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http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Volume 13, Issue 01 January 2024

RT-PCR Covid-19 Sample Collecting Robotic Arm

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Abstract— **Real time RT–PCR may be a nuclear-derived method for detecting the presence of specific genetic material in any pathogen, including a deadly disease. Originally, the tactic used radioactive isotope markers to detect targeted genetic materials, but subsequent refining has led to the replacement of isotopic labelling with special markers, most often fluorescent dyes. This system allows scientists to work out the results before long while the method remains ongoing, whereas conventional RT–PCR only provides results at the tip of the method. Real time RT–PCR is one amongst the foremost widely used laboratory methods for detecting the COVID-19 virus. While many countries have used real time RT–PCR for diagnosing other diseases, like Ebola virus and Zika virus, many need support in adapting this method for the COVID-19 virus, further as in increasing their national testing capacities.**

Currently, whole World are infected by the Corona Virus (Covid-19). The COVID-19 pandemic in India is a component of the worldwide pandemic of coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome corona virus 2 (SARS-CoV-2).

The prediction is additionally conditioned by the standard of the information. Consistent with this mathematical model, Covid-19 will end in early December this year. But this doesn't come without a note of caution. "The reality is that the future is usually uncertain. Nobody predicted the Covid-19 outbreak in October or November 2019.

Keywords- **Covid-19, RT-PCR, RT-PCR test, Covid-19 testing, Covid-19 testing robot, Covid-19 RT-PCR test, Covid-19 Sample collecting Robotic ARM, RT-PCR Sample collecting Robotic ARM.**

1. INTRODUCTION

Since the late 2019, the COVID-19 pandemic has been spread all round the world. The pandemic may be a critical challenge to the health and safety of the final public, the medical staff and also the medical systems worldwide. It's been globally proposed to utilize robots during the pandemic, to enhance the treatment of patients and leverage the load of the medical system. However, there's still a scarcity of detailed and systematic review of the robotic research for the pandemic, from the technologies' perspective. Thus, an intensive literature survey is conducted during this research and quite 280 publications are reviewed, with the main target on robotics during the pandemic. the most contribution of this literature survey is to answer two research questions, i.e. 1) what the most research contributions are to combat the pandemic from the robotic technologies' perspective, and 2) what the promising supporting technologies are needed during and after the pandemic to assist and guide future robotics research. These achievements of robotic technologies are reviewed and discussed in numerous categories, followed by the identification of the representative work's technology readiness level. The longer-term research trends and essential technologies are then highlighted, including computing, 5 G, big data, wireless sensor network, and human-robot collaboration.

In the past years, automated devices and robots have significantly changed the industry and existence. There's also an enormous interest in using robots within the scenario of communicable disease and epidemic. The intention is affordable because the robots offer the chance of delivering the work within the contagious or dangerous area, while not getting people infected or affected.

In the infectious scenario, the foremost important application is robotic surgery, including minimally invasive surgery supported robots. Automated laparoscopy and laparoscopic surgery are performed by the robot for higher protection and fewer complications. Certain diseases are mentioned thanks to the special nature, including adenocarcinoma, endometrial carcinoma, rectal cancer, and related surgeries like prostatectomy and hysterectomy. To recap, there has been an enormous and continuous interest in utilising robots within the medical scenarios since 2020, especially in surgical applications. However, the pandemic breakout in 2020 inspired many researchers during this area and added new perspectives to the research.

2. OVERVIEW

Testing is crucial to spot, curb the spread of, and contain severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Testing capacity will therefore have to increase substantially for the foreseeable future. Robotic testing technologies may help to extend testing capacity and also minimize the danger of nosocomial transmission. There are currently two ways of testing for coronavirus disease (COVID-19): Virological tests and serological tests. Virological methods work with genetic material obtained from nasal, throat, or saliva swabs and commonly use reverse transcription polymerase chain reaction (RT-PCR) technology to covert polymer (RNA) to polymer (DNA). This technology is employed to detect the presence of SARS-CoV-2. Serological tests use saliva, blood, serum, or plasma to seem for antibodies. Various new testing methods that are variants of those two approaches are currently in development.

