

A 3d PRINTED BASED REHABILITATION WEARABLE PORTABLE EXOSKELETON FOR PARKINSON'S PATIENT

Submitted in partial fulfilment of the requirements for the award of

Master of Technology Degree in

Medical Instrumentation

by

VARSHA.N (40440010)



DEPARTMENT OF BIOMEDICAL ENGINEERING

SCHOOL OF BIO AND CHEMICAL ENGINEERING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade "A" by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **VARSHA.N** (Reg. No.40440010) who carried out the project entitled "**A 3d Printed Based Rehabilitation Wearable Portable Exoskeleton for Parkinson's Patient**" under our supervision from **September 2021 to march 2022**.

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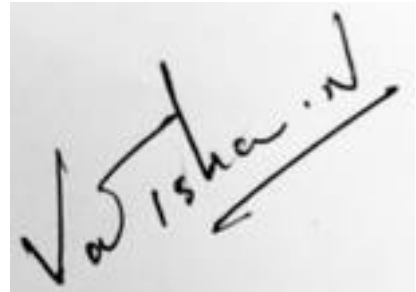
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DECLARATION

I VARSHA.N (40440010) hereby declare that the Project Report entitled “**A 3d Printed Based Rehabilitation Wearable Portable Exoskeleton for Parkinson’s Patient**” done by us under the guidance of **MS. BETHANNEY JANNEY**, M.E., (Ph.D.,) Department of Biomedical Engineering submitted in partial fulfilment of the requirements for the award of **Master of Technology** degree in **Medical Instrumentation**.

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PLACE: Chennai

A handwritten signature in black ink, reading 'Varsha.N', with a long horizontal stroke extending from the end of the name.

SIGNATURE OF THE CANDIDATE

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Abstract

A kind of wearable exoskeleton rehabilitation model is proposed for the dementia in Parkinson's disease (PD) patients with loss of hand function, limited range of motion, and insufficient finger muscle strength to carry out rehabilitation exercise training in a passive or auxiliary way. A novel joint structure based on 3d Printed material is introduced for the design of the device with bionic method, and experiments are conducted to verify the effectiveness of the proposed rehabilitation. A dynamic rehabilitation-training test of the rehabilitation glove was also carried out, and the results showed that the movement frequency of fingers could reach 05 - 08 times/min, which is sufficient for repetitive flexion/extension exercise. In order to verify the grasping characteristics of the device for irregular objects, experiments were carried out. The experimental results showed that the bionic device provided satisfactory result in grasping, which is close to the grasping characteristics of human hands, has the function of assisting daily life (ADL), and meets the requirements of rehabilitation.

KEYWORDS:

3D printed Exoskeleton Hand, Microcontroller, L298N Motor device, LCD display, Input Control Buttons, Parkinson disease, Rehabilitation.

TABLE OF CONTENTS

CHAPTER NO.	TITLE	PAGE NO.
	ABSTRACT	I
	LIST OF ABBREVIATIONS	IV
	LIST OF FIGURES	VI
	LIST OF TABLES	VII
01.	INTRODUCTION	1
	1.1 PARKINSON'S DISEASE	1
	1.2 FOUR MAIN SYMPTOMS	2
	1.3 THE 5 STAGES OF PD	3
	1.4 FOODS TO AVOID	7
	1.5 DEEP BRAIN STIMULATION	9
02.	LITERATURE REVIEW	11
03.	AIM AND SCOPE	14
	3.1 AIM	14
	3.2 EXISTING SYSTEM	14
	3.3 PROPOSED SYSTEM	15
	3.4 SCOPE AND APPLICATION	15
04.	MATERIALS AND METHOD	16
	4.1 HARDWARE COMPONENTS	16
	4.1.1 DC MOTOR	16

4.1.2	L298 MOTOR DRIVE	20
4.1.3	LCD DISPLAY	23
4.1.4	POWER SUPPLY	31
4.1.5	3D PRINTED EXOSKELETON HAND	34
4.2	SOFTWARE DESCRIPTION	35
4.2.1	ARDUINO MEGA 2560	35
4.3	BLOCK DIAGRAM	39
4.4	METHODOLOGY	39
05.	RESULT AND DISCUSSION	40
5.1	RESULTS	40
5.2	DISCUSSION	41
06.	SUMMARY AND CONCLUSION	42
6.1	SUMMARY AND CONCLUSION	42
6.2	FUTURE WORK	42
	REFERENCE	43
	APPENDIX	45

LIST OF ABBREVIATIONS

ABBREVIATIONS	FULL FORM OF ABBREVIATION
PD	PARKINSON'S DISEASE
ADL	ASSISTING DAILY LIFE
BDNF	BRAIN DERIVED NEUROTROPHIC FACTOR
PLA	POLYLACTIC ACID
FFF	FUSED FILAMENT FABRICATION
PVA	POLYVINYL ALCOHOL
RTP	REPETITIVE TASK EXERCISE
LCD	LIQUID CRYSTAL DISPLAY
MAO-B	MONOAMINE OXIDASE TYPE B
COMT	CATECHOL-O-METHYLTRANSFERASE
DBS	DEEP BRAIN STIMULATION
RSA	RIVEST-SHAMIR-ADLEMAN
RSB	REGULATOR OF SIGMA B
DC	DIRECT CURRENT
IC	INTEGRATED CIRCUIT
UV	ULTRAVIOLET
PWM	PULSE WIDTH MODULATION
UARTs	UNIVERSAL ASYNCHRONOUS RECIVER-TRANSMITTER
MHz	MEGAHERTZ
USB	UNIVERSAL SERIAL BUS

ICSP	IN-CIRCUIT SERIAL PROGRAMMING
SRAM	STATIC RANDOM-ACCESS MEMORY
EEPROM	ELECTRICALLY ERASABLE PROGRAMMABLE READ - -ONLY MEMORY
CRT	CATHODE RAY TUBE
DD RAM	DISPLAY DATA RANDOM ACCESS MEMORY
ROM	READ – ONLY MEMORY
CG RAM	CHARACTER GENERATOR RANDOM ACCESS MEMORY
BF	BUSY FLAG

LIST OF FIGURES

FIGURE NO	TITLE	PAGE NO
4.1	DC MOTOR	19
4.2	L289 MOTOR DRIVER	21
4.3	BRIDGES OF MOTOR DRIVER	22
4.4	CURRENT SENSEOR	23
4.5	LCD DISPLAY	31
4.6	BLOCK DIAGRAM OF POWER SUPPLY	33
4.7	CIRCUIT DIAGRAM OF POWER SUPPLY	34
4.8	BLOCK DIAGRAM	39
5.1	PROPOSED HARDWARE MODEL	40
5.2	OUTCOME OF THE RESULT	41

LIST OF TABLES

TABLE NO	TITLE	PAGE NO
4.1	SPECIFICATION OF L298 MOTOR DRIVER	20
4.2	PIN DETAILS OF L298 MOTOR DRIVER	21
4.3	REGISTER SELECTION	28
4.4	THERMAL PROPERTIES OF PLA	35
4.5	MECHANICAL PROPERTY OF PLA	35
4.6	FILAMENT SPECIFICATION OF PLA	35
4.7	SPECIFICATION OF ARDUINO MEGA 2560	36

CHAPTER 1

INTRODUCTION

1.1 PARKINSON'S DISEASE

Parkinson's Disease is one of the most common progressive neurodegenerative disorders, leading to loss of motor function and decreased quality of life. Parkinson's disease is named after James Parkinson who in 1817 wrote a classic "shaking palsy". Parkinson's disease occurs when nerve cells in the basal ganglia, an area of the brain that controls movement, become impaired and/or die. Normally, these nerve cells, or neurons, produce an important brain chemical known as dopamine. When the neurons die or become impaired, they produce less dopamine, which causes the movement problems of Parkinson's. Scientists still do not know what causes cells that produce dopamine to die.

People with Parkinson's also lose the nerve endings that produce norepinephrine, the main chemical messenger of the sympathetic nervous system, which controls many functions of the body, such as heart rate and blood pressure. The loss of norepinephrine might help explain some of the non-movement features of Parkinson's, such as fatigue, irregular blood pressure, decreased movement of food through the digestive tract, and sudden drop in blood pressure when a person stands up from a sitting or lying-down position. Many brain cells of people with Parkinson's contain Lewy bodies, unusual clumps of the protein alpha-synuclein. Scientists are trying to better understand the normal and abnormal functions of alpha-synuclein and its relationship to genetic mutations that impact Parkinson's disease and Lewy body dementia.

Although some cases of Parkinson's appear to be hereditary, and a few can be traced to specific genetic mutations, in most cases the disease occurs randomly and does not seem to run in families. Many researchers now believe that Parkinson's disease results from a combination of genetic factors and environmental factors such as exposure to toxins.

A study showed that exercise can trigger several plasticity-related events in the brain of PD patients, including cortical motor excitement, increasing and decreasing grey matter volume, and altering BDNF levels (Brain Derived Neurotrophic Factor). Parkinson's Disease ranked second for the world's most common chronic progressive neurodegenerative illness after Alzheimer's disease.

Increasing evidence supports the role of exercise in improving both motor and non-motor outcomes in PD. Studies on normal aging have shown that there may be a variety of potential effects of increased exercise capacity, including improved limb strength and flexibility, proprioceptive and postural awareness, neuromuscular coordination and reaction time, performance, and reduced fear of falling.

