DESIGN AND FABRICATION OF A ROBO-NURSE

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Abstract: Robo-nurse is a helping robot that will help patient in both house and in hospital by providing them medicine at right time according to routine. It's a semi-autonomous robot can perform its job without any human interfere also. This robot is featured with some other functions. Robo- nurse is able to make an alarm to make patient aware about the time to take medicine and can be moved to the patient by using a joy-stick or an android smart phone at the time to provide medicine. It is also featured to measure temperature of patient's body when patient is suffering from fever. For athsma patient there is an automatic setup to provide athsma medicine to patient in this robot. Athsma patient will be able to take medicine by just putting his mouth infront of inhaler. Patients will be helped in a great extent by using this robot and human nurse can also be replaced so that treatment cost will be reduced also.

Keywords: *Semi-autonomous, Medicine, alarm, inhaler, temperature.*

1. INTRODUCTION

From the very beginning of human civilization nursing is a noble job. Nursing of patient is very important in medical treatment, because result of medicine as well as treatment mostly depend on taking medicine in time and proper care of patient. Before twentieth century a male or female only took care of patient known as nurse or medical assistant. Nurse helped patients at both hospital and home. Nurse played an important role during disaster, war also. Sometimes they forget to provide medicine to patient. Sometimes they made mistake to provide medicine when they were taking care of several patient at a time. Sometimes patients who could not effort to pay nurse, have to take medicine by own often forgot to do it. Sometimes patients also forget to take medicine in time. So in order to reduce human effort in the middle of twentieth century scientists thought to make automatic machines to take care of patient. Some automatic electronic instrument is being used to observe patient from several years. Nowadays robotics became so much popular for its fabulous inventions with having artificial intelligence. Medical purpose robots are getting popular also for its accurate and ability of continuous work. Our country Bangladesh is a densely populated country with a poor nursing facility. According to WHO, where 23 medical help provider is needed for every thousand people, there Bangladesh has only 7.7 person for every thousand people and among them 93% is woman. So, according to socio economic condition of Bangladesh it is kind of impossible to have 24 hours nursing facility. So, a robot is proposed here to be developed that will be able to replace a human and can take care of a patient. Robo-nurse will be able to provide medicine to a patient in time, press an inhaler, can check the body temperature and blood pressure.

1.1 Problem Statement

(1) The first sub problem is to establish (produce) a conceptual design and then develop a detailed design of each of the different constituents of the robot.

(2) The second sub problem is to develop and build all the components of the robot and finally integrate.

(3) The third sub problem is to test the operation of the built model and assess its performance and limitations.

1.2 Hypothesis

(1) All units, mainly electronics, and mechanical parts will be integrated such that a coherent operation may result.

(3) The final model will be robust and able to execute commands and perform the requested task.

2. LITERATURE REVIEW

The desire of making work easy is a part of human nature. Building a system or machine that can reduce human effort is very fascinating. Automatic machines and robots are very popular in this era and used to reduce human efforts. A robot is a mechanical or virtual intelligent agent can perform tasks automatically or with guidance, typically by remote control [1]. In practice a robot is usually an electro-mechanical machine that is guided by computer and electronic programming. Robots can be autonomous, semi-autonomous or remotely controlled [2]. Robots ranges from humanoids such as ASIMO and TOPIO

