

An Approach to design Human Assisting Prototype Robot for providing Fast and hygienically secure environment to Clinical professionals in order to fight against COVID19 in Hospitals

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Abstract— In the current era robots play vital role in several industries, hospitals, and research organizations etc. In hospitals robots support and nursing staff currently may also use in this era during COVID19 Pandemic to transport such patient sample or dispose of their usage belonging to avoid spreading of this pandemic to clinical staff. From making deliveries, dispensing medication, visiting patients to aiding surgeries, robots are improving the way hospitals function. Central Sterilization Supply Department (CSSD) offers sterilization amenities to Outpatient Department (OPDs), wards and operation theatre (OT) of hospitals. It provides facilities to receive, clean, pack, disinfects, sterilizes, store and distribute instruments, in accordance with well-delineated protocols and standardizes procedures. An alarming boost in Hospital Acquired Infections (HAI) demonstrates the necessity of a well-organized CSSD to prevent surge in HAI. Although quality assurance procedures are followed to ensure safety and efficiency at all levels: appropriate handling of contaminated items, decontamination, proper cleansing, and instrument care, but the necessity of human presence to implement these procedure in-creases the threat of HAI. Thus, an intelligent autonomous multi-sensor wireless controlled NXT robot using MATLAB is proposed to handle contaminated items and sterilize equipments in the centralized sterilization sup-ply department. The proposed system is entirely automated and eliminates the need of human presence to implement quality assurance procedures, thus decreasing the threat of HAI. An archetype using Lego NXT robotic kit is developed to implement tasks performed in CSSD. MATLAB is used to control NXT robot instead of Lego Mindstorms software, due to its versatility, capability to perform computationally intensive tasks and wide usage by researchers. A powerful control system is designed that allows user to interrupt, control and monitor autonomous NXT robots.

Keywords— *COVID19* , *Robotics Invention System*, *Central Sterilization Supply Department*, *Hospital Acquired Infection*, *Operation Theater*.

Introduction

In the current era robots play vital role in several industries, hospitals, and research organizations etc. In hospitals robots are the newest members of the hospital support and nursing staff. This project focuses on design of an intelligent autonomous multi-sensor wireless controlled NXT robot using MATLAB to handle contaminated item and sterilize equipments in the centralized sterilization

supply department specially to protect clinical professional. The

system is entirely automated and quality assurance procedures, thus decreasing the threat of HAI. The choice of robotic podium for this project is the Lego Mind storms NXT. This system facility to collect, clean, pack, disinfects, sterilizes, stores, and distributes instruments, in accordance with well-delineated protocols and standardizes procedures [1-5].

Proposed System works as a single unit, which is control by MATLAB. MATLAB runs in monitoring computer which is wirelessly connected with robot via Bluetooth dongle and all other equipment in CSSD is connected with the serial port connection. We have to use advance software for controlling dongle. The dongle works as bi-direction serial port which enables us to use serial commands to communicate with Lego robot. For establishment of strong link between MATLAB and Lego NXT we have to install some program files in brick. This file helps us to easily communicate with robot by using MATLAB. First of all, we upgrade firmware of Lego NXT from 1.21 to 1.26. This was done because old firmware does not support RWTH toolbox. This Toolbox provides communication with robots with Bluetooth or USB. The toolbox includes routines for supporting interactions between robots and MATLAB. We use RWTH toolbox in MATLAB the commands were send through the MATLAB after creating the connections and robot work according to the given instructions remember as the robot have motors and sensors all were activated by via wireless connection no user or wire interface is there. as we know that the CSSD staff work manually al the process, they take contaminated material from the O.T and they enter into the department and processed it through washer and autoclaves there are some indications which already known by the staff that the equipment shows it become sterile, in short all work done by the staff according to the instructions. Same process is performing by the robot technology NXT ROBOT more accurate more smoothly and shows best performance there according to the instructions. The washer and autoclave are controlled by the microprocessor which also takes instructions through MATLAB. All the equipments of the department are interconnected with each other, there data is transfer via port to the main circuit board and then via serial port the data is transfer to the computer placed in an operating room. In this way a continues

feedback is provided and robot is monitored continuously so there is almost no chance of human error. The instructions of doors open, and robot enter and exit all timing are set and command by MATLAB [6-18]