Tremor is the involuntary oscillatory and rhythmic movement produced by synchronous or alternating contractions of agonist/antagonistic muscles. Tremor can be experienced in the hands, head, trunk, or legs. In PD, tremors can appear in the early stages of the disease and reduce the quality of life by interrupting activities such as reading, writing, and eating. More than 70% of all PD patients experience resting tremors in the course of the disease and their effects tend to be more severe with aging.

1.2 FOUR MAIN SYMPTOMS

- Tremor (trembling) in hands, arms, legs, jaw, or head.
- Stiffness of the limbs and trunk.
- Slowness of movement
- Impaired balance and exercises to strengthen muscles and improve balance.

Tremor is an involuntary oscillation of body part occurring at a slow frequency of 4 to 6 Hz. Resting tremors may also be seen in the forearm, jaw, or tongue. Lower limb tremors are apparent when the patient lies supine. Impaired balance and coordination, sometimes leading to falls other symptoms may include depression and other emotional changes, difficulty swallowing, chewing and speaking, urinary problems or constipation, skin problems and sleep disruptions. Symptoms of Parkinson's and the rate of progression differ among individuals. Sometimes people dismiss early symptoms of Parkinson's as the affects of normal aging. In most cases, there are no

medical tests to definitively detect the disease, so it can be difficult to diagnose accurately.

Early symptoms of Parkinson's disease are subtle and occur gradually. For example, affected people may feel mild tremors or have difficulty getting out of a chair. They may notice that they speak too softly, or that their handwriting is slow and looks cramped or small. Friends or family members may be the first to notice changes in someone with early Parkinson's. They may see that the person's face lacks expression and animation, or that the person does not move an arm or leg normally.

People with Parkinson's often develop a parkinsonian gait that includes a tendency to lean forward, small quick steps as if hurrying forward, and reduced swinging of the arms. They also may have trouble initiating or continuing movement. Symptoms often begin on one side of the body or even in one limb on one side of the body. As the disease progresses, it eventually affects both sides. However, the symptoms may still be more severe on one side than on the other. Many people with Parkinson's note that prior to experiencing stiffness and tremor, they had sleep problems, constipation, decreased ability to smell, and restless legs.

1.3 The 5 STAGES OF PARKINSON'S DISEASE

Stage I: Symptoms at this stage are mild and do not interfere with daily activities.

Stage II: This stage become worse, making daily activities more difficult. The person is, however, able to look after themselves.

Stage III: Symptoms at this stage (mid-stage) are more severe than those of stage II. However, the person is still independent. Loss of balance and bradykinesia (slowness of movements) are the hallmark symptoms of this stage. Daily activities such as eating, bathing and dressing are significantly impaired.

Stage IV: Independent living is almost impossible at this stage due to limitations in daily activities such as eating, bathing, dressing, sleeping, and waking. The person may be able to stand on their own but need assistance for moving around. A walker may help in the movement without falling.

Stage V: Symptoms at this debilitating stage become so severe that even standing on one's own may be impossible. The person becomes bedridden and needs a wheelchair to be moved around.

Several disorders can cause symptoms like those of Parkinson's disease. People with Parkinson's-like symptoms that result from other causes are sometimes said to have parkinsonism. While these disorders initially may be misdiagnosed as Parkinson's, certain medical tests, as well as response to drug treatment, may help to distinguish them from Parkinson's. Since many other diseases have similar features but require different treatments, it is important to make an exact diagnosis as soon as possible. There are currently no blood or laboratory tests to diagnose nongenetic cases of Parkinson's disease. Diagnosis is based on a person's medical history and a neurological examination. Improvement after initiating medication is another important hallmark of Parkinson's disease.

Specific medications such as levodopa and dopamine agonists remain the most effective drugs, at least in early clinical phases. However, after several years of treatment, these therapies decrease their effectiveness and produce side effects such as motor fluctuations and dyskinesias. Both men and women can have Parkinson's disease. However, the disease affects about 50 percent more men than women. One clear risk factor for Parkinson's is age. Although most people with Parkinson's first develop the disease at about age 60, about 5 to 10 percent of people with Parkinson's have "early-onset" disease, which begins before the age of 50. Early-onset forms of Parkinson's are often, but not always, inherited, and some forms have been linked to specific gene mutations.

Although there is no cure for Parkinson's disease, medicines, surgical treatment, and other therapies can often relieve some symptoms. Medicines prescribed for Parkinson's include:

- Drugs that increase the level of dopamine in the brain
- Drugs that affect other brain chemicals in the body
- Drugs that help control nonmotor symptoms

- The main therapy for Parkinson's is levodopa, also called L-dopa. Nerve cells use levodopa to make dopamine to replenish the brain's dwindling supply. Usually, people take levodopa along with another medication called carbidopa. Carbidopa prevents or reduces some of the side effects of levodopa therapy—such as nausea, vomiting, low blood pressure, and restlessness—and reduces the amount of levodopa needed to improve symptoms. People with Parkinson's should never stop taking levodopa without telling their doctor. Suddenly stopping the drug may have serious side effects, such as being unable to move or having difficulty breathing.
- Dopamine agonists

Several dopamine agonists that bind to dopamine receptors in the brain have similar effects to levodopa. These were initially used as a complementary therapy to levodopa for individuals experiencing levodopa complications (on-off fluctuations and dyskinesias); they are now mainly used on their own as first therapy for the motor symptoms of PD with the aim of delaying the initiation of levodopa therapy, thus delaying the onset of levodopa's complications. Dopamine agonists include bromocriptine, pergolide, pramipexole, ropinirole, priribedil, cabergoline, apomorphine, and lisuride.

Though dopamine agonists are less effective than levodopa at controlling PD motor symptoms, they are usually effective enough to manage these symptoms in the first years of treatment. Dyskinesias due to dopamine agonists are rare in younger people who have PD, but along with other complications, become more common with older age at onset. Thus, dopamine agonists are the preferred initial treatment for younger-onset PD, and levodopa is preferred for older-onset PD.

Dopamine agonists produce significant, although usually mild, side effects, including drowsiness, hallucinations, insomnia, nausea, and constipation. Sometimes, side effects appear even at a minimal clinically effective dose, leading the physician to search for a different drug. Agonists have been related to impulse-control disorders (such as compulsive sexual activity, eating, gambling, and shopping) even more strongly than levodopa. They tend to be more expensive than levodopa.

Apomorphine, a dopamine agonist, may be used to reduce off periods and dyskinesia in late PD. It is administered only by intermittent injections or

continuous subcutaneous infusions.¹ Since secondary effects such as confusion and hallucinations are common, individuals receiving apomorphine treatment should be closely monitored. Two dopamine agonists administered through skin patches (lisuride and rotigotine) are useful for people in the initial stages and possibly to control off states in those in advanced states.

➤ MAO-B inhibitors

MAO-B inhibitors (safinamide, selegiline and rasagiline) increase the amount of dopamine in the basal ganglia by inhibiting the activity of monoamine oxidase B, an enzyme that breaks down dopamine. They have been found to help alleviate motor symptoms when used as monotherapy (on their own); when used in conjunction with levodopa, they reduce the time spent in the "off" phase. Selegiline has been shown to delay the need for levodopa commencement, suggesting that it might be neuroprotective and slow the progression of the disease (but this has not been proven). An initial study indicated that selegiline in combination with levodopa increased the risk of death, but this has been refuted.

Common side effects are nausea, dizziness, insomnia, sleepiness, and (in selegiline and rasagiline) orthostatic hypotension. Along with dopamine, MAO-Bs are known to increase serotonin, so care must be taken when used with certain antidepressants due to a potentially dangerous condition known as serotonin syndrome.

➤ COMT inhibitors

During the course of PD, affected people can experience what is known as a "wearing off phenomenon", where they have a recurrence of symptoms after a dose of levodopa, but right before their next dose. Catechol-O-methyltransferase (COMT) is a protein that degrades levodopa before it can cross the blood-brain barrier and these inhibitors allow for more levodopa to cross. They are normally not used in the management of early symptoms, but can be used in conjunction with levodopa/carbidopa when a person is experiencing the "wearing off phenomenon" with their motor symptoms.

Three COMT inhibitors are available to treat adults with PD and end-of-dose motor fluctuations – opicapone, entacapone, and tolcapone. Tolcapone has been available for several years, but its usefulness is limited by possible liver damage

complications, so requires liver-function monitoring. Entacapone and opicapone have not been shown to cause significant alterations to liver function. Licensed preparations of entacapone contain entacapone alone or in combination with carbidopa and levodopa. Opicapone is a once-daily COMT inhibitor

Other medicines used to treat Parkinson's symptoms include:

- Dopamine agonists to mimic the role of dopamine in the brain
- MAO-B inhibitors to slow down an enzyme that breaks down dopamine in the brain
- COMT inhibitors to help break down dopamine
- Amantadine, an old antiviral drug, to reduce involuntary movements
- Anticholinergic drugs to reduce tremors and muscle rigidity

1.4 FOODS TO AVOID

➤ ***High-Protein Foods***

Patient needs to eat protein as part of a balanced diet. However, some people with Parkinson's disease find taking their medication with high-protein foods can make it difficult to absorb the right levels of the medicine to control their symptoms. If patient falls into this category, talk to his or her doctor about how to include protein in the diet. Some seniors may need to decrease the amount of protein they eat, while others may just need to change the timing.