to Nano-robots, Swam-robots, industrial robot, military-robots, mobile and servicing robots [3]. By mimicking a lifelike appearance or automatic movements, a robot may convey a sense that it is has an intent or agency of its own [4]. The branch of technology that deals with robots is robotics. An arbitrary complex system may have many of the features of a robot and not be a robot. A desktop computer is not a robot whereas a computer that controls a mobile platform is a robot. The desktop computer can be referred to as a static tool, whereas a robot could be classified as an active tool [6]. The presumed robot must have the capability to move through its environment before it can be considered a robot. An automobile cannot be considered as a robot since it is a static tool, if the automobile has an anti-lock brakes, which sense and affect the environment, albeit slightly, it could be considered as a robot. In our society, it is difficult to view an automobile as a robot, it really is a mass of metal and plastic hurtling a human occupant to some destination. An automated guide vehicle, like the Sea-tack automated subway system can be considered a robot. If a mobile platform is controlled by a computer physically removed from the platform, then the platform can be considered as a robot or part of a robot system. The first known medical robot utilized by the medical industry was in 1985, when the robot PUMA 560 placed a needle for a brain biopsy using CT guidance [7]. Three years later, the PROBOT from the Imperial College London helped doctors perform prostate surgery on a patient. Since then, persistent studies on robotic systems for specific use in health care were carried out by medical researchers like Intuitive Surgical. Mr. Gower is another medical robots patrol as nurses and staff members [7]. At a medical center in Maryland, a robot named Mr. Gower navigates the hallways, riding elevators, opening doors and delivering patient medications to the nurses' station all on its own. Another similar device is the IntelliFill i.v. a robot that can fill up to 60 drug-filled, patient-specific syringes per hour, also designed to ensure that the right medicine in the right dose gets to the right patient. A study by the Institute of Medicine in 1999 has estimated that as many as 98,000 Americans die each year because of medical errors — 7,000 of them from medication errors [7]. This has therefore prompted hospitals to computerize systems for prescription orders and use devices that automate the prescription-filling process. In the U.S., researchers from the University of Michigan, University of Pittsburg, and Carnegie Mellon University are working on a Nursebot called Pearl. Pearl is an assistant robot like its Japanese counterparts, and it serves to remind people about routine activities as well as guide the elderly through their environment (Jajeh). Pearl has many sensors that help with navigation and recognition of audio and video input, as well as a touch screen interface, and software for the various tasks that it can do [5]. It is a great technological tool for helping cognitively or physically disabled people get through day-to-day tasks. Pearl has been tested at the Longwood Retirement Community in Oakmont, PA, and has received very favorable reviews by the residents. It operates in a relatively un-intrusive manner, and is made to look like a robot, so patients do not feel uncomfortable around a humanoid machine. Pearls decision making is still at a relatively primitive level, but the residents of this community are already saying that they appreciate the considerate timing of her reminder program [7]. As of today, robot nurses do not yet possess this level of sophistication. Current prototypes for robot nurses are designed as assistants, and no fully integrated autonomous system exists. Japan, which is the current leader in robot nurse production, has several robots that address different needs in the medical community. One such robot is called RIBA, which stands for "Robot for Interactive Body Assistance." RIBA can lift a person up to 135lbs from a lying or sitting position and move them to another location. RIBA has strong arms with advanced tactile sensors that prevent slipping. It is also equipped with two cameras and two microphones so it can follow cues from an operator.

3. SYSTEM DESIGN AND IMPLEMENTATION

A robo-nurse is made of a mechanical and an electrical system and also a built in software to control them. Designing such a robot requires multidisciplinary involved span from electronics, programming, control engineering, mechanical design, material and manufacturing. The mechanical design and the size of the machine was important and it had to be able to move, press the inhaler and shoot a medicine box to the counter. It had to be able to measure the temperature of patient body and display it in a screen. Detailed design of robo-nurse is divided in three subsystems: Mechanical structure, Electronics and Programming.

3.1 Mechanical Design

The mechanical design consists of design of all the mechanical part of the robot. First we had to design the robot base where others parts will be added. Then we designed medicine dispensing system, inhaler pressing system, temperature measurement system and mounted them on the base. All the separate systems integrated such a way that the base can move smoothly with all systems mounted on it.

3.1.1 Robot chassis

Robot chassis is a strong frame which carry the total weight of robot when it move. It contains 4 12V DC gear motor. The robot body is attached over the robot chassis if user want robot to move. Otherwise without robot chassis robo-nurse can also be used as stationary.
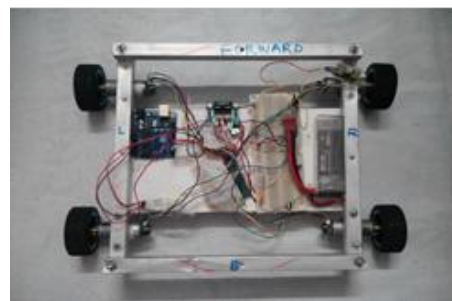

Fig.1: Robo-nurse chassis

3.1.2 Robot body

Robot body consist of a solid body which hold all other parts like circuit board, display, inhaler pressing system, medicine box, battery in it. Its bottom surface is made of

wood given circular shape and upper surface is made of plastic wood given same shape of bottom. Its front and right side is rectangular shaped and rest of the body is surrounded with circular shaped. Robot body hold display at its top surface so that user can see it easily. Top, front and right side view are attached below.

