Design, Manufacturing and Simulation of Smart Trolley For Monitoring of Infected Patients

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Abstract- *Millions of Health care workers (HCW) get infected by infectious diseases per year in concern of this problem for minimizing doctors-patient interaction we have designed a smart trolley which can be used to deliver food and medicines to patients, for supervising the medical staff by the doctor and improve coordination of medical staff and for patients meetings with family. In 2020 covid -19 was came and all world suffered through this disease and also doctors and other medical staffs also get infected due to the contact with patients. In order to keep minimum contact between active patients and medical authorities, we have devised the fabrication of automated trolley to deliver essentials (i.e, medicine, food & water bottle's) to active patients without medical authorities coming in contact with them. And also measure temperature by using temperature sensor(MLX 96014), and measure oxygen level by using oximeter(MAX 30102) without contact. . Our trolley capable of carrying approximate 10 to 15 kg weight and is functional in real time. By successful implementation of such project, It will be minimum possible contact between medical authorities and patients*

Keywords- HCW, NODE MCU, Arduino nano, MLX 96014, MAX 30102, Smart trolley.

I. INTRODUCTION

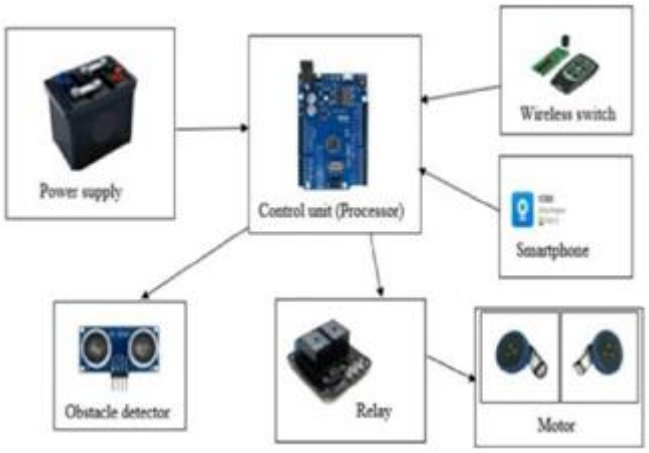
Doctor's direct or indirect contact during interactions with the patient suffering through the contagious or infectious diseases like COVID-19 is unsafe for doctors. But to keep the attention on patients and satisfy their needs is also important. In 2020, due to the pandemic situation of COVID19, social distancing has become a very crucial factor in our life. In this situation, mainly doctors and nurses and all medical staff should take care of themselves. Smart Medicine Trolley is one type of help for these covid warriors Hence, we designed the automated trolley which can be used by medical authorities to keep attention on patient health and to provide medicines and other essentials with minimum contact of medical authorities with patients and improve the hospital staff coordination. per report of WHO health care workers have been central to the COVID-19 response since the beginning of the pandemic. Many of their functions and roles put them at risk of exposure to hazards that can impact their working conditions as well as have impact their physical and social well-being. It is therefore critical to monitor the multidimensional factors affecting HCWs as the pandemic continues HCWs continue to face a range of interconnected factors that affect their mental health and stress levels which increase with irregular working hours, higher levels of exposure to illness, fear of infection with COVID19 related to exposure, and/or lack of adequate PPE amongst others. Published studies show that the prevalence of mental health conditions among HCWs was significantly higher than other professional groups.

Social distancing and quarantining are now standard practices which are implemented worldwide since the outbreak of the novel coronavirus (COVID-19) disease pandemic in 2019. Due to the full acceptance of the above control practices, frequent hospital contact visits are being discouraged. However, there are people whose physiological vital needs still require routine monitoring for improved healthy living. Interestingly, with the recent technological advancements in the areas of Internet of Things (IoT) technology, smart home automation, and healthcare systems, contact-based hospital visits are now regarded as non-obligatory. For this purpose we will design and manufacturing the smart trolley for carry the essentials and monitoring the infectious patients.