➤ ***Dairy Products***

No one is sure why it happens, but people who eat large amounts of dairy products seem to have a higher risk of developing Parkinson's. Those who have already been diagnosed with the disease can slow its progression by limiting how much dairy they consume. Patient should also choose low-fat options when he or she does consume dairy products such as cheese or milk. If elderly patient has been diagnosed with a serious condition and needs help with tasks like meal preparation, transportation, bathing, and grooming, reach out to Home Care Assistance, a leading

provider of at-home care Amarillo, TX, families can trust. We also offer comprehensive care for seniors with dementia, Alzheimer's, and Parkinson's.

➤ ***Processed Foods***

People with Parkinson's often experience constipation. Processed foods tend to lack fiber, which can make it difficult for older adults to have proper bowel movements. These packaged foods also tend to be high in salt and nitrites, which aren't good for brain health.

➤ ***Hard-To-Chew Foods***

As Parkinson's disease progresses, your loved one might have a difficult time chewing and swallowing food. To prevent choking, you may need to explore new ways to cook healthy foods such as vegetables rather than serving them raw. Stews are a great way to soften both meat and vegetables, and you can also create dishes such as mashed potatoes and pureed carrots to satisfy the patient's nutritional needs. There are a variety of age-related health conditions that can make it more challenging for seniors to live independently. However, many of the challenges they face can be easier to address if their families opt for professional elder care. You can rely on expertly trained caregivers to keep patient's safe and comfortable while aging in place.

➤ ***Salty Foods***

Seniors (patient) need good blood circulation throughout the body to minimize the effects of Parkinson's symptoms. Salty foods, such as chips and canned goods, can lead to issues such as high blood pressure, which can make Parkinson's symptoms worse.

➤ ***Acidic Foods***

The medications prescribed for seniors with Parkinson's disease can sometimes cause nausea as a side effect. Nausea can cause seniors to dread meals, which could be a major impediment to achieving their nutritional goals. Observe patient's symptoms to determine if he or she gets nauseated after meals. If so, you may

want to limit serving acidic foods such as citrus until patient had time to process medication.

1.5 DEEP BRAIN STIMULATION

For people with Parkinson's who do not respond well to medications, deep brain stimulation, or DBS, may be appropriate. DBS is a surgical procedure that surgically implants electrodes into part of the brain and connects them to a small electrical device implanted in the chest. The device and electrodes painlessly stimulate the brain in a way that helps stop many of the movement-related symptoms of Parkinson's, such as tremor, slowness of movement, and rigidity.

The current standard for PD evaluation consists of a clinical examination of patients by a neurology specialist, usually in an ambulatory hospital clinical setting and in sparse visits per year. In these examinations, medication scheme and dosing are adjusted, based on self-reported symptoms and a brief assessment of motor function. Although this method is widely used, the results depend on subjective clinical judgment and the patient's report, potentially compromised by wrong self-perception due to cognitive impairment, making it difficult to accurately monitor the patient's condition and disease progression. Therefore, there is a need for continuous and objective monitoring of motor symptoms in PD to improve the therapeutic regimen and enhance the outcomes of clinical trials.

Other therapies may be used to help with Parkinson's disease symptoms. They include physical, occupational, and speech therapies, which help with gait and voice disorders, tremors and rigidity, and decline in mental functions. Other supportive therapies include a healthy diet and exercises to strengthen muscles and improve balance.

Apart from traditional pharmaceutical treatments, if you have Parkinson's disease, your doctor may recommend vitamins (vitamin- B12, C, D, E and Folate) with antioxidant properties.

Rehabilitation of the hands with a therapist can help restore basic motor function, however intensive physical therapy usually involves the use of repetitive task exercise (RTP), which is inefficient, time-consuming and laborious. Therefore, the rehabilitation needs of such patients will be a huge challenge to the technology. Robotics is being proposed as a solution to assist hand function recovery and is being

used to assist patients with nerve damage in hand rehabilitation training and grasping functions through a wearable driving platform, the robotic exoskeleton system.

Traditional hand exoskeleton is composed of dc motor, rigid connector and other rigid parts, and their stiffness, weight and constraints on joints freedom cause complications. Compared with artificial physiotherapist, rehabilitation robots have many potential advantages: It can provide sustained, accurate and quantitative motor stimulation for the affected limb, the training process is tested and feedback to facilitate system evaluation, multiple training modes, and it is easy to make rehabilitation equipment portable, family-oriented and intelligent, benefiting more patients.

CHAPTER 2

LITERATURE REVIEW

V.A and G.W. JIJl Proposed a technique of Parkinson's disease diagnosis using image processing which is very crucial for management and treatment of the disease. Dopaminergic images such as single photon emission tomography that detect PD. These techniques detect PD at earlier stage till today these images are mostly interpreted by humans which can be server variability and inconsistency.

P. ACTON and NEWBERG proposed for the diagnosis of PD by artificial neural network classifier. This model used 200 SPETC images, 100 of healthy normal and 100 of PD, obtained from Parkinson's marker initiative the area values of ROI WERE DEL FED to the and which is hypothesized to mimic pattern of human observer. The outcome is simple but fast ANN built, could classify the subjects with and without PD with an accuracy of 94% sensitivity.

Andres Ortiz, Jorge Munuel Martinez-Ibanez, et.al. Parkinson's Disease Detection Using Isosurfaces-Based Features and Convolutional Neural Networks (2019) proposed the use of isosurfaces as a way to extract the relevant information from 3D DatSCAN images so that they can be used as inputs of CNN architectures. As a result, a classification system that uses LeNet-based and AlexNet CNN architectures has been implemented. This system achieves accuracy of 95.1% and AUC = 97%, providing comparable (slightly better) values to those obtained for recently proposed systems. It can be concluded, therefore, that the computation of isosurfaces reduces the complexity of the inputs significantly while keeping the relevant information, resulting in high classification accuracies with reduced computational burden. Finally, in order to determine which areas of the input brain images has a greater impact on the predicted output class, saliency maps of the last two-neuron layer are also computed.

Jiajie Peng, Jiaojiao Guan and Xuequn Shang, Predicting Parkinson's Disease Genes Based on Node2vec and Autoencoder (2019) identifying genes associated with Parkinson's disease is of great importance for the treatment of Parkinson's disease. In this article, they present a new algorithm, named N2A-SVM, to predict Parkinson's disease gene. N2A-SVM includes three steps: (1) extracting the vector representation of each gene in the PPI network using node2vec; (2) reducing dimension of the

obtained vector using autoencoder; (3) predicting the genes associated with Parkinson's disease using SVM. They compare N2A-SVM with RWR and distance-based method and prove that N2A-SVM performs better than the compared methods. In addition, used the N2A-SVM algorithm to discover new genes associated with Parkinson's disease. Ten genes most likely to be associated with Parkinson's disease have been proved by literature study.

LIGIASOUSA accuracy of clinical diagnosis of PD biomarkers derived from human voice can offer as PD because of their neuromuscular function. Accuracy of 85% provided by machine learning modules non experts of clinical diagnosis and (79.6% without follow up 83% after following up) post-mortem examinations as truth. Di Pan, Rohit Dhall, et.al, A mobile cloud-based Parkinson's disease assessment system for home-based monitoring (2015) In this project, they sought to design, develop, and evaluate a prototype mobile cloud-based mHealth app, "PD Dr", which collects quantitative and objective information about PD and would enable home-based assessment and monitoring of major PD symptoms. So, they designed and developed a mobile app on the Android platform to collect PD-related motion data using the smartphone 3D accelerometer and to send the data to a cloud service for storage, data processing, and PD symptoms severity estimation. To evaluate this system, data from the system were collected from 40 patients with PD and compared with experts' rating on standardized rating scales. The evaluation showed that PD Dr could effectively capture important motion features that differentiate PD severity and identify critical symptoms. For hand resting tremor detection, the sensitivity was .77 and accuracy was .82. For gait difficulty detection, the sensitivity was .89 and accuracy was .81. In PD severity estimation, the captured motion features also demonstrated strong correlation with PD severity stage, hand resting tremor severity, and gait difficulty. The system is simple to use, user friendly, and economically affordable. The results of this study proved feasibility and a promising future for utilizing mobile technology in PD management.

Catalina Punin, et.al, A Non-Invasive Medical Device for Parkinson's Patients with Episodes of Freezing of Gait (2017), A critical symptom of Parkinson's disease (PD) is the occurrence of Freezing of Gait (FOG), an episodic disorder that causes frequent falls and consequential injuries in PD patients. There are various auditory, visual, tactile, and other types of stimulation interventions that can be used to induce PD

patients to escape FOG episodes. In this article, it described a low-cost wearable system for non-invasive gait monitoring and external delivery of superficial vibratory stimulation to the lower extremities triggered by FOG episodes. The intended purpose is to reduce the duration of the FOG episode, thus allowing prompt resumption of gait to prevent major injuries. The system, based on an Android mobile application, uses a tri-axial accelerometer device for gait data acquisition. Gathered data is processed via a discrete wavelet transform-based algorithm that precisely detects FOG episodes in real time. Detection activates external vibratory stimulation of the legs to reduce FOG time. The use of this developed device helps the patient to move and perform their daily activities without restrictions, and, at the same time, allows their real-time monitoring. In addition, storage of gait data that would help to understand, process and clarify FOG episodes occurs.

The mathematical tool of the DWT is useful to find differences in the acquired signals and to establish thresholds variables that define an episode of FOG, with the possibility of characterizing other types of motor anomalies.

CHAPTER 3

AIM AND SCOPE

3.1 AIM

The aim is to create wearable exoskeleton rehabilitation model for dementia in PD patients to provide grasping characteristics of human hands which has the function of assisting daily life.

