Covid-19 Human Breathing Monitoring and Assessment Using Memsaccelerometer-Based Digital Analog Converters (Daq) - An Approach Based Onmachinelearning

Mr.C.Rajeshkumar[1], Dr.K.Ruba Soundar[2], Dr.M.Vargheese[3], Mr.A.Siva[4], S.Sarjin[5]

[1]Assistant Professor/CSE,PSN College of Engineering and Technology,Tirunelveli,India
[2]Associate Professor/CSE,Mepco Schlenk Engineering College,Sivakasi,India
[3]Professor/CSE,PSN College of Engineering and Technology,Tirunelveli,India,
[4]Assistant Professor/CSE,PSN College of Engineering and Technology,Tirunelveli,India
[5]CSE Student,PSN College of Engineering and Technology, Tirunelveli, India

Abstract:
The coronavirus-2 virus, which was discovered in 2019, is a serious disease that has the potential to result in bothrespiratory distress failure and death. Research has been done looking at how the sickness caused by coronavirus-2affects the respiratory system. The purpose of this study is to create a portable device that is capable of providingaccurate and affordable monitoring of respiratory function. Persons infected with COVID-19 as well as healthyindividuals have had the hardware installed on their computers. The purpose of the research is to look for anomaliesinthesetsofdatathatmaybeusedtomakeestimatesontherateofrespiration.

Keywords: coronavirus-2, COVID-19,sickness,

Published in IJIRMPS (E-ISSN: 2349-7300), Volume 11, Issue 2, March-April 2023

Introductions:
Asignificantnumberofpatientsarehesitanttoself-reporttheirillnessesbecauseoftheepidemicphaseofCOVID-19. Because of this, hospitals and critical care units are suffering from a scarcity of employees and crucial pieces ofequipment. In addition to this, it has compelled the creation of innovative strategies for the monitoring of patientsremotely. The patient's resting rate may be used as a diagnostic and triage tool, as well as a means of determiningwhether or not they have COVID-19. Additionally, meeting this requirement is necessary in order to be admitted tothe critical care unit. A majority of the time, people who have been afflicted by the COVID-19 respiratory orbreathing problem need to have mechanical ventilation in order to prevent further impairment of respiratory muscledegradation,gasexchange, anddeath[7].