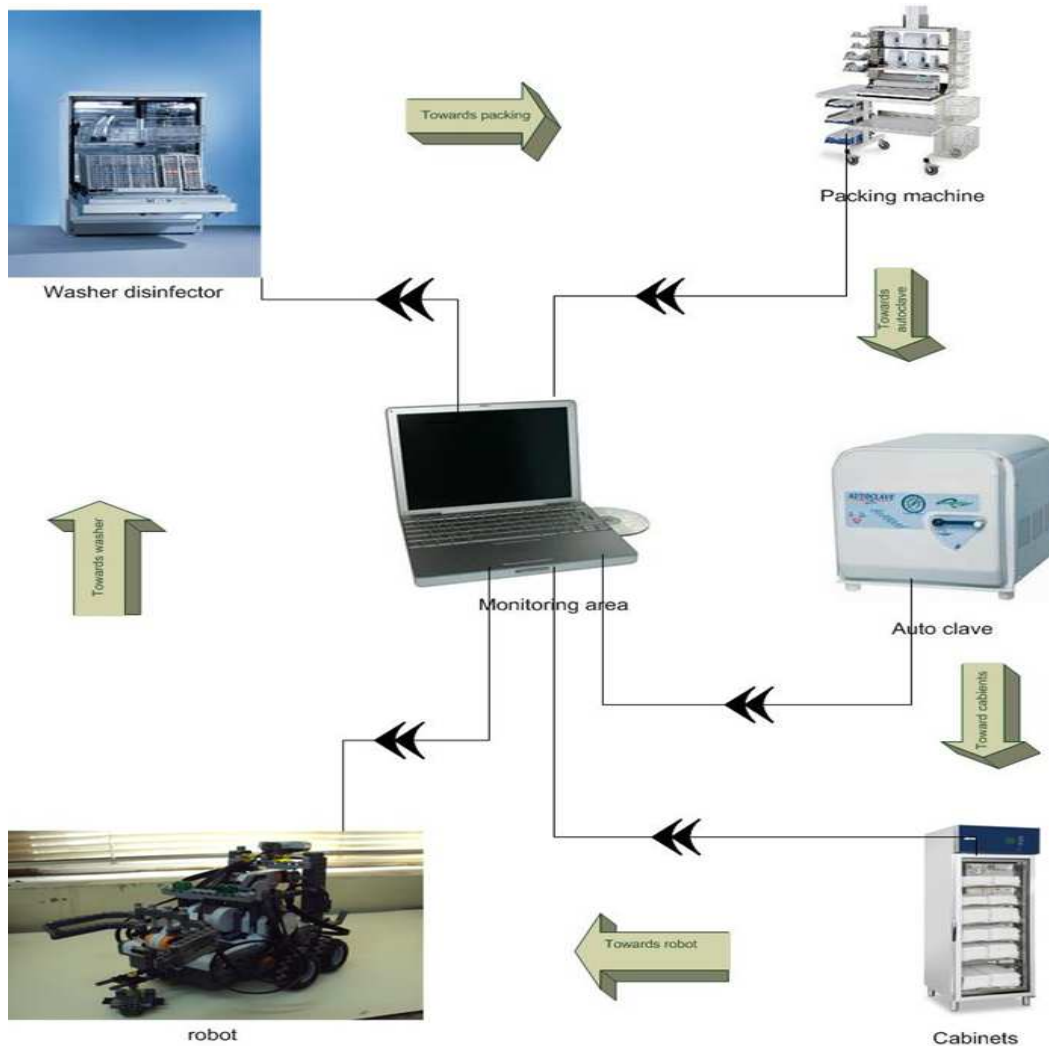


Figure 1. Shows the Working Principle of the proposed designed

I. DESIGN METHODOLOGY

A. Material Selection in proposed designed

Lego Mindstorms kit with MATLAB software were used in this project, in addition to design whole prototype some extra materials are also used in the completion of complete prototype design as shown in Figure 2. Lego Mindstorms consists of different construction blocks, sensors and controlling brick [6], The controller brick used in the proposed system in controlling all functions of Lego robot, which includes ,4 input ports,3 output ports,1 Bluetooth connection. Light Sensors used to help the Robots to move on the desired location where the object placed, Ultrasonic Sensors are integrated with designed robot to assure not to collide with any surface or objects, Sound Sensor also used to identify if the hazardous material or object detected by the robots or not, Touch Sensor were also incorporated with