Robots for SARS-CoV-2 testing procedures can be either patient-facing (e.g., collecting nasal swabs and thereby reducing exposure of those collecting swabs) or non–patient-facing (e.g., liquid handling machines that reduce exposure for laboratory technicians). To date, patient-facing testing robots are mainly experimental, deployed as pilots and in limited settings. Examples include remote-controlled robots taking throat swabs that are utilized in parts of China, a robotic arm handing out test tubes to drivers in cars for SARS-CoV-2 testing, and a 3D-printed robotic arm taking throat swabs that was developed in Denmark. Such robots are expensive (the Chinese robot costs approximately £62,000 [US $81,069]), can only do a limited number of activities on 1 sample at a time

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(and therefore don't greatly increase the number of tests carried out). They'll also cause patients to stress thanks to a scarcity of non-public contact. Previous research has further found that patient-facing robotic applications can have unintended consequences resulting from adverse impacts on health care professional work practices, and on patient satisfaction. As an example, frail older adults and isolated patients depend upon face-to-face contact as a source of emotional support. Attempts at making these applications more human-like may only partly address this issue, as robots that look too human-like will be perceived as threatening. Patient-facing robots may, however, play a job in high-risk settings where infection control must be prioritized. They cannot replace face-to-face interactions that are required to produce high-quality and safe take care of the bulk of patients.
However, the functionality of those machines varies. Some RT-PCR liquid handlers only help up to the extraction and addition of samples for PCR/RT-PCR, while others also transfer the fabric to a thermal cycler where PCR/RT-PCR happens (i.e., extraction and amplification). Clearly, a closed-loop process (where technicians input a sample and therefore the machine prepares samples and tests) is preferable because it minimizes human contact with samples (including testing for multiple viruses).
Another potential issue is that the interfacing with existing software and therefore the associated communication of results. Some automated testing robots don't allow automatic downloading of results from the robot to the most laboratory computer, which then renders the full process impractical because the sizable number of results generated must be manually entered by technicians. This might also introduce the danger of transcription errors, which can successively have adverse consequences for patient care. Additional integration software can help to handle this issue, but adds to the general cost (in relevancy both acquisition and maintenance) and will require additional programming.