II. MATERIALS AND METHODOLOGY

1. Proposed Method*:-*

The flow process of the smart trolley involved the implementation of hardware and software development is shown in fig 3. The flow process begins with the input signals is transmitted to the Arduino Uno R3. The input signal transfer information to the Arduino and then transfer to the trolley start to move according to the instruction given. The motor wheel the trolley backward or forward based on the ultrasonic sensor. Once the ultrasonic sensor detect the in front of it, it will stop moving until another path is recognized. Then the trolly will start move otherwise it will just move until it reach the location given by the instructor.



2. Hardware implementation:-

A Hardware implementation is used that include battery, wireless switch, smartphone, control unit, Arduino UnoR3, ultrasonic sensor and motor . Fig4 shows the system architecture of this project . The system architecture used consists the power supply to power up the control unit . The wireless switch and smartphone is used as to send information to the control unit. The control unit will control the movement of the trolley based on the object detector, relay and motor.

Arduino Uno R3	Output
pinA0 (6* Analog IN)	Resistor R1
pinA1 (6* Analog IN)	Resistor R2
pinA2 (6* Analog IN)	Resistor R3
pinA3 (6*Analog IN)	Resistor R4
pin 13 (14*Digital IN/OUT)	Ultrasonic sensor 1
pin 12 (14*Digital IN/OUT)	Ultrasonic sensor 1
pin11 (14*Digital IN/OUT)	Ultrasonic sensor 2
pin 10 (14*Digital IN/OUT)	Ultrasonic sensor 2
pin9 (14*Digital IN/OUT)	Relay
pin8 (14*Digital IN/OUT)	Relay
pin7 (14*Digital IN/OUT)	Relay
pin6 (14*Digital IN/OUT)	Relay
pin5 (14*Digital IN/OUT)	RF module receiver
pin4 (14*Digital IN/OUT)	RF module receiver
pin3 (14*Digital IN/OUT)	RF module receiver
pin2 (14*Digital IN/OUT)	RF module receiver

3. Arduino Uno R3:

Arduino is widely used as an open-source single-board microcontroller for the development platform which is flexible, easy-to-use hardware and software components. In this study. Arduino Uno R3 with an onboard USB to serial chip is used to load code into on-board Atmega328 Microcontroller. This Arduino contains everything needed to support the microcontroller. To get started, user simply needs to connect Arduino Uno R3 to a computer with a USB cable. The Arduino consist 14 digital input/output pins which is used as a PWM outputs, 6 analog inputs, 6MHz crystal oscillator, a USB connection, a power jack an in-circuit system programming (ICSP) header and a reset button. The pin Connection of Arduino UNO R3 with Other Hardware as shown in Table 1.

4. Battery Power:

For instance, the proper operation of microcontrollers, depended on the voltage quality supplied to them [14-18]. Battery power is used to supply power to the trolley. To avoid from malfunction, the battery is set to 12-volt maximum voltage.

5. IP camera with wi-fi module:

The IP camera with Wi-Fi module is used in this project to monitor the movement of the trolley. The IP camera is applied for the nurse to put medical equipment onto the medical surgical trolley while surgery is conducted. In this way, the nurse can avoid interrupting the surgeon from going in and out from the operating theatre only to get any medical equipment that is needed while the operation is conducted.

6. MOTOR SELECTION :-

Numerical Simulation (Selection of Motor):
Calculation involved in the selection of a Motor:
Total weight carries by trolley = 25 kg
Diameter of wheel =100 mm = 0.1 m
Radius (r)=0.1/2
Assume,
Speed (N)= 200 rpm
Torque (T) = Force*radius
Force = Mass*Accelaration
= 25 *9.81
= 245.25 N
r = 0.05 m
Ttotal = 245.25*0.05
Ttotal = 12.26 N.m
Torque per wheel =12.26/4 = 3.065 N.m

Power = 2* π *N*T/60

=2* π *200*3.065/60

Power = 64.16 Watt

Hp = 64.16/746 = 0.086Hp

Power = Voltage Current

P = V I

64.16 = 12 I

- I = 5.34 Amp

7. Material Selection:

Now it is the time to articulate the research work with ideas gathered in above steps by adopting any of below suitable approaches: These below factors are considered in selecting the best material for the application.