3.2 EXISTING SYSTEM

One of the most common concerns in the attention of patients with Parkinson's disease is the difficult to objectively evaluate the illness progress or the treatment efficacy, in terms of tremors intensity and frequency. Patient shakes are produced by the gradual degradation of the pigmented neurons in the brain's substantia nigra. To tackle such problem, this work proposes a Smartphone application for the quantitative detection, measurement and analysis of the Parkinson's tremor.

To achieve this goal, an Android platform was proposed, because it's widespread among Smartphone users, and the low cost of some Android compliant devices. This work covered research aspect about the symptoms of the Parkinson's disease, how to measure them, and the design, development and implementation of an application to get quantitative measurement of Parkinson's symptoms. The idea of the Parkinson Tremor Detection software is to offer an alternative application that could be downloaded by patients or medical staff from the Internet directly into their phones to be used at any moment.

3.3 PROPOSED SYSTEM

In Proposed System, we will be providing solution with rehabilitation method. A novel joint structure based on 3d Printed material is introduced for the design of the device with bionic method, and experiments are conducted to verify the effectiveness of the proposed rehabilitation. A dynamic rehabilitation-training test of the rehabilitation glove was also carried out, and the results showed that the movement frequency of fingers could reach 05 - 08 times/min, which is sufficient for repetitive flexion/extension exercise. In order to verify the grasping characteristics of the device for irregular objects, experiments were carried out. The experimental results showed that the bionic

device provided satisfactory result in grasping, which is close to the grasping characteristics of human hands, has the function of assisting daily life (ADL), and meets the requirements of rehabilitation.

3.3.1 Advantages of Proposed System

- It is portable device
- Light weight and recreate the natural hand movement (rehabilitation movement)
- Individual rehabilitation for each finger, and complete rehabilitation for all the fingers at the same time.
- Wearable
- Simple system (less complexity)

3.4 SCOPE AND APPLICATION

Our Scope of this Project is to develop and fabricate a light weight 3d Printed exoskeleton system which will provide relief to people with Parkinson by helping them with their lost motor controls by using Embedded System Technology.

- Rehabilitation
- Flexibility Revival
- Grasping

CHAPTER 4

MATERIALS AND METHODS

4.1 HARDWARE COMPONENTS

4.1.1 DC motor

A DC motor is any of a class of 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 motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A 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. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight motor used for portable power tools and appliances. Larger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many.

Electromagnetic Motor

A coil of wire with a current running through it generates an electromagnetic field aligned with the center of the coil. The direction and magnitude of the magnetic field produced by the coil can be changed with the direction and magnitude of the current flowing through it.

A simple DC motor has a stationary set of magnets in the stator and an armature with one or more windings of insulated wire wrapped around a soft iron core that concentrates the magnetic field. The windings usually have multiple turns around the core, and in large motors there can be several parallel current paths. The ends of the wire winding are connected to a commutator. The commutator allows each armature coil to be energized in turn and connects the rotating coils with the external power

supply through brushes. (Brushless DC motors have electronics that switch the DC current to each coil on and off and have no brushes.)

The total amount of current sent to the coil, the coil's size and what it's wrapped around dictate the strength of the electromagnetic field created.

The sequence of turning a particular coil on or off dictates what direction the effective electromagnetic fields are pointed. By turning on and off coils in sequence a rotating magnetic field can be created. These rotating magnetic fields interact with the magnetic fields of the magnets (permanent or electromagnets) in the stationary part of the motor (stator) to create a force on the armature which causes it to rotate. In some DC motor designs the stator fields use electromagnets to create their magnetic fields which allow greater control over the motor. At high power levels, DC motors are almost always cooled using forced air.

Different number of stator and armature fields as well as how they are connected provide different inherent speed/torque regulation characteristics. The speed of a DC motor can be controlled by changing the voltage applied to the armature. The introduction of variable resistance in the armature circuit or field circuit allowed speed control. Modern DC motors are often controlled by power electronics systems which adjust the voltage by "chopping" the DC current into on and off cycles which have an effective lower voltage.

Since the series-wound DC motor develops its highest torque at low speed, it is often used in traction applications such as electric locomotives, and trams. The DC motor was the mainstay of electric traction drives on both electric and diesel-electric locomotives, street-cars/trams and diesel electric drilling rigs for many years. The introduction of DC motors and an electrical grid system to run machinery starting in the 1870s started a new second Industrial Revolution. DC motors can operate directly from rechargeable batteries, providing the motive power for the first electric vehicles and today's hybrid cars and electric cars as well as driving a host of cordless tools. Today DC motors are still found in applications as small as toys and disk drives, or in large sizes to operate steel rolling mills and paper machines. Large DC motors with separately excited fields were generally used with winder drives for mine hoists, for high torque as well as smooth speed control using thyristor drives. These are now replaced with large AC motors with variable frequency drives.

If external power is applied to a DC motor it acts as a DC generator, a dynamo. This feature is used to slow down and recharge batteries on hybrid car and electric cars or to return electricity back to the electric grid used on a street car or electric powered train line when they slow down. This process is called regenerative braking on hybrid and electric cars. In diesel electric locomotives they also use their DC motors as generators to slow down but dissipate the energy in resistor stacks. Newer designs are adding large battery packs to recapture some of this energy.

Series Connection

A series DC motor connects the armature and field windings in series with a common D.C. power source. The motor speed varies as a non-linear function of load torque and armature current; current is common to both the stator and rotor yielding current squared (I^2) behavior. A series motor has very high starting torque and is commonly used for starting high inertia loads, such as trains, elevators or hoists. This speed/torque characteristic is useful in applications such as dragline excavators, where the digging tool moves rapidly when unloaded but slowly when carrying a heavy load.

A series motor should never be started at no load. With no mechanical load on the series motor, the current is low, the counter-EMF produced by the field winding is weak, and so the armature must turn faster to produce sufficient counter-EMF to balance the supply voltage. The motor can be damaged by overspeed. This is called a runaway condition.

Series motors called universal motors can be used on alternating current. Since the armature voltage and the field direction reverse at the same time, torque continues to be produced in the same direction. However they run at a lower speed with lower torque on AC supply when compared to DC due to reactance voltage drop in AC which is not present in DC. Since the speed is not related to the line frequency, universal motors can develop higher-than-synchronous speeds, making them lighter than induction motors of the same rated mechanical output. This is a valuable characteristic for hand-held power tools. Universal motors for commercial utility are usually of small capacity, not more than about 1 kW output. However, much larger universal motors were used for electric locomotives, fed by special low-frequency traction power networks to avoid problems with commutation under heavy and varying loads.

Shunt Connection

A shunt DC motor connects the armature and field windings in parallel or shunt with a common D.C. power source. This type of motor has good speed regulation even as the load varies, but does not have the starting torque of a series DC motor. It is typically used for industrial, adjustable speed applications, such as machine tools, winding/unwinding machines and tensioners.

Compound connection

A compound DC motor connects the armature and fields windings in a shunt and a series combination to give it characteristics of both a shunt and a series DC motor. This motor is used when both a high starting torque and good speed regulation is needed. The motor can be connected in two arrangements: cumulatively or differentially. Cumulative compound motors connect the series field to aid the shunt field, which provides higher starting torque but less speed regulation. Differential compound DC motors have good speed regulation and are typically operated at constant speed.

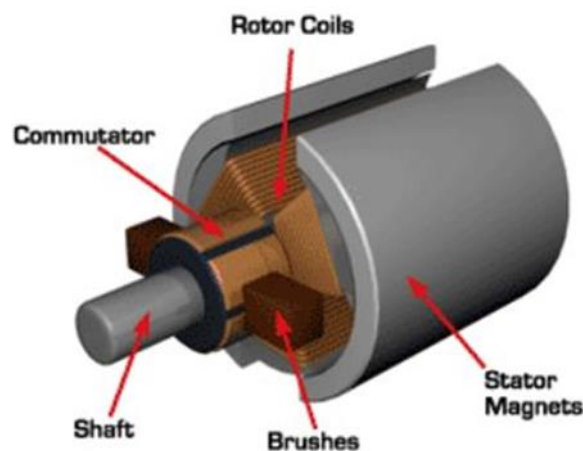


Fig no 4.1 DC Motor

4.1.2 L298 Motor Driver

The L298 Driver is a high voltage, high current dual full bridge driver designed to accept standard TTL logic levels and drive inductive loads such relays, solenoids, DC and stepping motors. Two enable inputs are provided to enable or disable the device independently of the input signals. The emitters of the lower transistors of each bridge are connected the corresponding external terminal can be used for the connection of an external sensing resistor.

➤ FEATURES

- Operating supply voltage up to 46 V
- Total DC current up to 4 A
- Low saturation voltage
- Over temperature protection
- Logical "0" input voltage upto 1.5 V (HIGH NOISE IMMUNITY)
- Two motor direction indicator LEDs
- An onboard user-accessible 5V low-dropout regulator
- Schottky EMF-protection diodes
- Screw-terminals for power and motor connections
- High quality PCB FR4 Grade with FPT Certified

➤ APPLICATION

- MCU controlled vehicle
- Wheel robots

➤ SPECIFICATION

Table 4.1 Specification of L298 Motor Driver

PARAMETER	VALUES
Operating Voltage	Up to 46v
DC Current	4A

➤ PIN DETAILS

Table 4.2 Pin Details of L298 Motor Driver

PIN	NAME	DETAILS
1	Gnd	ground
2	+12v	Power supply input
3	IN1	Direction of motor 1
4	IN2	Direction of motor 1
5	ENA	Controlling motor 1
6	ENB	Controlling motor 2
7	IN3	Direction of motor 2
8	IN4	Direction of motor 2

➤ WORKING

The L298 integrates two power output stages (A, B). The power output stage is a bridge configuration, and its outputs can drive an inductive load in common or differential mode, depending on the state of the inputs. The current that flows through the load comes out from the bridge at the sense output: an external resistor (RSA, RSB.) allows to detect the intensity of this current.