3. PROBLEM STATEMENT

The World Health Organization (WHO) on January 30, 2020 publicly declared the COVID-19 pandemic as a "global emergency" due to the rapidity at which it had spread worldwide. The virus has shaken worldwide economies resulting in a stock exchange crash in many countries. Since, the first bunch of cases identified in Wuhan City, China, in December 2019, the coronavirus pandemic has rapidly spread across China also as over the borders, causing multiple incidents in nearly all countries of the globe except Antarctica. Despite the scarcity of publicly available data, scientists round the world have made progress in estimating the size of the pandemic, the progression rate, and various transmission patterns of the disease. Recently, clinical data confirmed that a major portion of the COVID-19 patients show diminutive symptoms for the primary four days, which illustrates the stealthy transmission potential of this contagion. Scientists have deliberated that COVID-19 is much more transmittable and lethal than the normal flu.
According to the WHO's situational report 127 published on May 26, 2020, so far, 5,404,512 confirmed cases are reported worldwide with 343,514 casualties. The death rate is highest among older people compared to young ones, while male patients are more at risk of risk compared to female patients within the same people. Patients with pre-existing cardiovascular diseases/hypertension, diabetes, cancer, and chronic respiratory disease have greater probability to expire because of covid-19 complications compared to patients without comorbid conditions. U.S., China, Italy, Iran, Brazil, France, U.K, and Germany are to this point the foremost affected countries of the globe. The routes of COVID-19 transmission may be pre-symptomatic, symptomatic or asymptomatic thanks to the highly contagious nature of the disease. Therefore, it's of utmost importance to use hand sanitizers, facemasks, and practice social distancing to avoid the virus infection, which may spread through sneezing, touching, and shaking hands. For the medical and healthcare community, the employment of private protective equipment (PPE) including N-95 facemasks and gloves for covering against the spread of corona-virus is mandatory for close monitoring of COVID-19 patients. Therefore, alternate technologies involving medical robots and tele-medicine systems are focused so as to regulate the spread of infection to a large population. Considering the present disastrous situation, robots are like minded for caring for the well-being of COVID-19 patients thus replacing or a minimum of sharing the workload of the medical staff in hospitals under oversaturated conditions. Variety of robotic systems are used for medical support in hospitals today.
In China, robots are assigned multiple tasks to reduce the spread of COVID-19, such as utilizing them for cleaning and food preparation jobs in infected areas hazardous for humans. This study is one among the primary studies, which highlights the importance of robotics in hospital and healthcare facilities specially concerned with the COVID-19 outbreak. The purpose of this study is to explore strategic healthcare digitization innovation through robotics utilization in terms of worldwide COVID-19 management perspectives. This study will provide decision-makers and policy-makers with strategic insights in improving the healthcare quality in local and global disasters along with pandemic settings and other similar situations.
In the present study, we aim to explore a special strategy and develop a low-cost, easy-to-assemble robot with small footprint to help NP swab collections. The NP swab collections involve inserting a specifically manufactured swab into a patient's nasal cavity. The head of the patient is anticipated to be tilted back (at approximate 70°) so the nasal passage becomes straight and accessible. The swab is then inserted through the nostril parallel to the palate, all the thanks to the nasopharynx. After left in situ for several seconds for secretion absorptions, the swab is then rotationally retracted from the bodily cavity slowly. During this paper, we aim to present the look concept, the implementation method, the simulation study, and also the preliminary phantom and tests of this new robot.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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4. LITERATURE SURVEY

In Covid various countries like China, USA, Brazil, France, Germany, and Denmark working on Robotic system to help health workers. Some make covid-19 sample collecting robotic arm and someone made Covid-19 Disinfection machine and many more things to prevent our frontline workers in this pandemic. Here we discuss some helpful robotics technology made in this pandemic to prevent Health workers.

5. IIM SWAB SAMPLE COLLECTION ROBOT FOR SAFE AND SPEEDY TESTING

The fight against the rapidly spreading COVID19 pandemic has received a shot in the arm with an Indian Institute of Management Kozhikode (IIMK) based incubate start-up's indigenous robotic intervention. The effort has led to the development of a functional prototype of a robotic swab sample collection arm which can be remotely controlled for safe and speedy swab sample collection process.

Fig 4.1 IIM Swab Collection Robotic ARM

The start-up, which has been seed-funded by the collaborative initiative between IIMK LIVE and Mangalore Refineries and Petrochemicals Limited (MRPL) has developed this robot to replace the manual swab collection process and thereby reducing the COVID19 threat to frontline health workers involved in test sample collection. The robot armed with a 180-degree rotation gripper is extendable up to 1 meter in length. With the android app, a technician can easily operate it and regulate its movement beyond a safe physical barrier.

4.2 development of robot-assisted untact swab sampling system for upper respiratory disease

Fig 4.2 Taking Sample of China Made Robotic ARM

We propose a new tele robotic system for untact swab sampling to prevent the infection of medical staff during upper respiratory sample collection. The system consists of a slave robot and two master devices. The slave robot is designed to move a swab in 6 degrees of freedom within the facial area and to insert and remove the swab under remote control by an operator at the master site based on magnified imaging of the patient's facial area. The insertion and removal of the swab into and from the nostril are implemented by means of a swab insertion unit; as the counterpart to this unit, the master system also includes a swab insertion device to control the swab insertion unit remotely.