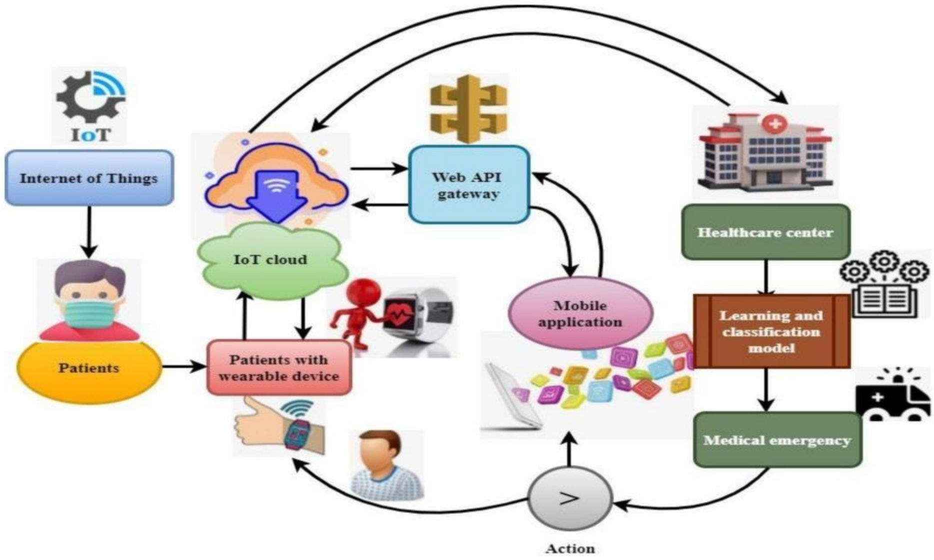

Figure1:Automatedloggingofvasculardatausingseveralmonitoringtechnologies

PatientsdiagnosedwithCOVID-19haveexpressedawishtomakeuseofsuchequipmentinordertogetaidwiththe skills that enable remote R.R. Control. As shown in Figure 1(A), the technology of a smart device equipped withan internal camera is utilized for the tracking of respiratory rate (R.R), which can be caused by vibrations under thechestwallsoftherespiratorysystemorinconsequentialvariationsunderaparticipant'srestingfacialinterjection. The technology of smart devices equipped with an internal microphone, as shown in Figure 1(B), may be used tocapture respiratory sounds, such as a patient's breathing noises. Figure 1(C) is a representation of the constant R.R.monitoring,whichusesamechanizedfutontocapturethepatient'schestwallmotionswhenthepatientisexperiencing breathing-related concerns. The movements of the chest wall under the blood oxygenation modulationwere displayed in Figure 1(D), which was used for transmitting the signals via radio wave transmissions or Wi-FisignalsourceandreceiversinordertodetermineR.R.values(nobodysensorsareneeded)[7].

Related Works:

The literature describes a handheld device that can monitor a person's breathing rate by using a microprocessor withalowpowerconsumption.Themethodthatthecomputeremploystodetectmotioniscalledmotionsensing,anditis drivenbyareducedMOSFET. Oneadditionaluseforthedeviceis long-termmonitoring[1-2].

M. R. Ambedkar and S. Prabhu, who are bothauthors, were the ones who proposed the novel strategy [3]. AnEEMD technique is offered in order to separate the essential information about the respiratory system from the Ecgsignals. This method works particularly effectively with mobile or non-stationary signs. According to the findings ofthis research, the EEMD approach yields outcomes that are much superior than those achieved utilizing the EMDmethodology. The EEMD gadget was able to capture accurate images of the respiratory system. In 97% of cases, themethod provides correct results. As a consequence, one conclusion that can be drawn from the findings of theexperimentisthatEEMDdoeshaveahigheroperationalrangethanEMDdoes.Inaddition,theproposedmethod [5]wasmodeledinMATLABusingtheR2013 versionofthesoftware.

Methodology

There are a few different methods that may be used in order to compute or evaluate the respiration rate. The cheststrap,which is adevice that includes impedance-basedpneumographic equipment, is the one that isused themajority of the time. The capnograph is a device that is often used in medical settings to detect the rate of breathing.Plethysmography is an additional approach that has been suggested for assessing the rate of respiratory activity. Tocomputethedisplacementofthediaphragm,mechanicalequipmentsuchasaforcesensor,magnetometer,barometer, gas pressure sensor, and so on are often utilized. An ECG waveform analysis or a photoplethysmogrammay be used in order to ascertain the rate of the subject's respiration. However, the accuracy achieved by many ofthese approaches is relatively average, and some of them even results in motion-induced susceptibility. The topic oftelecommunication is the most important and crucial field for treatment employing such technologies for dealingwith affected individuals spread across a broad geographic region. This is because telemedicine allows forpatientsto be treated regardless of their location. Through the use of telemedicine technology, a physician may treat a patientwhoislocatedinanotherregion.

Inthisstudy,aMEMSaccelerometerisusedtocalculateaccelerationinthreedifferentdirectionsthatareorthogonal to one another (using a non-contact device, such as X, Y, and Z). In addition, the ADXL335 sensor has aBluetooth device and a triaxial accelerometer integrated into it. These features allow the sensor to control excitationsforeachsituationwheneverthereisadifficultyintryingtomeasureaccelerationsduetothelackofaccessibilityofasmallzonethatallthreeaccelerometerscannotreach.

Buildinga DAQdevice:

The recommended gear includes embedded processors, which are utilized to retrieve breathing data from healthypeople as well as patients afflicted with COVID19. The Arduino Microcontroller module was selected because of itssmall size. It also combines the necessary hardware, which consists of a 433MHz range wireless transmitter as wellas reception, and an accelerometer. A data gathering system is broken down into its component parts and shown inFigure2.Configuringwiththecharacteristicsassociatedwith ADXL335inordertogetamonolithicthree-axial accelerometer. Its architecture, which is open-loop, makes it possible to employ a variety of analog and digitalsignals.Tilt-sensingappsareanotherpossibleuseforthegadget.