Fig.2: Top view

Fig.3: Front view

Fig.4: Right side view

3.1.3 Inhaler pressing system

Inhaler pressing system consist of a servo motor which is controlled by arduino program, a sensor to sense human body, an inhaler from which user will get medicine. A servo

horn is attached with servo shaft, when servo motor rotates the servo horn rotate with the shaft and strike at the top of attached inhaler, push it downward. This way an inhaler is pressed.
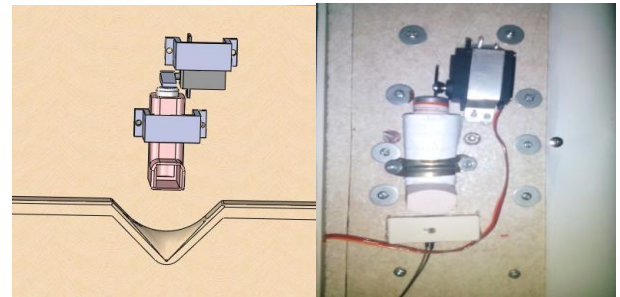

Fig.5: Inhaler pressing mechanism

3.1.4 Medicine dispensing box

Medicine dispensing box consist of a chamber where medicines are loaded in a small box, a servo which push the small box out of chamber at time. Servo is controlled by arduino. Its servo motor rotates 45 degree to push a medicine contained small box.
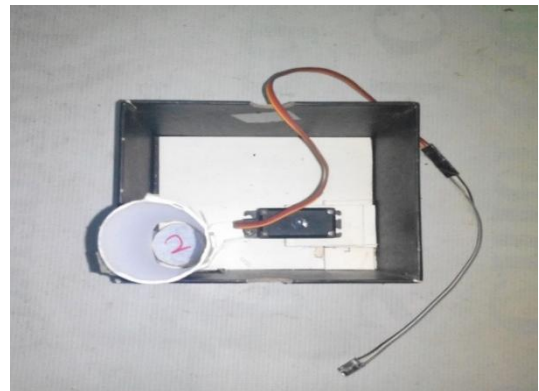

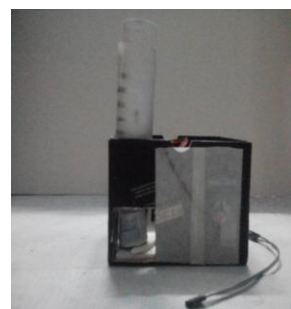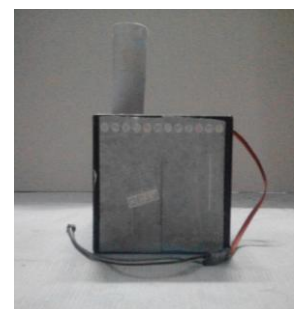Fig.6: Top view (medicine box)

Fig.7: Front view   Fig.8: Right side view

3.2 Electronics

This automatic system being an electromechanical system it has several circuits used in this project. The most important circuit is microcontroller circuit and motor driver circuit.

3.2.1 Microcontroller

A microcontroller is a small computer on a single integrated circuit containing a processor core, memory and

programmable input/output peripherals microcontroller are used in automatically controlled devices. Here an arduino uno is used which contains an ATmega328P microcontroller. The microcontroller is programmed so that it can execute program and give output according to the input. Microcontroller gives signal to the motor driver circuit.

Fig.9: Arduino uno (Microcontroller)

3.2.2 Servo Motor

A servo motor is a rotary or linear actuator that allows for precise linear or angular position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a sophisticated controller as well as a dedicated module designed for use with servomotors.

3.2.3 DC Motor

A DC motor is any of an electrical machines that converts direct current electrical power into mechanical power. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic to periodically change the direction of current flow in part of the motor. Most types produce rotary motion; a linear motor directly produces force and motion in a straight line. DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings.