A force sensor installed on the swab holder enables monitoring of the force generated when the swab touches the target. In experiments, a virtual specimen was installed on the posterior nasopharynx wall of a life-size head phantom model. The nasopharyngeal swab samplings of the phantom model were successfully performed thanks to the force monitoring capability of the proposed tele robotic system, showing that this system is suitable for remote upper respiratory sample collection.

5 DESIGN OF PROJECT MODEL

Design of Project Model are discussed in below:

5.2 Process Descriptions

Process Description are described as follow:

International Journal of Engineering Research & Technology (IJERT)
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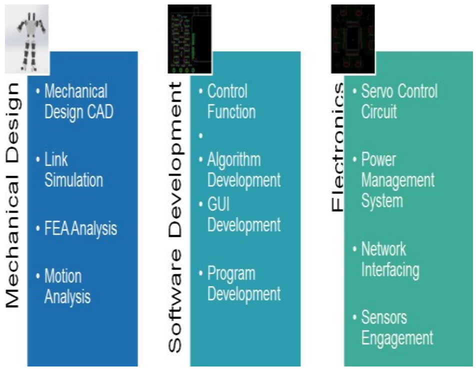

Fig 5.1 Process Description of Project

The whole mechanical design was done by employing a 3D CAD software, Solid Work 2020. The body of Robot is especially fabricated from 3D Design so as to comprehend antithetical concepts; light weight, high stiffness and wide movable range. Each actuator system of joint consists of a DC High torque servo motor. These motors comprise of sequential gears and heavy load carrying capability with large reduction ratio attached with a potentiometer to get the specified position and feedback. Properties of joints like maximum torque and rotating angular velocity are acquired supported data of software simulations. Newton-Euler's Method may be wont to simulate the estimated mass distribution and also the behaviour of the robot under static and dynamic conditions. A series of the simulations were dole out for the determination of the joint specification.

5.2 3D Model Design

The process of modelling is being done by using Computer aided design (CAD) software's. This involves creating computer models defined by geometrical parameters. These models typically appear on a computer monitor as a three-dimensional representation of a part or a system of parts, which can be readily altered by changing relevant parameters. These software's are also being utilized to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and mainly it is also used to create a database for manufacturing.