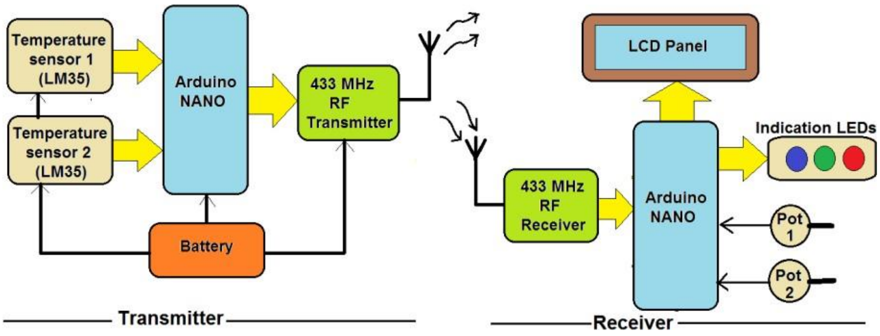

Fig2:WDAQtransmitterandReceiverBlockdiagram

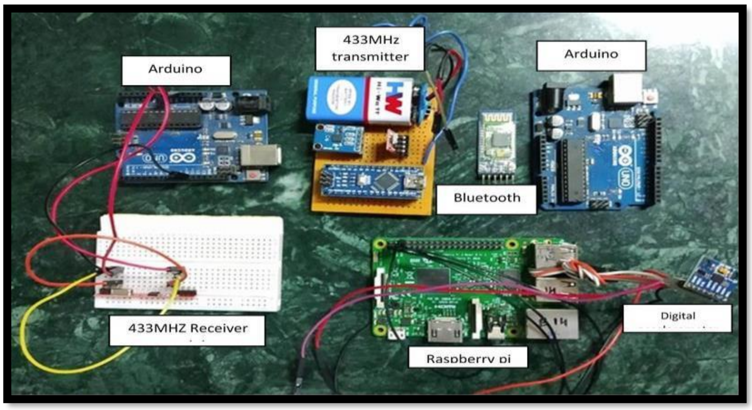

Fig3: WDAQtransmitterandReceiverAssembler

When the ADXL335 accelerometer is connected to the standardized system that is integrated to the fronts of unwellpersons, the Microcontroller Board is used for analyzing the sensor data. In addition, the PLXDAQ software iscapable of receiving data from the serial display of the Arduino IDE and then sending that data to a local laptop. TheCSV files are where the results of the PLXDAQ program's analysis are saved. The project's objective is to combinethe two large datasets that are currently accessible. In this case, the first data set contains information on healthyindividuals, whereas the subsequent data set focuses on those who have been afflicted. After that, a number ofmethods areusedinordertocomparethedatasetsforthestandardandtheafflictedpopulations.[6]

Implementation:

ThecircuitfortheADXL335accelerometerissimple,anditdoesnotinvolvetheuseofanycomplicatedcomponents or wiring. It allows for a direct connection to an Arduino. The following is a list of the procedures thatneedtobetakeninorderto attachanArduinoUnotoanADXL335accelerometer:Connectthe5VpinofArduinoto the VCC pin, the GND pin to the ground pin, and the analogue pins of Arduino to the data outputs along the axisof X, Y, and Z in the order of A0, A1, and A2. Additionally, the X, Y, and Z axes create an equal voltage thatrepresents the analogue value, and they are associated with the calculation of acceleration that is done using theADXL335. The analog-to-digital converter, or ADC, may be used by microcontrollers to transform voltages intodigital signals that can subsequently be processed. Both the transmitter and receiver for the Bluetooth modules433MHzR.F.areincludedinto theArduino[10].UtilizethesoftwareknownastheParallaxDataAcquisitionTool (PLX-DAQ) package to establish a connection between Excel and the Arduino. It is possible to connect to it insidethe Microsoft Excel platform in the form of a free add-on service. Aged eight and eleven years old combinedInstallationofArduino'ssoftwareandhardwareisrequiredbeforeitispossibletoconnectArduinotoExcel. This isa prerequisite for linking Arduino to Excel (IDE). After the code for the Arduino has been uploaded, go to thespreadsheet icon on the PLX-DAQ. After that, choose the Arduino interface from the drop-down menu, identify it intheboxlabeledDownloadData,andclickontheLinkbutton.Thesubsequentstepwillincludetheincorporationofal inegraphintotheunderstandingofthechartingofreal-timeexecution.