3.2.4 Motor Driver

Motor driver is used to control motor. Motor driver acts as interface between microprocessors and motors. Most microprocessors operate at low voltage and require a small current to operate where the motors require relatively high
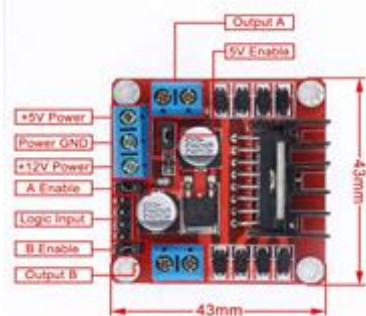

Fig.10: L298 Motor driver module

voltage and current. So microprocessor cannot supply sufficient current to the motor. That's why motor driver is used to supply the required voltage and current to the motor. Another vital use of the motor driver is to drive the motor bi directionally.

3.2.5 Real time clock

A real-time clock (RTC) is a computer clock most often in the form of an integrated circuit that keeps track of the current time. Most RTCs use a crystal oscillator, but some use the power line frequency. In many cases, the oscillator's frequency is 32.768 kHz.
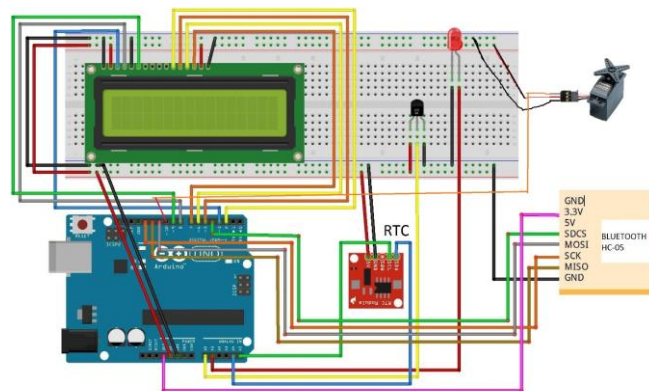

Fig.11: RTC module

3.2.6 Circuit Diagram

Fig.12: Circuit diagram

3.3 Programming and Software

The implementation of robo-nurse requires some Arduino programming is based on C programming language. The program developed in the arduino is the main brain of this robot. Most of the task is controlled by the arduino using the program and managed the entire task to be carried out. An android application is developed using android studio to control the robot using android system (mobile/tab). To complete this project it requires some software used for programming, for simulation, for circuit design and for burn the code to the Arduino. They are-

- Arduino – It is used to program the ardiuno uno R3 board to get desired output.
- Proteous – It is used to draw the circuit diagram and simulation of electronics component.
- Android studio – It is used to develop an android app.

3.3.1 Android application (Remote Controller)

A remote control is a component of an electronic device or other home appliance, used to operate the device wirelessly from a short distance. A customized android

application is used to move robo-nurse to forward-backward and left- right direction. A communication establishes between robo-nurse and this application through a Bluetooth module (HC-05) and bluetooth of android system.

Fig.13: Android controller app interface

4. WORKING PRINCIPLE
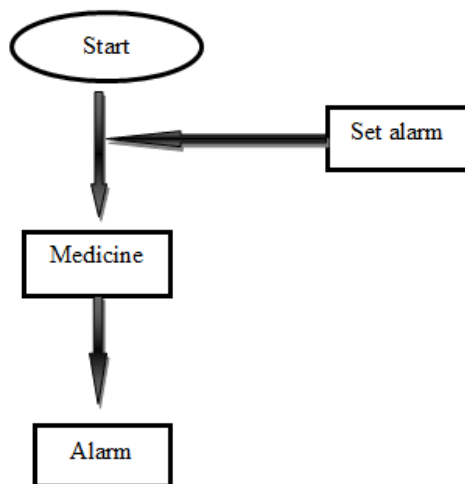
4.1 Medicine Dispensing System

Fig.14: Flowchart of Medicine Dispensing System

The aim was to develop a medicine dispensing system is providing medicine at the time and make patient alert about their medicine if they forget. Here a RTC module is integrated with an arduino board and a medicine box designed such a way with servo motor which can shoot preloaded medicine from chamber to output point at the pre-set routine. After shooting medicine a continuous alarm is made until the medicine is collected.