robots to hold the object after feeling touch sensation. Three servo motors are also used to control the robots' gripper and arm angle. Shaft Encoder used to measure the speed of the servo motor to ensure that the designed robot manipulate its task accurately, finally Blue tooth dongle were also used, this wireless system helps robot to easily move anywhere and send back its location and status to monitoring system. This adapter is high speed and medium range which is about 100m in circle. Adapter is capable to operate in bi-direction mode. [6]. The conveyer belt is used inside the equipments to transfer the material from entrance to exit which is placed by the robot. The conveyer belt has widely used in industries for the supply chain and transfer of the material from the idea of that industries make me an example to provide a better way to hold and control the material through conveyer belt. It consists of single motor

which is the center of the belt and belt is rotate on it when

the motor allows to move clockwise or anti clockwise.



Figure 2. At Left: Lego NXT Controller units connected with different sensors, At Right shows the Bluetooth dongle used with the system for wirelessly controlling the whole system.

B. HARDWARE ARCHITECTURE

C. SOFTWARE DECSRIPTION

In Robot designing two NXT Robots' bricks were used to control severe servo motors especially four motors used among which two were used for driving and steering wheels of designed robot while one used for robotic gripper and one for robotic lifter as shown in Figure 1-2. The proposed designed system also has ability to sense different color packages with the help of color sensor to detect and distinguish visible colors based on these color sections Robot can easily pick and place of different color and shape objects, an ultrasonic sensors also used to detect obstacle during the Robot moving towards the object for handling or dispose of contaminated object like the mask or any belonging used by COVID 19 patient to protect the direct interaction of ward boy form this pandemic. ,an ultrasonic sensor may also use to retrieve the robot's distance to its starting point and light sensor was also used to rover the Robot in the straight path which may detect the lines for its path findings where user want to move the robot to move. The wireless BLUETOOTH communication used in the proposed system which provides access to control and communicate with robot from computer. 8-bit microcontroller and a 100x64 LCD monitor. This brick supports up to four sensorial inputs and can control up to three servomotors. It also has an interface displayed by the LCD System works as a single unit which is control by MATLAB. MATLAB runs in monitoring computer which is wirelessly connected with robot via Bluetooth dongle and all other equipment in CSSD relates to the serial port connection. We have to use advance software for controlling dongle. The dongle works as bi-direction serial port which enables us to use serial commands to communicate with Lego robot. For establishment of strong link between

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process after the completion of the task it will come back to its starting position.

The Robot receive command from PC from the execution of its work wirelessly for this purpose Bluetooth adapter was uses through the wireless Bluetooth adapter. The MATHLAB NXT toolbox has been used in this system [14]. The software used in this designing is a free open source subject to the GNU GENERAL PUBLIC LICENSE (GPL). Desired task commands are sent to NXT robot to achieve task by using this connection, it is also use for receiving data from sensors like distance from ultrasonic sensor of each robot. A replica of CSSD was designed as shown in Figure 1 (Working Principle Diagram) to A replica of CSSD was designed as shown in Figure 1 (Working Principle Diagram) to provide better practical approach system, we built replica of whole department with all necessary equipment use in process. Prototype includes model of washer disinfector, autoclave, supply cabinet and special chamber for sterilizing robot, all equipments are design by acrylic sheets. Models are mechanically active to perform basic functions like opening and closing of doors, receiving, and transmitting commands to main controlling computer. [15]. PIC controller is use as Communication Bridge between CSSD replica and PC server. C high level programming language is used to program PIC controller, PIC-C compiler. The main board is connecting the departments equipment with computer in monitoring area. this is done in a simple way

that first data is sent via port to the main circuit board and then it is transfer serially to the computer where it is monitored as shown in Figure 1 and Figure 4 respectively.