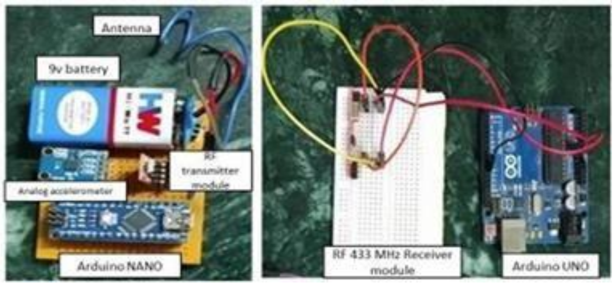

Fig4:DAQTransmitterandReceiverModule

It is important to make use of a mobile application, which will be positioned over the belly, in order to collect thedata from the accelerometer sensor. Additionally, the application permits recording from many sensors at once.When integrated in Figure 6, it offers a comprehensive perspective of the numerous operations that are carried outbythesensors.

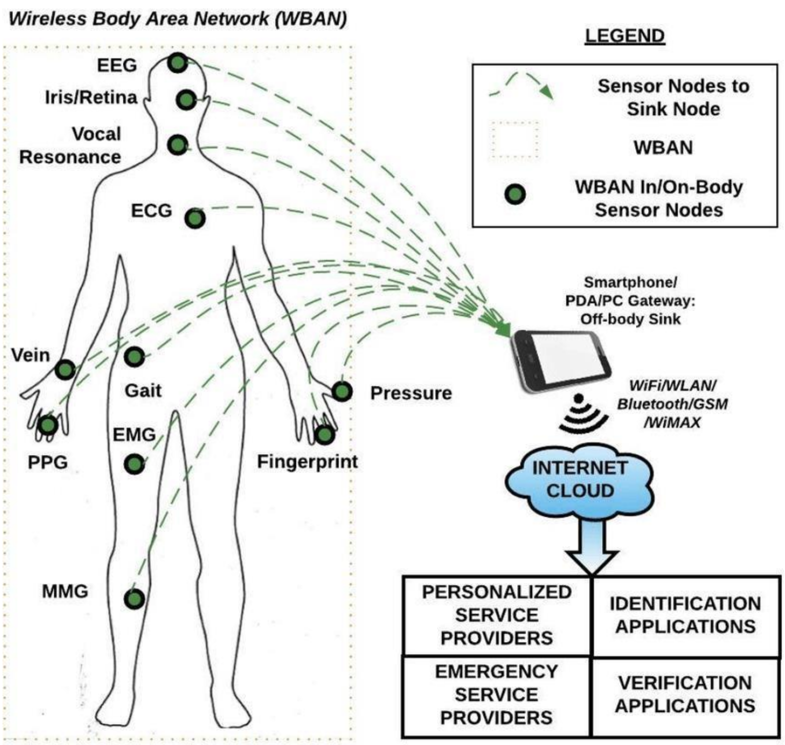

Fig5:MappinginrealtimeoftheTxandRxmodules

Utilizationofsensordataisverynecessaryinordertoconstructasystemthatiscapableofdeterminingtheirregularities thatarepresentinthedata.Theuseofunsupervisedlearningstrategieswouldbethesolutiontothis problem given that the data being used is both real-time and natural. Mpreover, the data that is provided does nothave labels attached to it. The purpose of this project is to develop a strategy for determining if the results includeany peculiarities or not. In the event that an irregularity is found, the study will define the health state of theindividual whose data is being researched. On the target data, the project makes use of a One-Class SVM analysisapproach. When compared with data that has not been labeled, the performance of an algorithm that does not getsupervision is much enhanced. Finding the judgment surface across the data is accomplished via the use of the one-class approach.