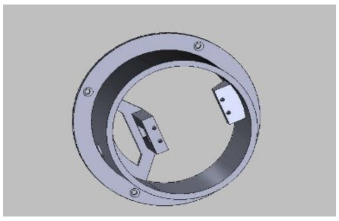

Fig 5.2: Model of Base

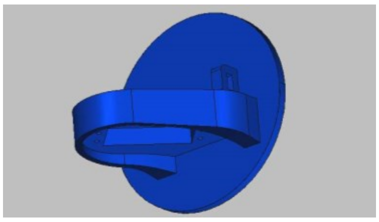

Fig 5.3: Model of Waist

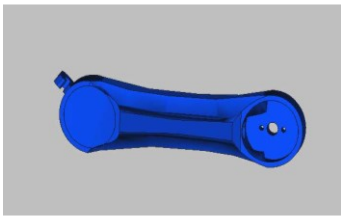

Fig 5.3: Model of ARM- 01

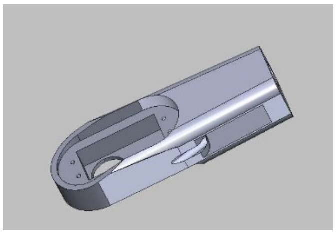

Fig 5.4: Model of ARM- 02

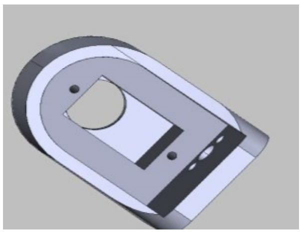

Fig 5.5: Model of ARM- 03

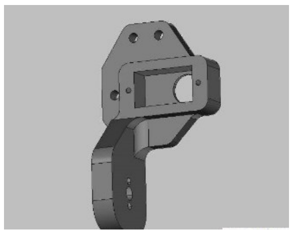

Fig 5.6: Model of Gripper Base

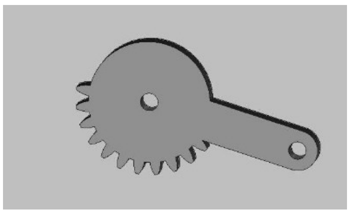

Fig 5.7: Model of Gripper Gear 1

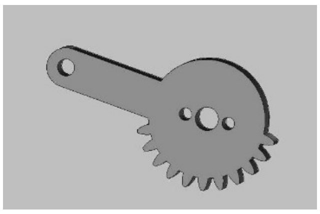

Fig 5.8: Model of Gripper Gear 2

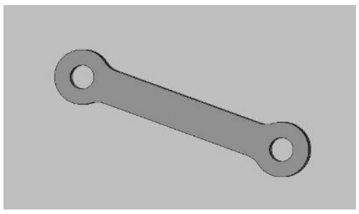

Fig 5.9: Model of Grip link

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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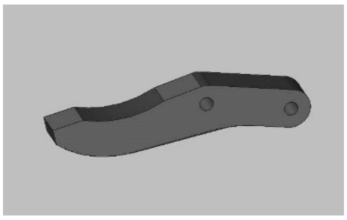

Fig 5.10: Model of Gripper

5.3 3D Model Analysis

Modal analysis is one of the studies which is being used to determine the vibration characteristics (natural frequencies and mode shapes) of a structure or a machine component when it is being designed. It also serves as a starting point for dynamic analysis, such as a harmonic response or full transient dynamic analysis. Modal analysis is also one of the most basic dynamic analysis types available in ANSYS.A reduced solver, utilizing automatically or manually selected master degrees of freedom is being used to reduce the problem size and solution time. The model is being imported from SOLIDWORKS in IGES format.

5.4 Structural Analysis

Structural analysis is being done by using Finite Element Analysis (FEA). FEA was first developed in 1943 by R. Courant, who utilized the Rayleigh-Ritz method of numerical analysis and minimization of vibrational calculus to obtain approximate solutions to a vibration system. The pressure state of a designed structure with various type of loading is being Building a model in SolidWorks usually starts with a 2D sketch. This sketch consists of geometry such as points, lines, arcs, conics and splines. Dimensions are added to the sketch to define the size and location of the geometry. Relations are used to define attributes such as tangency, parallelism, perpendicularity, and concentricity. The dimensions in the sketch can be controlled independently, or by relationships to other parameters inside or outside the sketch. In an assembly, the analog to sketch relations are being called as mates. The assembly mates define equivalent relations with respect to the individual parts or components, allowing easy construction of assemblies. The figures 5.2-5.10 shows the different parts of the robotic arm. Figure 5.11 shows the assembly of robot arm. Characterized by the FE analysis results. The arm geometry with the FE model, boundary conditions, and loading conditions are the input information for FE analysis. The direction and location of each load input to the component define the loading conditions.

The advantage of simulation is less time, cost and easier comparison to experiment method. FEA consists of a computer model of a material or design that is stressed and analysed for specific results. It is used in new product design, and existing product refinement. SOLIDWORKS assembly of the robotic arm is converted into STEP or IGES file format so that it can be imported to the ANSYS software. ANSYS uses the static structural toolbox to calculate component stresses and deformation.