For the safety of complete Robotic system used in proposed design , The system will be stopped if the system started malfunctioning for example if the user give the system instructions command to follow the straight path and execute their work as per command received through PC software if system started malfunctioning and does acts upon received instructions the system will be because of many sensors are being incorporated within the system to assure the system behaves properly without or with minim error during execution of any task performed by the system. ,whenever a robot is about to going outside the workspace or lost its path, the whole process is stopped, and robot come back to their initial position for this purpose an emergency button access given to operator in system control console which is shown in Figure 8 . This option may use if operator realized there is any automatic shut off needed in any emergency case.

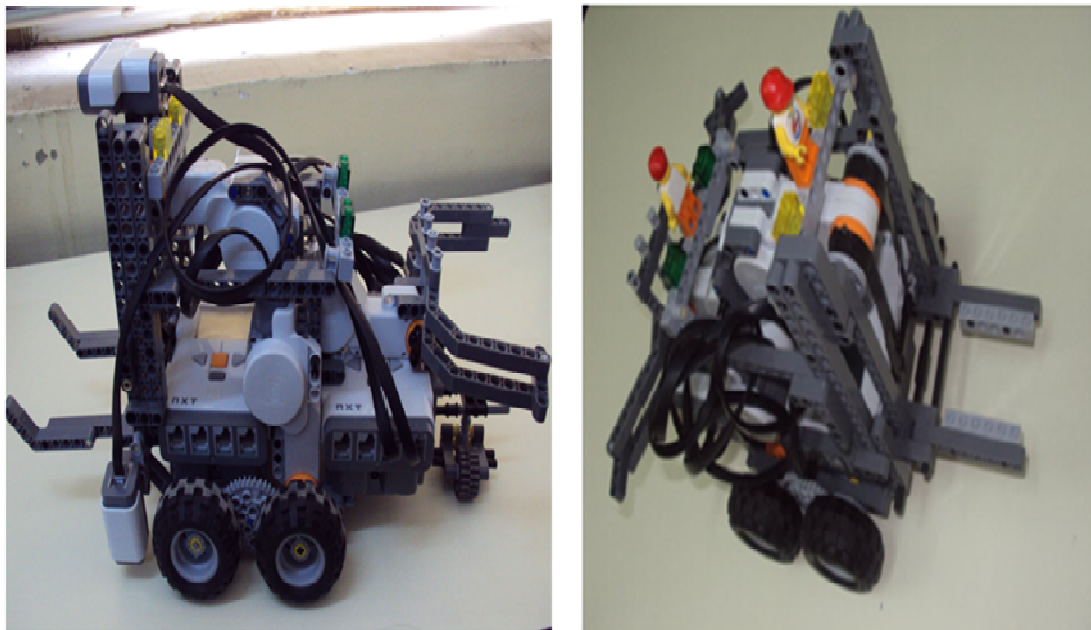


