SMART WHEELCHAIR COMPONENT SYSTEM

Project report submitted in fulfillment of the requirement for the degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

By

Kartik Katoch (191020)
Ripunjay Singh Jandrotia (191017)

UNDER THE GUIDANCE OF

Dr. Nishant Jain

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

May 2023

TABLE OF CONTENTS

DECLARATION

We hereby declare that the work reported in the B.Tech Project Report entitled **"Smart Wheelchair Component System"** submitted at **Jaypee University of Information Technology, Waknaghat, India** is an authentic record of our work carried out under the supervision of **Dr. Nishant Jain.** We have not submitted this work elsewhere for any other degree or diploma.

Signature of Student1	Signature of Student2
Kartik Katoch	Ripunjay Singh Jandrotia
191020	191017

This is to certify that the above statement made by the candidates is correct to the best of my knowledge.

Signature of the Supervisor
Dr. Nishant Jain
Date:

Head of the Department/Project Coordinator

ACKNOWLEDGEMENT

It brings me great pleasure to present this project summary for the "Smart Wheelchair Component System" project. We want to express our gratitude to Dr. Nishant Jain, our supervisor, whose oversight and direction allowed us to work on this project. The Department of Electronics and Communication and JUIT have to be commended for offering research facilities. Without the help and collaboration of our supervisor and the other group members, this project cannot be finished. Last but not least, we would like to thank our friends and respondents who assisted with this project directly or indirectly.

LIST OF ACRONYMS AND ABBREVIATIONS

- MSA - Multiple System Atrophy
- ALS – Amyotrophic Lateral Sclerosis
- AD – Alzheimer Disease
- CP - Cerebral Palsy
- C4 – Fourth Cervical Vertebra
- CP - Cerebral Palsy
- o MS - a medical condition known as Multiple Sclerosis
- o PSP - a neurological disorder called Progressive Supranuclear Palsy
- o SCI - damage or injury to the spinal cord known as Spinal Cord Injury
- o TBI - an injury to the brain caused by trauma referred to as Traumatic Brain Injury
- o SWCS - an intelligent component system designed for wheelchairs, called Smart Wheelchair Component System.
- CVA - Cerebrovascular Accident
- PD - Parkinson Disease
- CNS - Central Nervous System

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

The requirements of people with disabilities can be fulfilled with common wheelchairs, but there are some people who find it impossible or difficult to man oeuvre a normal wheelchair. Therefore, a lot of research is being done to develop & " Smart wheelchair" that lessen the physiological, visual, and ability to think needed to operate a regular wheelchair in order to suit this group. Our goal is to create a Smart Wheelchair Component System (SWCS) that can be attached to a wide range of standard wheelchairs from various manufacturers on the market. We tested the wheelchair component system on prototype vehicle for our report.

CHAPTER 1
INTRODUCTION

One thing that everyone wants in their life is to be independent and this goes same for the people with disabilities. Lack of independent movement at any age creates extra barriers in the way of pursuing professional and academic objectives. While many people with disabilities may have their needs met by ordinary wheelchairs, other people with disabilities find it challenging to use a standard wheelchair. This population includes people with low vision, visual field, spasticity, tremors, or cognitive deficits. So our aim is to provide these individuals with a cost efficient smart wheelchair that can be operated easily and independently.

1.1) Approach

We are focused on persons with impairments who have difficulty operating a motorised wheelchair on their own due to symptoms such as impaired vision, reduced cognitive and motor skills, and so on. It is often necessary to use a standard wheelchair for various illnesses, but some symptoms can make it challenging for individuals to operate the wheelchair safely and independently, sometimes. Typically, the percentage of patients with a particular condition who require a wheelchair due to a particular symptom is not readily accessible.

