitation and being biocompatible. The components are designed and selected with consideration to reduce the weight of the robot and at the same time be safe and efficient. The current scenario requires innovative contactless solutions to prevent the spread of contagious diseases. Our project has the potential to be a viable solution for this. The fabrication and testing of the robot is the next stage in this project. Real time environment recognition technologies like LIDAR and SLAM can be implemented along with Artificial Intelligence and Machine learning to make the robot adaptive to changing environment and being more approachable to the patients. Speech recognition technology can be used to understand the feedback from patients of different backgrounds and help interact with them more efficiently in the future. Accurate heart rate measurement through image processing, facial recognition and retinal scanning techniques can also be implemented for the identification of patients and for advance contactless tests.

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