Fig no 4.2 L289 Motor Driver

Input Stage

Each bridge is driven by means of four gates the input of which are In1; In2; EnA and In3; In4; EnB. The In inputs set the bridge state when The En input is high; a low state of the En input inhibits the bridge. All the inputs are TTL compatible. A non-inductive capacitor, usually of 100 nF, must be foreseen between both Vs and Vss, to ground, as near as possible to GND pin. When the large capacitor of the power supply is too far from the IC, a second smaller one must be foreseen near the L298. The sense resistor, not of a wire wound type, must be grounded near the negative pole of Vs that must be near the GND pin of the IC. Each input must be connected to the source of the driving signals by means of a very short path. Turn-On and Turn-Off: Before to Turn-On the Supply Voltage and before to Turn it OFF, the Enable in-put must be driven to the Low state.



Fig no 4.3 Bridges of Motor Driver

Current Sensing

Between this pin and ground is connected the sense resistor to control the current of the load.

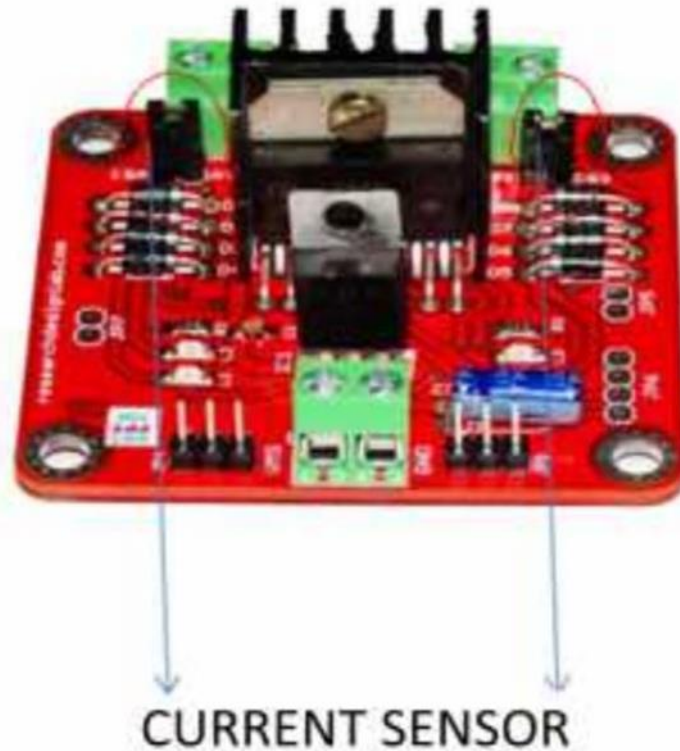


Fig no 4.4 current sensor

4.1.3 LCD Display

Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid but are grouped together in an ordered form like a crystal. An LCD consists of two glass panels, with the liquid crystal material sandwiched in between them. The inner surface of the glass plates is coated with transparent electrodes which define the character, symbols or patterns to be displayed. Polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle.

On each polariser is pasted outside the two glass panels. These polarisers would rotate the light rays passing through them to a definite angle, in a particular direction. When the LCD is in the off state, light rays are rotated by the two polarisers and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent. When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by the polarisers,

which would result in activating / highlighting the desired characters. The LCDs are lightweight with only a few millimetres thickness. Since the LCD's consume less power, they are compatible with low power electronic circuits, and can be powered for long durations. LCDs don't generate light and so light is needed to read the display. By using backlighting, reading is possible in the dark. The LCD's have long life and a wide operating temperature range. Changing the display size or the layout size is relatively simple which makes the LCD's more customer friendly.

The LCDs used exclusively in watches, calculators and measuring instruments are the simple seven-segment displays, having a limited amount of numeric data. The recent advances in technology have resulted in better legibility, more information displaying capability and a wider temperature range. These have resulted in the LCDs being extensively used in telecommunications and entertainment electronics. The LCDs have even started replacing the cathode ray tubes (CRTs) used for the display of text, graphics and also in small TV applications.

Power supply

The power supply should be of +5V, with maximum allowable transients of 10mv. To achieve a better / suitable contrast for the display, the voltage (VL) at pin 3 should be adjusted properly.

A module should not be inserted or removed from a live circuit. The ground terminal of the power supply must be isolated properly so that no voltage is induced in it. The module should be isolated from the other circuits, so that stray voltages are not induced, which could cause a flickering display.

Hardware

- Develop a uniquely decoded 'E' strobe pulse, active high, to accompany each module transaction. Address or control lines can be assigned to drive the RS and R/W inputs.
- Utilize the Host's extended timing mode, if available, when transacting with the module. Use instructions, which prolong the Read and Write or other appropriate data strobes, so as to realize the interface timing requirements.
- If a parallel port is used to drive the RS, R/W and 'E' control lines, setting the 'E' bit simultaneously with RS and R/W would violate the module's set up time.

- A separate instruction should be used to achieve proper interfacing timing requirements.

Mounting

- Cover the display surface with a transparent protective plate, to protect the polarizer.
- Don't touch the display surface with bare hands or any hard materials. This will stain the display area and degrade the insulation between terminals.
- Do not use organic solvents to clean the display panel as these may adversely affect tape or with absorbent cotton and petroleum benzene.
- The processing or even a slight deformation of the claws of the metal frame will have effect on the connection of the output signal and cause an abnormal display.
- Do not damage or modify the pattern wiring or drill attachment holes in the PCB. When assembling the module into another equipment, the space between the module and the fitting plate should have enough height, to avoid causing stress to the module surface.
- Make sure that there is enough space behind the module, to dissipate the heat generated by the ICs while functioning for longer durations. When an electrically powered screwdriver is used to install the module, ground it properly.
- When an electrically powered screwdriver is used to install the module, ground it properly.
- While cleaning by a vacuum cleaner, do not bring the sucking mouth near the module. Static electricity of the electrically powered driver or the vacuum cleaner may destroy the module.

Environmental Precautions

- Operate the LCD module under the relative condition of 40°C and 50% relative humidity. Lower temperature can cause retardation of the blinking speed of the display, while higher temperature makes the overall display discolour.

- When the temperature gets to be within the normal limits, the display will be normal. Polarization degradation, bubble generation or polarizer peel-off may occur with high temperature and humidity.
- Contact with water or oil over a long period of time may cause deformation or colour fading of the display. Condensation on the terminals can cause electro-chemical reaction disrupting the terminal circuit.

Trouble Shooting

- When the power supply is given to the module, with the pin 3 (VL) connected to ground, all the pixels of a character gets activated in the following manner: All the characters of a single line display, as in CDM 16108.
- The first eight characters of a single line display, operated in the two-line display mode, as in CDM 16116.
- The first line of characters of a two-line display as in CDM 16216 and 40216. The first and third line of characters of a four-line display operated in the two-line display mode, as in CDM 20416.
- If the above mentioned does not occur, the module should be initialized by software.
- Make sure that the control signals 'E', R/W and RS are according to the interface timing requirements.

Improper Character Display

- When the characters to be displayed are missing between, the data read/write is too fast. A slower interfacing frequency would rectify the problem.
- When uncertainty is there in the start of the first characters other than the specified ones are rewritten, check the initialization and the software routine.
- In a multi-line display, if the display of characters in the subsequent lines doesn't take place properly, check the DD RAM addresses set for the corresponding display lines.
- When it is unable to display data, even though it is present in the DD RAM, either the display on/off flag is in the off state or the display shift function is not

set properly. When the display shift is done simultaneous with the data write operation, the data may not be visible on the display.

- If a character not found in the font table is displayed, or a character is missing, the CG ROM is faulty and the controller IC have to be changed
- If particular pixels of the characters are missing, or not getting activated properly, there could be an assembling problem in the module.
- In case any other problems are encountered you could send the module to our factory for testing and evaluation.

Crystalonics Display

Crystalonics dot –matrix (alphanumeric) liquid crystal displays are available in TN, STN types, with or without backlight. The use of C-MOS LCD controller and driver ICs result in low power consumption. These modules can be interfaced with a 4-bit or 8-bit microprocessor /Micro controller.

The built-in controller IC has the following features:

- Correspond to high speed MPU interface (2MHz)
- 80 x 8-bit display RAM (80 Characters max)
- 9,920-bit character generator ROM for a total of 240-character fonts. 208-character fonts (5 x 8 dots) 32-character fonts (5 x 10 dots)
- 64 x 8-bit character generator RAM 8-character generator RAM 8-character fonts (5 x 8 dots) 4 characters fonts (5 x 10 dots)
- Programmable duty cycles
1/8 – for one line of 5 x 8 dots with cursor
1/11 – for one line of 5 x 10 dots with cursor
1/16 – for one line of 5 x 8 dots with cursor
- Wide range of instruction functions display clear, cursor home, display on/off, cursor on/off, display character blink, cursor shift, display shift.
- Automatic reset circuit, that initializes the controller / driver ICs after power on.