ResultsDiscussions:

A three-axis accelerometer and a microprocessor incorporated onto a single circuit are used to gather and analyzerespiration data. After then, an analysis using a method known as machine learning may be performed on the data inordertofindaberrantpatterns.

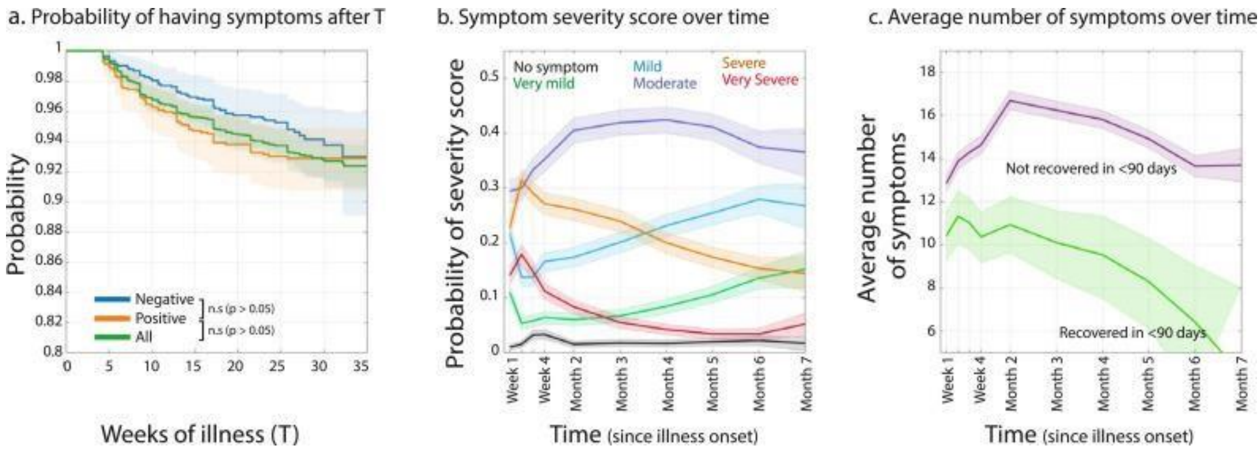

Fig 6:Normalindividualand Covid patientdataalongallthreeaxes(X,Y &Z)