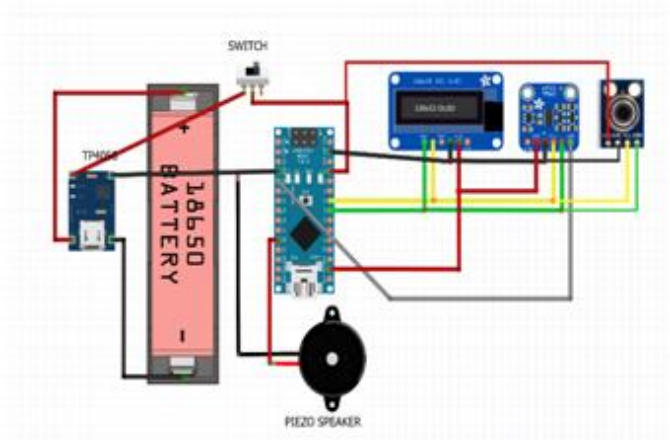
(i) Materials must have adequate strength and corrosion resistance to safely handle the essentials.
(ii)Materials should have no effect of sanitation on them.
(iii) The system and environment temperature in which it operates depend on the material
(iv) Other factor is cost

Material properties	Galvanised steel	Stainless steel	Aluminium
Temperature (°C)	650	649	204
Rated pressure (Kg/cm^2)	50000	20000	4000
SUT (MPa)	600	505	250
Cost (Rs/kg)	63	220	135
Corrosion resistance	excellent	excellent	good
Weight (Kg/m^2)	7.88	7.42	2.21

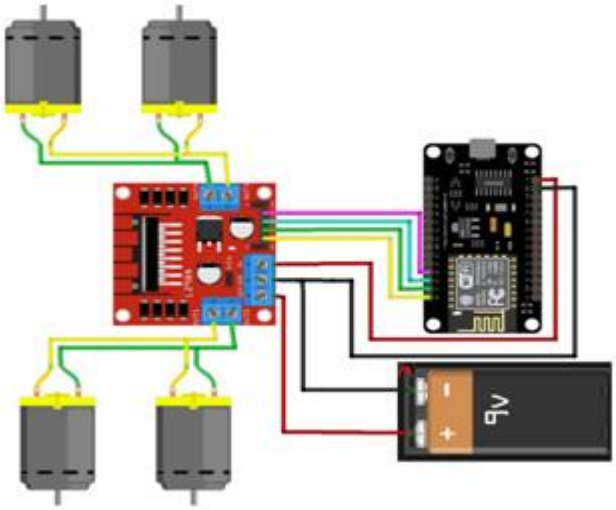
Conclusion – From the above table selected material is stainless steel.

8. Electric Circuits:-

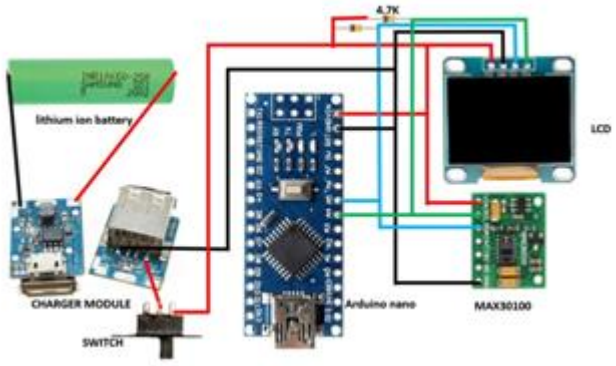
1) Temperature sensor with display:



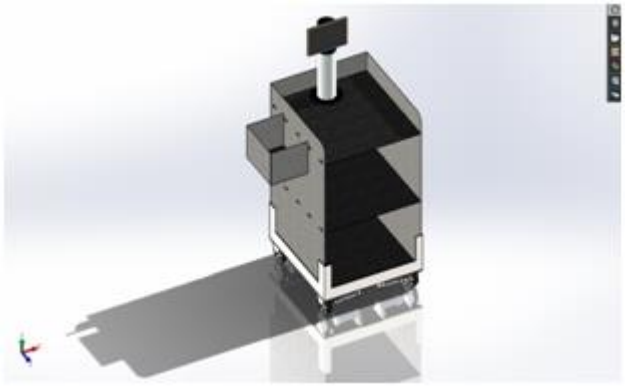
2) Oximeter circuit



3) Trolley Motion control circuit:



9. CAD model :-



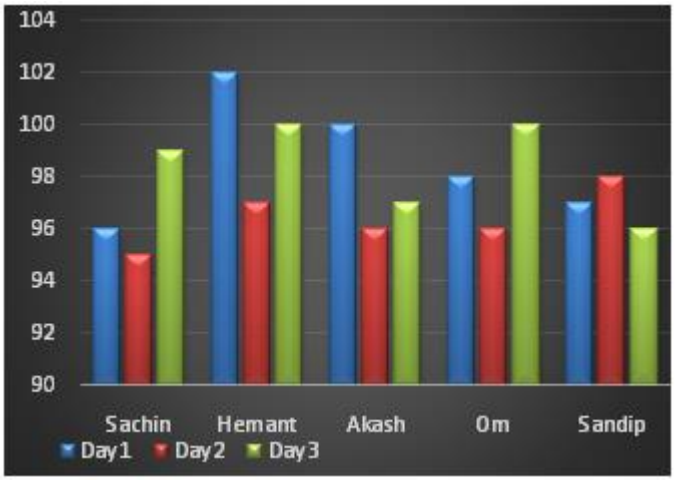
10. PROTOTYPE:-

III. EXPERIMENTAL INVESTIGATION

The parameters that are going to be measured by our smart trolley are listed below:

1. Measurement of the temperature of investigation in 8 hr. cycle:

Sr. No	Name of Patients	Temp.	Time Required Before Implementation (sec)	Time
1	Sachin	96°F	60	20
2	Hemant	102°F	60	20
3	Akash	100°F	60	20
4	Om	98°F	60	20
5	Sandip	97°F	60	20



So, temperature sensor integrated with our automated trolley helps to measure the temperature of every patient on daily basis and nurse gets to know about daily health condition of patients.

2. Load calculations of Healthcare Workers:

1) Approximate load calculation

Sr. No	Activities	Time Required Before Implementation (min)	Time Required After Implementation (min)
1	Body Temp	1	0.5
2	Blood oxygen level	1	0.5
3	Pulse rate	0.5	-
4	Interaction with patients	10	5
5	Food delivery	3	2
		Total = 15.5	8

Working load on nurse (before implementation):-

= number of beds * average time of task (mentioned in above table)*number of visits to the patient

=32*5.5 min*4

=704 min

Working load on 1 nurse= 704/5

= 140.8 min/day (2.34 hr/day)

Working load on nurse (After implementation):-
= number of beds * average time of task (mentioned in above table)*number of visits to the patient
=32*3 min*4
=384 min
Working load on 1 nurse= 384/5
= 76.8 min/day (1.28 hr/day)

Reduction in load on nurse after implementation of trolley:-
=load on nurse (before implementation) – load on nurse (After implementation)
= 140.8 – 76.8
= 64 min/day (1.06 hr/day)

IV. CONCLUSION

An android based smart trolley is developed for the doctors and other medical staffs to provide the medical equipment and essentials to the patients. In the designing process of the trolley, by designing, simulation and analysis of the trolley cad model in solidworks we had obtained the safer structure for the smart trolley.The Automatic smart trolley system is developed with the microcontroller based on Atmega328 called Arduino Uno R3 and ESP8266. An IP camera with Wi-Fi module is attach as the monitoring system for the Nurse to move the trolley in and out from the operating room. This system design enables the movement control of the medicine trolley. And the movement of the trolley in forward-backward, right-left is controlled by the remote controller as per requirement. It will avoid collision with the help of Ultrasonic sensor. With the help of temperature sensor, it will measure the temperature of the patients. the obtained from the experimental analysis of the working of smart trolley we concluded that the smart trolley can reduce the load on health care workers and help in the monitoring of the patient efficiently.

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