Registers

The controller IC has two 8-bit registers, an instruction register (IR) and a data register (DR). The IR stores the instruction codes and address information for display data RAM (DD RAM) and character generator RAM (CG RAM). The IR can be written, but not read by the MPU.

The DR temporally stores data to be written to /read from the DD RAM or CG RAM. The data written to DR by the MPU, is automatically written to the DD RAM or CG RAM as an internal operation.

When an address code is written to IR, the data is automatically transferred from the DD RAM or CG RAM to the DR. data transfer between the MPU is then completed when the MPU reads the DR. likewise, for the next MPU read of the DR, data in DD RAM or CG RAM at the address is sent to the DR automatically. Similarly, for the MPU write of the DR, the next DD RAM or CG RAM address is selected for the write operation.

Table 4.3 Register Selection

RS	R/W	OPERATION
0	0	IR write as an internal operation
0	1	Read busy flag (DD7) and address counter (DB0 to DB6)
1	0	DR write as an internal operation (DR TO DD RAM or CG RAM)
1	1	DR read as an internal operation (DD RAM or CG RAM to DR)

Busy Flag

- When the busy flag is 1, the controller is in the internal operation mode, and the next instruction will not be accepted.
- When RS = 0 and R/W = 1, the busy flag is output to DB7.
- The next instruction must be written after ensuring that the busy flag is 0.

Address Counter

The address counter allocates the address for the DD RAM and CG RAM read/write operation when the instruction code for DD RAM address or CG RAM address setting, is input to IR, the address code is transferred from IR to the address counter. After writing/reading the display data to/from the DD RAM or CG RAM, the address counter increments/decrements by one the address, as an internal operation. The data of the address counter is output to DB0 to DB6 while R/W = 1 and RS = 0.

Display Data RAM (DD RAM)

The characters to be displayed are written into the display data RAM (DD RAM), in the form of 8-bit character codes present in the character font table. The extended capacity of the DD RAM is 80 x 8 bits i.e., 80 characters.

Character Generator ROM (CG ROM)

The character generator ROM generates 5 x 8 dot 5 x 10 dot character patterns from 8-bit character codes. It generates 208, 5 x 8 dot character patterns and 32, 5 x 10 dot character patterns.

Character Generator RAM (CG RAM)

In the character generator RAM, the user can rewrite character patterns by program. For 5 x 8 dots, eight-character patterns can be written, and for 5 x 10 dots, four-character patterns can be written.

Interfacing the Microprocessor / Controller

- The module, interfaced to the system, can be treated as RAM input/output, expanded or parallel I/O.

- Since there is no conventional chip select signal, developing a strobe signal for the enable signal (E) and applying appropriate signals to the register select (RS) and read/write (R/W) signals are important.
- The module is selected by gating a decoded module – address with the host – processor's read/write strobe. The resultant signal, applied to the LCDs enable (E) input, clocks in the data.
- The 'E' signal must be a positive going digital strobe, which is active while data and control information are stable and true. The falling edge of the enable signal enables the data / instruction register of the controller. All module timings are referenced to specific edges of the 'E' signal. The 'E' signal is applied only when a specific module transaction is desired.
- The read and write strobes of the host, which provides the 'E' signals, should not be linked to the module's R/W line. An address bit which sets up earlier in the host's machine cycle can be used as R/W.
- When the host processor is so fast that the strobes are too narrow to serve as the 'E' pulse.
 - a) Prolong these pulses by using the host's 'Ready' input.
 - b) Prolong the host by adding wait states.
 - c) Decrease the Hosts Crystal frequency.
- In spite of doing the above mentioned, if the problem continues, latch both the data and control information and then activate the 'E' signal
- When the controller is performing an internal operation, the busy flag (BF) will set and will not accept any instruction. The user should check the busy flag or should provide a delay of approximately 2ms after each instruction.
- The module presents no difficulties while interfacing slower MPUs.
- The liquid crystal display module can be interfaced, either to 4-bit or 8-bit MPUs.
- For 4-bit data interface, the bus lines DB4 to DB7 are used for data transfer, while DB0 to DB3 lines are disabled. The data transfer is complete when the 4-bit data has been transferred twice.
- The busy flag must be checked after the 4-bit data has been transferred twice.
- Two more 4-bit operations then transfer the busy flag and address counter data.
- For 8-bit data interface, all eight-bus lines (DB0 to DB7) are used.

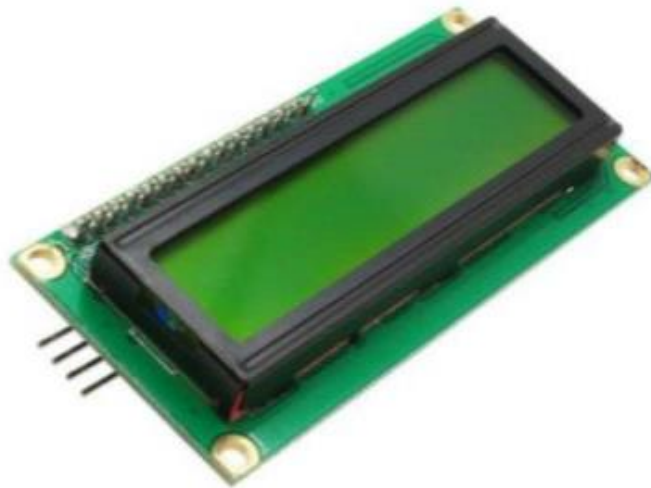


Fig no 4.5 LCD Display

4.1.4 Power supply

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

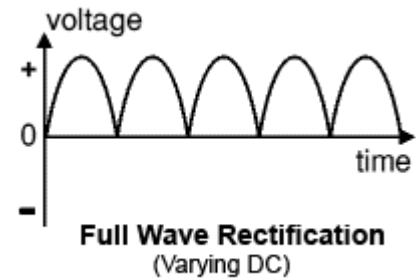
➤ Working Principle

The potential transformer will step down the power supply voltage (0-230V) to (0-15V) level. If the secondary has less turned in the coil, then the primary the secondary coil's voltage will decrease and the current or AMPS will increase or decreased depend upon the wire gauge. This is called a STEP-DOWN transformer. Then the secondary of the potential transformer will be connected to the rectifier.

Bridge Rectifier

When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners. Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4.

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow. The path for current flow is from point B through D1, up through Load, through D3, through the secondary of the transformer back to point B.



One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 and D3. Current flow will now be from point A through D4, up through Load, through D2, through the secondary of transformer, and back to point A. Across D2 and D4. The current flow through Load is always in the same direction. In flowing through Load this current develops a voltage corresponding to that. Since current flows through the load during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional half-wave circuit. This bridge rectifier always drops 1.4Volt of the input voltage because of the diode. We are using 1N4007 PN junction diode, it cut off region is 0.7Volt. So, any two diodes are always conducting, total drop voltage is 1.4 volt.

Filter

If a Capacitor is added in parallel with the load resistor of a Rectifier to form a simple Filter Circuit, the output of the Rectifier will be transformed into a more stable DC Voltage. At first, the capacitor is charged to the peak value of the rectified Waveform. Beyond the peak, the capacitor is discharged through the load resistor until

the time at which the rectified voltage exceeds the capacitor voltage. Then the capacitor is charged again, and the process repeats itself.

IC voltage regulators

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. A fixed three-terminal voltage regulator has an unregulated dc input voltage, it is applied to one input terminal, a regulated dc output voltage from a third terminal, with the second terminal connected to ground. The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts.

This is a regulated power supply circuit using the 78xx IC series. These regulators can deliver current around 1A to 1.5A at a fix voltage levels. The common regulated voltages are 5V, 6V, 8V, 9V, 10V, 12V, 15V, 18V, and 24V. It is important to add capacitors across the input and output of the regulator IC to improve the regulation. In this circuit we are using 7812 regulator so it converts variable dc into constant positive 5V power supply. If the input voltage goes to below 14.6Volt means the output also varied. That is why we are using 230/15V step-down transformer. Transformer output is higher than the regulator minimum level input.

Block Diagram



Fig no 4.6 Block Diagram

Circuit Diagram

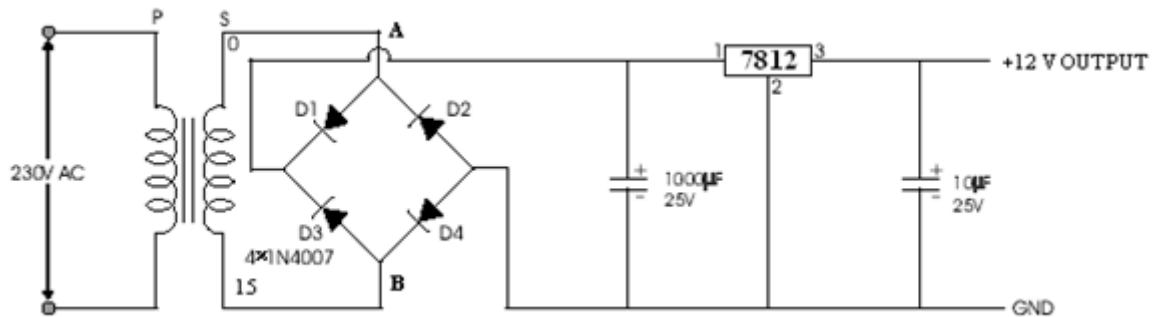


Fig no 4.7 Circuit Diagram of power supply

4.1.5 3D PRINTED EXOSKELETON HAND

PLA (Polylactic Acid) is a biodegradable, sustainable and food safe polymer made from organic sources. It is the most common used filament in FFF 3D printers for its ease of use and a wide range of applications, especially those not mechanically or thermally demanding. A good starting point to learn about the 3D Printing manufacturing process.