4.2 Temperature Measurement System
The aim was to develop a temperature measuring system is to make measuring body temperature easy when a user is suffering from fever. Sensor measure the body temperature when it is in contact, so that value of body temperature can be displayed in the display within in a very short time.
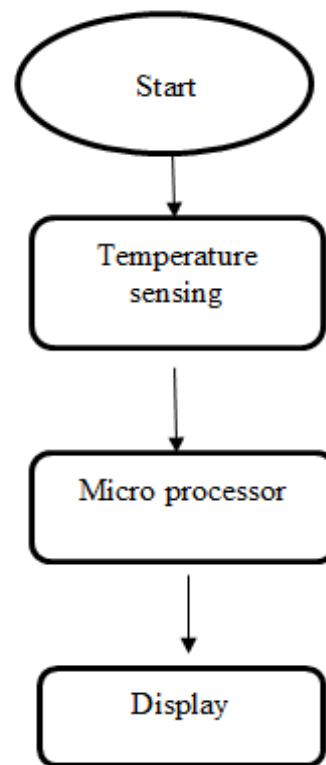

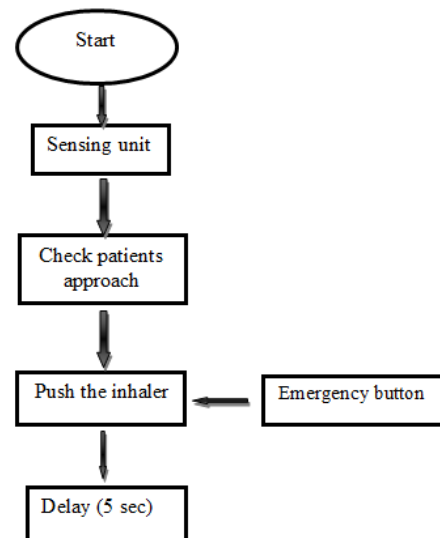Fig.15: Flowchart of Temperature Measurement System

4.3 Inhaling System

Fig.16: Flowchart of InhalingSystem

The aim was to develop an automatic inhaling system is providing the asthma medicine form inhaler when human mouth is set at the inhaler output. Sensing human mouth using a LDR sensor a servo motor press the inhaler automatically within 2 sec.

5. TEST AND RESULT

Integration of parts is the most interesting and difficult task of developing a device. It reveals a lot of crucial issues. Integration resulted in a number of process. All the mechanical parts were integrated and joints were made very carefully. Then the motors installed and the moving parts were checked. Then all the electronics as well as circuit board, arduino, motor driver, real time clock, buzzer, bluetooth, battery, display, sensor and the power cables were installed very carefully and isolated to a safe place.

5.1 Performance

Table 1: Performance Table

Function	Feature	Performance
Human body temperature	Measurement and show	√
Medicine dispensing	At routine time	√
Alarm for Medicine	Until medicine is collected	√
Inhaler pressing	Automatic	√
Android control	Front move	√
	Back move	√
	Right move	√
	Left move	√

6. DISCUSSION

The performance of the developed robo-nurse is quite satisfactory. Use of automatic machine and robots became more popular recently at home and commercial purposes cause it reduces human effort, can work continuously even when humans are sleeping, and more reliable.
Robo-nurse will –
- Reduce human effort to take medicine
- Remember patient/user to take medicine
- Help to take right medicine at right time
- Help user to measure body temperature
- Help user/patient who don't know to use thermometer.
- Press inhaler for user automatically even those user who is not able to press inhaler manually.
- Move to user using a simple android app

7. CONCLUSION

Quality, Feature and safety this is the triad of competitiveness. Though automatic device and robots are expensive compare to other but it has a great importance in reducing human efforts and limitations. Robo-nurse is a new step to help in medical science using the knowledge of robotics. It can be further developed and extra feature can be added. Though it has some limitations, hope it will serve patient properly and can replace a human nurse. Further study, improvement and feature that can be added to robo-nurse are –
- Image processing system can be added to recognize individual patient.
- Extra medicine chamber can be added.
- GPS system can be added to locate user automatically
- GSM/ wifi module can be added through which robo-nurse can inform doctor or relative at the emergency situation.
- New system can be added to provide injection or liquid medicine.
- Voice control can be added.
- Wifi module can be added so that robo-nurse can be controlled from far using internet.
- Database and intelligence can be developed so that robo-nurse can give primary treatment.

8. REFFERENCES

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