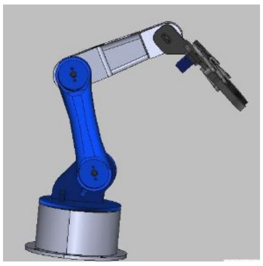

Fig 5.11: Assembly of Robotic ARM

5.5 Meshing

Meshing is one of the most integral parts of engineering simulation process where complex geometries are being divided into simple elements that can be used as discrete local approximations of the larger domain. FEA uses complex system of points called nodes which make a grid called a mesh. This mesh is being programmed to contain the material and structural properties which defines how the structure will react to certain loading conditions. Nodes are assigned at a certain density throughout the material depending for the anticipated stress levels in a particular area. The areas which receive large amounts of stress will have higher node density than the areas which experience little or no stress. Points of interest may consist of: fracture point of previously tested.

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International Journal of Engineering Research & Technology (IJERT)
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6 SCHEMATICS

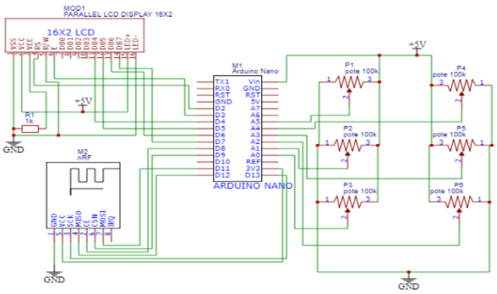

Fig 6.1: Schematic of Transmitter Circuit

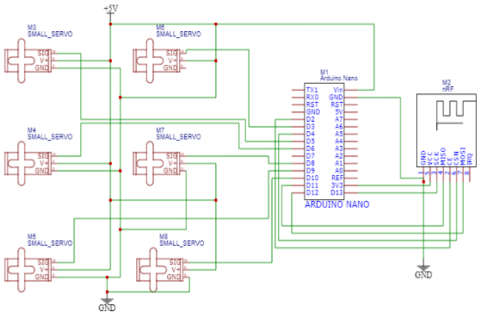

Fig 6.2: Schematic of Receiver Circuit

We used two circuits in this project one for transmitter and one for receiver. In Transmitter Circuit we used Arduino Nano, nrf24L01, 100k Potentiometer and 16x2 Display.

7 RESULTS

The Complete Project are displayed in below pictures.

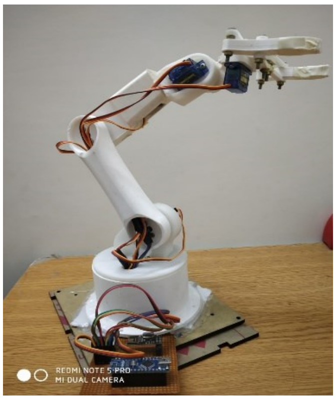

Fig 7.1: Complete Robotic ARM with Receiver Circuit

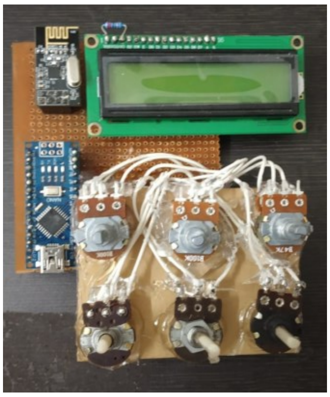

Fig 7.2: Transmitter Circuit of Robotic ARM

8 CONCLUSIONS

The detailed motion study of the robot has been carried out in various software and a suitable design is developed using CAD. Finite element analysis has also been done to reduce the weight of the links which result in light body weight and ease in control of the bot. Step by step process has been adopted to carry out the project in a smooth and functional way. 3D Printing technology has been adopted for fabrication of the link joints. ATmega 328p with Arduino library has been used to control the motion of the servo motors which are powered by 5V, 2A Adaptor. A suitable control method using Wireless (nrf24L01+) have been initiated for better graphical display and user interaction for Health workers.

9 FUTURE SCOPE

We modified this project in following field in future.

- We add Wireless Audio & Video Call Interfacing to communicate Doctor and Patient.
- We will made a stand for patients. Patient put the head on stand and give the sample of robot.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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