➤ Properties

- Detailed and glossy surface quality
- Good tensile strength
- Rigid, fragile behaviour
- Good UV resistance
- Withstand operating temperatures up to 50 °C.
- Odour-free, ideal for educational and office environments
- Compatible with PVA supports
- Low humidity resistance

Thermal Properties

Table 4.4 Thermal Properties of Polylactic acid (PLA)

	Typical value	Test Method
Melting temperature	115±35°C	ISO 11357
Vicat softening temperature	60 °C	ISO 306
Glass transition temp	57 °C	ISO 11357

Mechanical property

Table 4.5 Mechanical Property of Polylactic acid (PLA)

	Typical value	Test method
MFR 210°C/2,16 kg	9,56 gr/10 min	ISO 1133
Tensile strength at yield	70 MPA	ISO 527
Strain at yield	5 %	ISO 527
Strain at break	20 %	ISO 527
Tensile Modulus	3120 MPa	ISO 527
Impact strength-Charpy method 23°C	3.4 kJ/m2	ISO 179
Moisture absorption	1968 ppm	ISO 62

Filament specification

Table 4.6 Filament Specification of Polylactic acid (PLA)

Diameter	Ø 2.85 mm
Max roundness deviation	Ø 2.85 mm
Net filament weight	750 g
Specific gravity (ISO 1183)	1,24 g/cm3

4.2 SOFTWARE USED

4.2.1 Arduino mega 2560

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get

started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

➤ **Specification**

Table 4.7 Specification of Arduino mega 2560

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	54 (of which 14 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	40 mA
Flash Memory	Flash Memory
DC Current per I/O Pin	50 mA
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz

Power

The Arduino Mega2560 can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The Mega2560 differs from all

preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

The power pins are as follows:

- VIN. The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V. The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator or be supplied by USB or another regulated 5V supply.
- 3V3. A 3.3-volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND. Ground pins.

Memory

The ATmega2560 has 256 KB of flash memory for storing code (of which 8 KB is used for the bootloader), 8 KB of SRAM and 4 KB of EEPROM (which can be read and written with the EEPROM library)

Input and output

Each of the 54 digital pins on the Mega can be used as an input or output, using `pinMode()`, `digitalWrite()`, and `digitalRead()` functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- Serial: 0 (RX) and 1 (TX); Serial 1: 19 (RX) and 18 (TX); Serial 2: 17 (RX) and 16 (TX); Serial 3: 15 (RX) and 14 (TX). Used to receive (RX) and transmit (TX) TTL serial data. Pins 0 and 1 are also connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- External Interrupts: 2 (interrupt 0), 3 (interrupt 1), 18 (interrupt 5), 19 (interrupt 4), 20 (interrupt 3), and 21 (interrupt 2). These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the `attachInterrupt()` function for details.
- PWM: 0 to 13. Provide 8-bit PWM output with the `analogWrite()` function.
- SPI: 50 (MISO), 51 (MOSI), 52

(SCK), 53 (SS). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language. The SPI pins are also broken out on the ICSP header, which is physically compatible with the Duemilanove and Diecimila.

LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

I 2C: 20 (SDA) and 21 (SCL). Support I2C (TWI) communication using the Wire library (documentation on the Wiring website). Note that these pins are not in the same location as the I2C pins on the Duemilanove. The Mega2560 has 16 analog inputs, each of which provide 10 bits of resolution (i.e., 1024 different values). By default, they measure from ground to 5 volts, though it is possible to change the upper end of their range using the AREF pin and `analogReference()` function.

There are a couple of other pins on the board:

- AREF. Reference voltage for the analog inputs. Used with `analogReference()`.
- Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

PROGRAMMING

The Arduino Mega2560 can be programmed with the Arduino software (download). For details, see the reference and tutorials. The Atmega2560 on the Arduino Mega comes preburned with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files). You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header; see these instructions for details.

4.3. BLOCK DIAGRAM

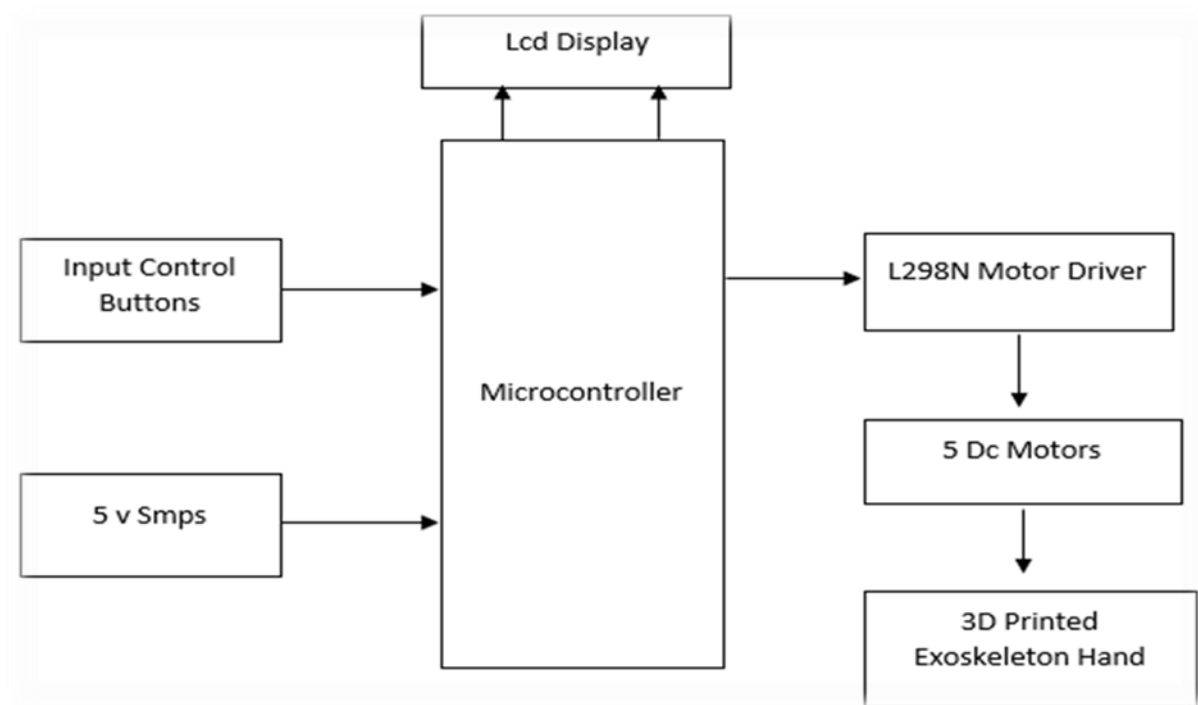


Fig no 4.8 Block diagram

4.4 METHODOLOGY

In our Project we will be using fuzzy logic to implement our concept we are using Arduino microcontroller and dc motors to control the exoskeleton for people with Parkinson disease to implement this module a 3d printed exoskeleton is printed and the whole module is Embedded c Program using Arduino ide software and the dc actuators are controlled using push buttons which were tested, and satisfactory results were found.

CHAPTER 5

RESULT AND DISCUSSION

5.1 RESULTS

The proposed model of a 3D Printed Based Rehabilitation Wearable and Portable Exoskeleton is used for Parkinson's disease with design of the bionic method, which results in the movement frequency of fingers could reach 05-08 times/min for extension exercise, repetitive flexion and also used to grasp the things in daily life.

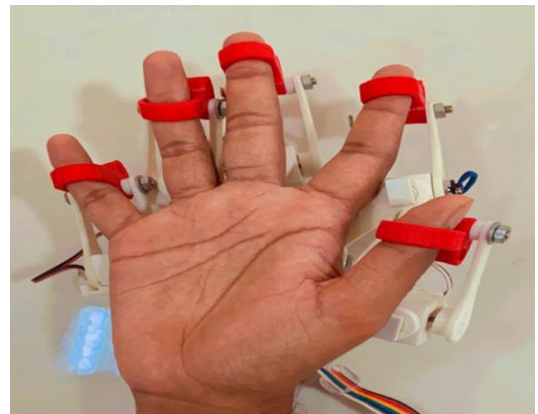
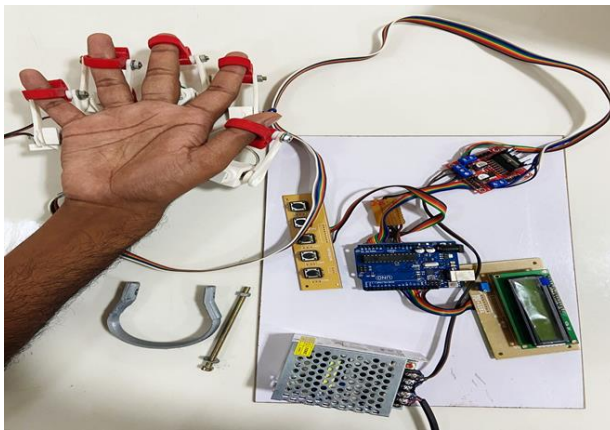
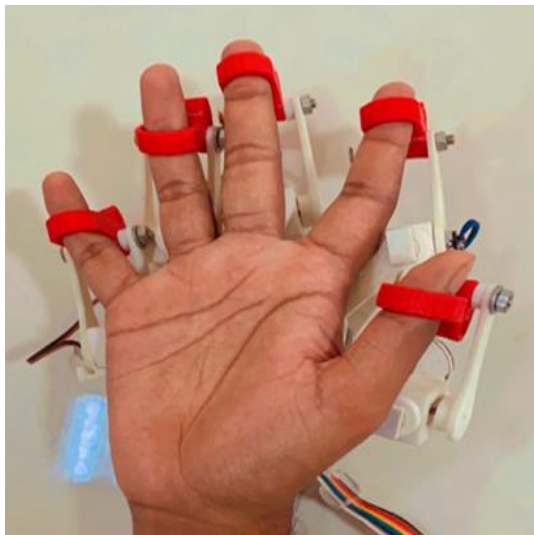
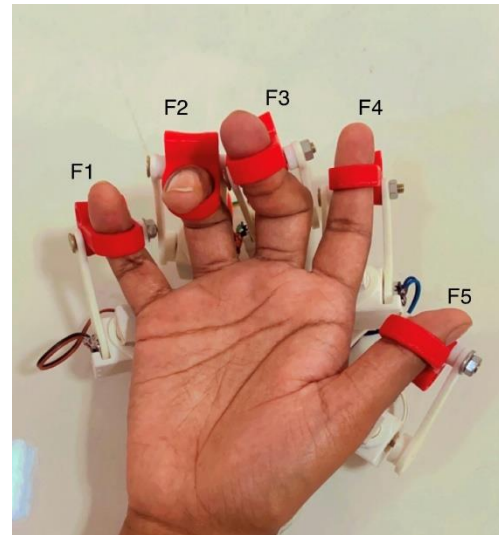