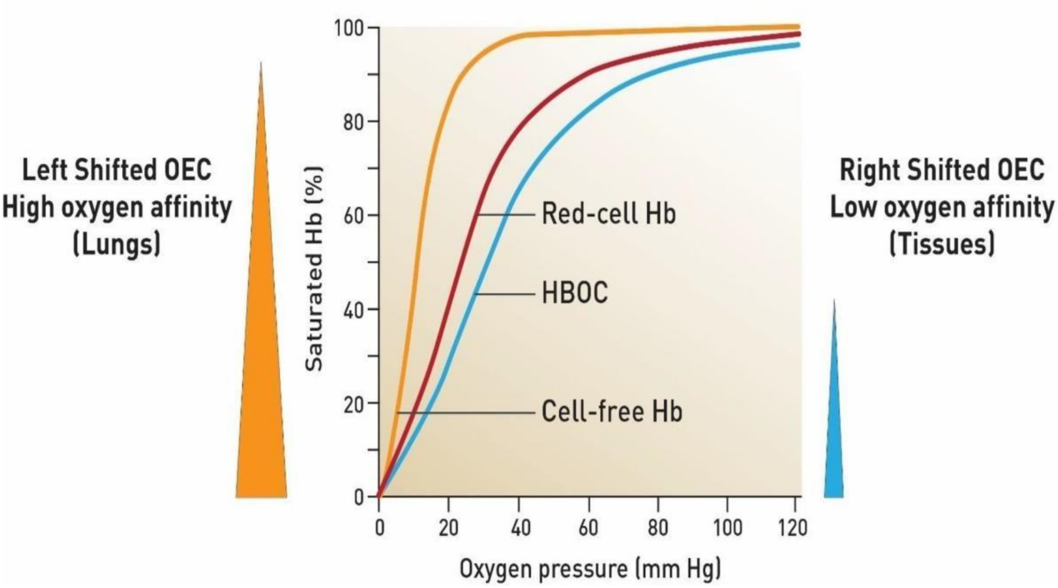

Fig7:Informationgathered fromCovid patients'sensorsintheexistenceandabsenceofoxygen

It is necessary to compare the data from an accelerometer with the data from the intended hardware of a mobilephonein ordertovalidatethefunctioningofboth thesensorandtheindividualbeingtracked.Inaddition,thestaticalanalysis reveals that the data along the x-axis have achieved a higher quality than those along the other axes. Thiswas discovered.

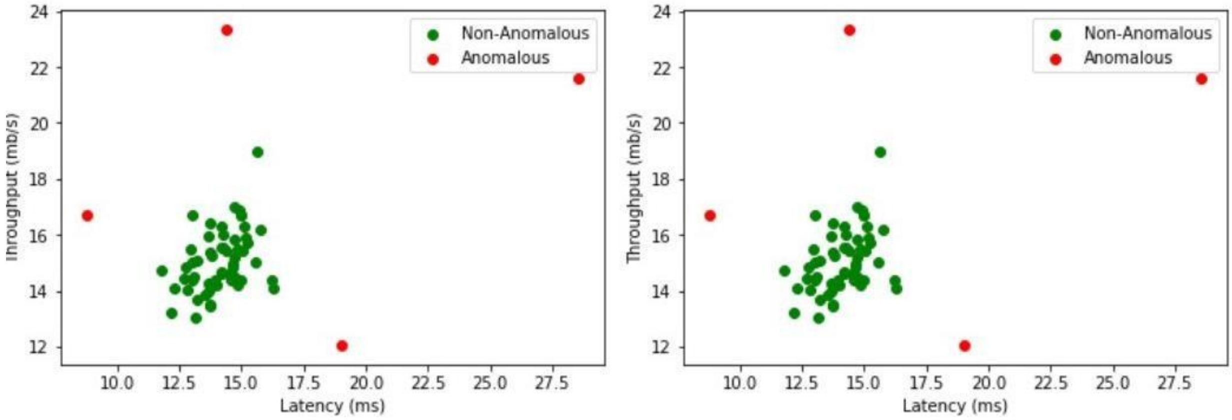

Fig8:Analyzing discrepanciesbetween twodatasetsusingascatter plot

The one-class support vector machine (SVM) approach is a popular paradigm for coughing data analysis. Python isthe programming language that is used to construct an anomaly detection method that is data-driven and learns fromits experiences.It creates graphplots that include red lines to show departures from the norm. This projectis tomake use of the concept of telemedicine in order to develop an online application that enables a patient and aphysician to have a consultation over the internet [4]. It is clear that each individual patient must allow their ownaccount inside the framework of the online web application in order to access their report and the prescription thattheir doctor has given them. Then, after the patient has been chosen, the administrator who is holding the patient'sinformation directs the network program with recorded reports to the doctor, who then downloads the medication tothe patient's computer. As a consequence of this, real-time data monitoring provides medical professionals with anaidinaccuratelyidentifyingpatients priortothedeteriorationoftheirconditions [8, 9].