Figure 3. Proposed Robot Hardware Structure



Figure 4. Project Hardware Circuit

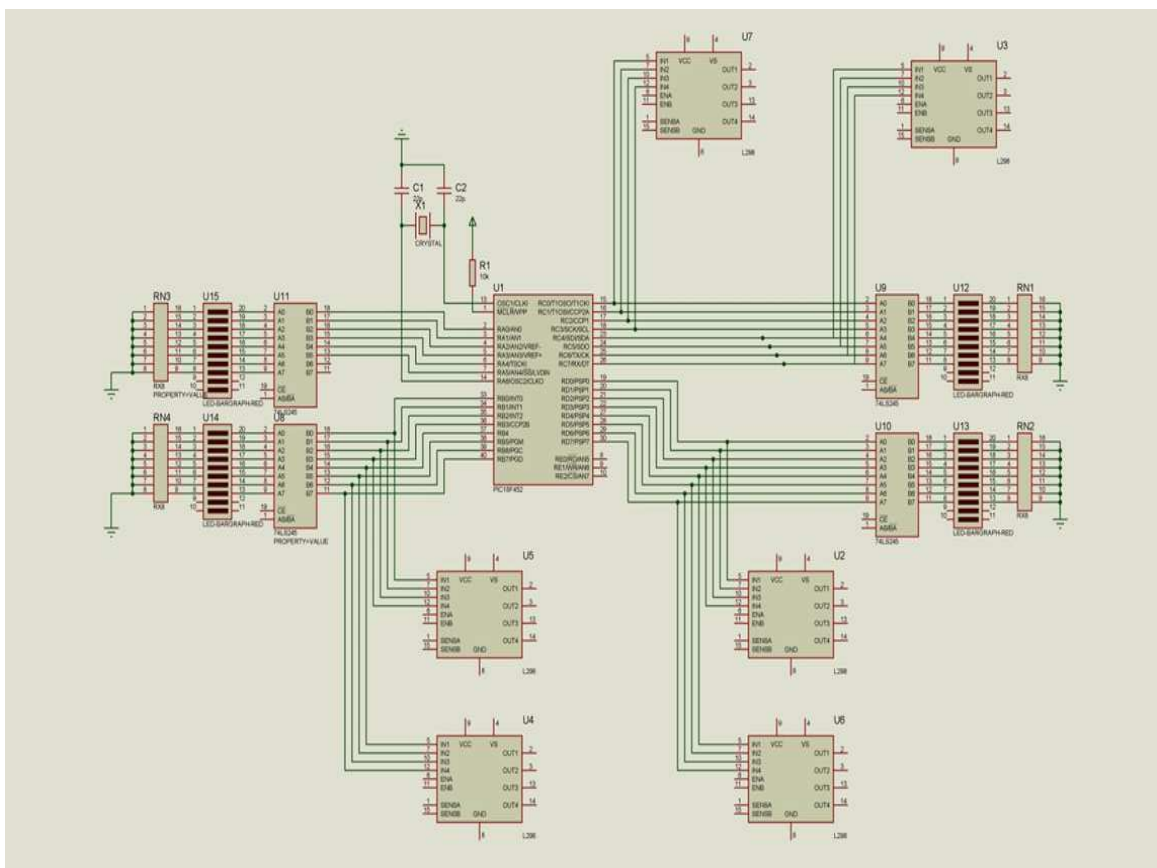


Figure 5. Hardware Circuit Schematic designed for the proposed system

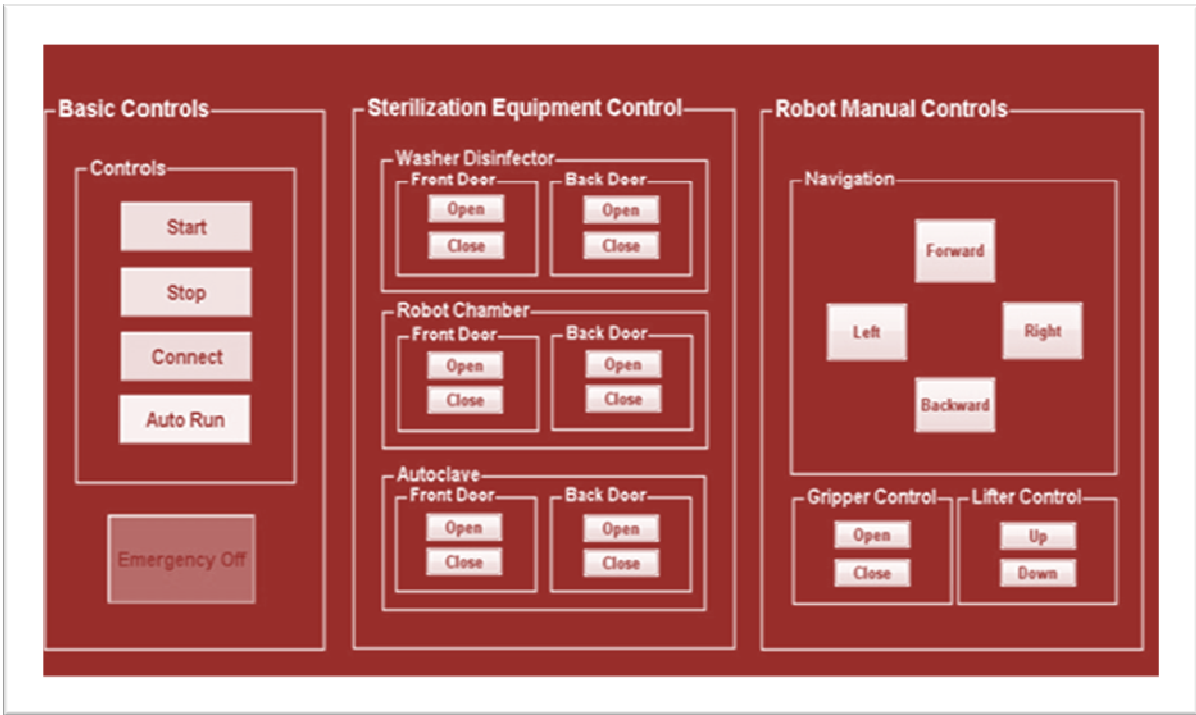


Figure 7. Basic Algorithm Flow Chart used in the Proposed Robot System Design

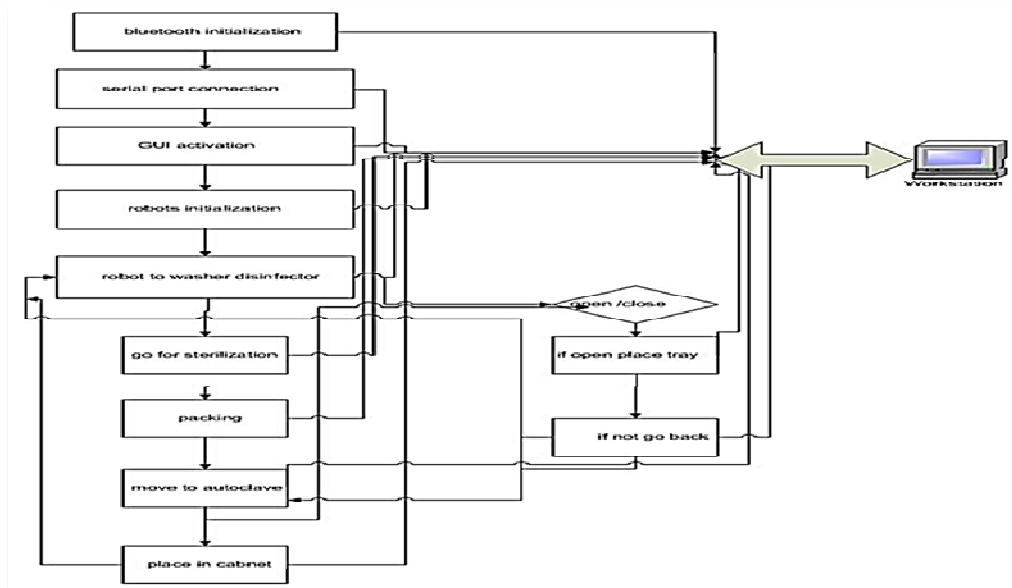


Figure 8. Proposed System operating console At Left: Basic control with star/end/auto start/emergency switches, At Center: Different operating console having provision of sterilization equipment control , Robot chamber control and autoclave operation control depicted, At Right: Robot Navigation control depicted with gripper control provision. with basic access control.

II. CONCLUSION

Proposed designed project may provide provides fast and hygienically secure environment to hospital Central Sterilization Supply Department especially now a days to cope the spreading of COVID19 in clinical staff special in ward. Our system helps hospital administration to keep their hygienic quality at top. Whole system is cost effective and

able to do those works which are hazardous for health of human. All hazardous material will be carrying out by robot. Whole process will automatic so very less chance of any error. In case of emergency whole system will auto, shutoff and inform operators immediately. System ensures sterilization process more reliable and accurate. We hope in future our design plays important role in maintaining hygienic quality of hospital and also make whole process

faster. Robot can work freely without any risk of infections. System will able to work 24x7 without any stop. Designing of GUI for simplicity for user. System can be monitor by wireless. This phase covers all monitoring and feedback systems. In this part we try to make our robot vision intelligent so it can differentiate between objects and equipments. Image processing also helps us to find out location of robot in CSSD.

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