Fig no 5.1 Proposed Hardware Model

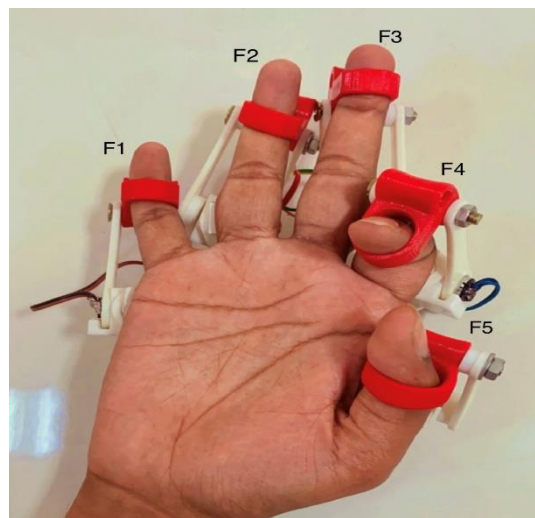
Fig: 5.1: shows the complete hardware of the proposed design. The full hardware components is connected to Arduino board, 12 volt 3 ampere switched mode power supply is used to control and give the power supply for the arduino board. The output 12V is connected to the L298 motor driver which is used to move forward and backward direction of 3D Printed Exoskeleton Fingers. The input connections of motor driver (6 wires) is connected to output of the hand motor and power distributor board is connected with arduino and display.



(a)



(b)



(c)

Fig no 5.2 Outcome of the Result

The F1, F2, F3, F4, F5 are mentioned to each finger. Two L298 motors are used in this device. one motor is connected to F1, F2, F3 and other motor is connected to F4, F5. The figure :5.2: (a) shows the fingers are opened and in rest state. The figure :5.2: (b) F1, F2, F3 are closed but F4, F5 are in open condition. Figure: 5.2: (c) shows F4 and F5 are closed rest of F1, F2, F3, are in open. These open and closed function are controlled by manually using push buttons. In push button CN1, CN3 -open, CN2, CN4 – closed. Through LCD it shows the output.

CHAPTER 6

SUMMARY AND CONCLUSION

6.1 SUMMARY AND CONCLUSION

The main purpose of the project consisted of designing and manufacturing an exoskeleton for patient who suffer from Parkinson's disease. This is used to perform a day to life activities for the Parkinson's disease by themselves. Also, it is strong and conveniently designed. Allows for the possibility of handling it with safety and simplicity. To secure the device to the patient hand, a cuff has been implemented covering the wrist and adjustable making a complete and support. The use of dc motors and the addition of other components make it possible to perform the complete movement. The treatment of Parkinson's disease varies for each person but in most case, it is designed to maintain quality of life. The goal of the project to improve mobility and function.

Finally, and concerning the environment, the used and wasted materials in 3D printing can be completely recycled and can be used to produce new printing filaments.

6.2 FUTURE WORK

This work can be demonstrate vast opportunities to work on the device and can customize the 3D printed Exoskeleton hand for Parkinson's disease patient. It can also design in light weight. Rechargeable battery operating method can be introduced. Should focus on adapting existing therapies to home scenarios, adding further data collection procedures, such as monitoring hand tremors, perhaps with a finger sensor and heart rate variability. These are the future work can be done in this project.

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APPENDICES

```
int in1=2; int in2=3; //pin connections from arduino to dc motor driver
```

```
int in3=4;
```

```
int in4=5;
```

```
void setup()
```

```
{
```

```
  pinMode(in1,OUTPUT);
```

```
  pinMode(in2,OUTPUT);
```

```
  pinMode(in3,OUTPUT);
```

```
  pinMode(in4,OUTPUT);
```

```
}
```

```
void loop()
```

```
{
```

```
  digitalWrite(in1, LOW);
```

```
  digitalWrite(in2,LOW); //motor1 is on and motor2 is off
```

```
  digitalWrite(in3, HIGH);
```

```
  digitalWrite(in4, HIGH);
```

```
  delay(500); // delay of 500ms
```

```
  digitalWrite(in1, HIGH);
```

```
  digitalWrite(in2,HIGH);
```

```
  digitalWrite(in3, LOW); //motor2 is on and motor1 is off
```

```
  digitalWrite(in4, LOW);
```

```
  delay(500); // delay of 500ms
```

```
  digitalWrite(in1, HIGH);
```

```
  digitalWrite(in2,LOW);
```

```
  digitalWrite(in3, HIGH);
```

```
  digitalWrite(in4, LOW);
```

```

delay(500); // delay of 500ms
digitalWrite(in1, LOW);
digitalWrite(in2,HIGH);
digitalWrite(in3, LOW);
digitalWrite(in4, HIGH);
delay(500); // delay of 500ms
digitalWrite(in1, LOW);
digitalWrite(in2,LOW);
digitalWrite(in3, LOW);
digitalWrite(in4, LOW);
delay(500); // delay of 500ms
}

```

```

int E1 = 5;                                //Enable Pin
int IN1 = 3;
int IN2=4;
void setup()
{
  Serial.begin(9600);                      //Set Baud Rate
  pinMode(IN1, OUTPUT);
  pinMode(IN2, OUTPUT);
}
void loop()
{ int value;
for(value = 0 ; value <= 255; value+=5)
{
  digitalWrite(IN1,HIGH);
  digitalWrite(IN2, LOW);
  analogWrite(E1, value);                  //PWM Speed Control
  Serial.println(value);
}
}

```

```

delay(30);
}
}

#include<LiquidCrystal.h>

LiquidCrystal lcd(13, 12, 11, 10, 9, 8);

#define splash splash1

#define key1 A0
#define key2 A1
#define key3 A2
#define key4 A3
#define key5 A4

#define m1 2
#define m2 3
#define m3 4
#define m4 5
#define En 6

int key1_r, key2_r, key3_r, key4_r, key5_r;

int dis_t = 1000;
int disp = dis_t ;

void setup() {
  // put your setup code here, to run once:
  Serial.begin(115200);
  pinMode(m1, OUTPUT);
  pinMode(m2, OUTPUT);
  pinMode(m3, OUTPUT);
  pinMode(m4, OUTPUT);

```

```

digitalWrite(m1, LOW);
digitalWrite(m2, LOW);
digitalWrite(m3, LOW);
digitalWrite(m4, LOW);

LcDSet();
}

void LcDSet()
{
  lcd.begin(16, 2);

  splash(0, "Robotic");
  splash(1, "Hand");

  delay(2000);
  lcd.clear();
}

void loop() {
  // put your main code here, to run repeatedly:
  analogWrite(En, 200);
  key1_r = keys(key1);
  key2_r = keys(key2);
  key3_r = keys(key3);
  key4_r = keys(key4);
  key5_r = keys(key5);

  disp++;

  if (key1_r) {
    digitalWrite(m1, HIGH);

```

```

digitalWrite(m2, LOW);

splash(1, "Open");
}

else if (key2_r) {
    digitalWrite(m2, HIGH);
    digitalWrite(m1, LOW);
    splash(1, "Close");
}
else {
    digitalWrite(m1, LOW);
    digitalWrite(m2, LOW);

}

if (key3_r) {
    digitalWrite(m3, HIGH);
    digitalWrite(m4, LOW);
    splash(1, "Open");
}
else if (key4_r) {
    digitalWrite(m4, HIGH);
    digitalWrite(m3, LOW);
    splash(1, "Close");
}
else {
    digitalWrite(m4, LOW);
    digitalWrite(m3, LOW);

}

```

```
if (disp > dis_t) {  
  
    Serial.print(key1_r);  
    Serial.print(" \t");  
    Serial.print(key2_r);  
    Serial.print(" \t");  
    Serial.print(key3_r);  
    Serial.print(" \t");  
    Serial.print(key4_r);  
    Serial.print(" \t");  
    Serial.print(key5_r);  
    Serial.print(" \t");  
    Serial.println();  
    disp = 0;  
}  
  
}
```