Conclusions:

It is anticipated that the use of precision remote patient monitoring will play a significant role in the response to theCOVID-19 pandemic era. This device may assist reduce the amount of time that COVID-19 patients spend inisolation and increase the level of medical treatment that is accessible to them. Using data collected in real time frompatients' blood, the purpose of this project is to devise a strategy for lowering the risk of infections occurring inhospitals. Additionally, the constructionof reliable diagnostic and prognostic models would be made possible viathe use of this technology. The data also suggested that remote R.R. monitoring is very useful for identifyingCOVID-19 occurrences as well as other important aspects. Nevertheless, the appropriate instruments and methodsmusttobeusedtoaccomplishthisobjective.

References:

1. PreejithSpi,AhamedJeeJanil,PareshManiyarl,JayarajJosephlandMohanasankSivaprakasam"Accelerometer Based System for Continuous Respiratory Rate Monitoring" IEEE Instrumentation MeasurementSociety2017
2. S. Fleming et al., "Normal ranges of heart rate and respiratory rate in children from birth to 18 years of age:asystematicreviewofobservationalstudies,"TheLancet,vol.377,no.9770, pp.1011-1018,Mar. 2011.
3. M. R. Ambekar and S. Prabhu, "A Novel Algorithm to Obtain Respiratory Rate from the PPG Signal,"InternationalJournalofComputerApplications,vol.126, no. 15, 2015.
4. AndrewBates,MartinLing,ChristianGengy,AliceTurkyandD.K.Arvind"Accelerometer-basedrespiratorymeasurementduringspeech"2011InternationalConferenceonBodySensorNetworks
5. P.D. HUNG1,2, S. BONNET1, R. GUILLEMAUD1, E. CASTELLI2, P. T. N.YEN2 "Estimation

ofrespiratorywaveformusingan accelerometer"IEEEInternationalSymposiumonBiomedicalImagingJune2008.

6. Dusarlapudi, K., Narasimha Raju, K., "Embedded prototype of 3 DOF parallel manipulator for endoscopeapplication using 3 axis MEMS accelerometer", Journal of Advanced Research in Dynamical and Control Systems,Vol12, issue2,1225-35, Mar2020.
7. UdayKiran,K.,Shakeela,S.,Kalyan,D.,...SaiChaitanya,G.,EkanathReddy,G.,Detectionofabnormalities in covid-19 infected human respiratory system using accelerometer with the aid of machine learning,InternationalJournalofPharmaceuticalResearch,2020, 12(4),pp. 3399–3407.
8. Preeti,M.,Guha,K.,Baishnab,K.L.,Dusarlapudi,K., NarasimhaRaju,K.,Lowfrequency MEMSaccelerometersinhealthmonitoring–Areviewbasedonmaterialanddesignaspects,MaterialsToday:Proceedings,2019, 18, pp. 2152–2157.
9. Narayana,M.V.,Dusarlapudi,K.,UdayKiran,K.,SakthiKumar,B.,IoTbasedrealtimeneonatemonitoringsystemusingArduino,JournalofAdvancedResearchinDynamicalandControlSystems,2017,9(Specialissue14),pp. 1764–1772.
10. Kalyan Dusarlapudi, K Narasimha Raju, Preeti M, ASCS Sastry, Genesis of MEMS Accelerometers forSelecttheOptimalAccelerometerforBioApplications,InternationalJournalofInnovativeTechnologyandExploringEngineering,2019, Volume-9Issue-2,December2019
11. Lekshmi Kalinathan, Ruba Soundar Kathavarayan, “Segmentation of Multiple Nuclei from Non-overlapping Immuno-histochemically Stained Histological Hepatic Images”, Journal of Digital Imaging (2022). https://doi.org/10.1007/s10278-022-00688-7 online first published on August 02, 2022.
12. C.Rajeshkumar, et.al., "SVM based Human Presence and Face Detection System", International Journal of Novel Research and Development, Vol.7, Issue 5, pp.1415-1420.
13. Le Minh Tuan, Le Hoang Son, Hoang Viet Long, L Rajaretnam Priya, K Ruba Soundar, Y Harold Robinson, Raghvendra Kumar, "ITFDS: Channel-aware integrated time and frequency-based downlink LTE scheduling in MANET", Sensors, Vol.20, Issue 12, 2020