The literature review assumes that symptoms are evenly spread across a particular diagnosis. This suggests that if, for instance, 25% of diagnosed individuals use a wheelchair, and 10% experience symptoms that hinder their ability to operate a wheelchair, then 10% of that 25% who use a wheelchair have that symptom. Additionally, the remaining 75% who do not use a wheelchair may include 10% with symptoms similar to those who use wheelchairs. Consequently, individuals with physical limitations or illnesses that hinder their ability to use a regular wheelchair effectively opt for wheelchairs.

The author utilised the technique of estimating the number of persons who have two or more symptoms and assumed that those who have the most prevalent symptom also have other symptoms.

1.2) Symptoms causing wheelchair use

Various diagnoses where a wheelchair is required and additional symptoms that can cause an individual to not being able to use a wheelchair easily and independently are mentioned in this section as follows:

Alzheimer Disease

In this disease, an abnormal protein is deposited in an individual's brain, affecting brain functions such as language, perception, and motor skills.

Amyotrophic Lateral Sclerosis

Amyotrophic Lateral Sclerosis (ALS) occurs mostly in the individuals who are in their 40s and 50s. It causes muscle weakness which can interfere while driving a wheelchair as a person suffering from ALS gets fatigued easily which makes it impossible to operate a wheelchair continuously for long distances.

Cerebral Palsy

Cerebral Palsy (CP) can occur to a new borne due to a brain injury occuring before full cerebral development in brains. It causes physical and mental dysfunction which further results in deterioration of sensation, cognitive and motor skills.

Cerebrovascular Accident

Cerebrovascular accident(CVA), often known as stroke, is an irregular blood flow to the brain caused by a burst artery.. This results in impaired brain functions like visual field loss, later reaction time etc. All these symptoms interfere with the ability of a person to use a wheelchair.

Multiple Sclerosis

The myelin sheath protecting nerve fibers in the central nervous system is harmed by multiple sclerosis (MS). Within and between individuals, symptoms might change over days or even hours. The location of demyelination in the CNS makes it impossible to predict which motor control problems would manifest first. The following signs and symptoms are pertinent to using a wheelchair: spasticity, tremors, exhaustion, ataxia, and impaired executive functioning.

Multiple System Atrophy

Parkinson's diseaase (PD) is a neurological disorder. is frequently confused with a series of progressive neurodegenerative illnesses known as multiple system astrophy (MSA). Shy-Drager syndrome, striatonigral degeneration, and olivopontocerebellar atrophy were the three categories into which MSA was initially subdivided, but this difference is no longer made. Decreased executive functioning are MSA symptoms that can make it difficult to use an autonomous wheelchair.

Progressive Supranuclear

Progressive supranuclear palsy (PSP), a type of parkinsonian illness, is occasionally mistaken for Parkinson's disease (PD). PSP is characterised by the degeneration of neurons, abnormal protein accumulation, and gliosis in the central nervous system (CNS). Symptoms of PSP include postural instability, repeated falls, supra nuclear gaze palsy, parkinsonism, subcortical dementia, bradykinesia, and axial rigidity. PSP is also associated with visual abnormalities such as slow lateral movements, apraxia of lid opening/closing, spontaneous closure of the eyelid due to orbicularis oculi spasms, and a decrease in blinking frequency.

Progressive Supranuclear Palsy

A parkinsonian illness called progressive supranuclear palsy (PSP) is sometimes confused for Parkinson's disease (PD). Neurodegeneration, gliosis, and aberrant protein buildup in the CNS are features of PSP. PSP's signs and symptoms are postural instability, recurrent falls, , parkinson's , subcortical dementia, loss of balance, and axial rigidity.

Injury to the Spinal Cord Above the Fourth Cervical Vertebra

People who have sustained spinal cord injuries (SCI) at or above the fourth cervical vertebra (C4),manual wheelchair operation is not an option. They may be unable to detect obstructions in front of or behind their wheelchair due to their stiffness or lack of neck movement, which can make it challenging for them to manoeuvre a powered wheelchair.

Paralysis is the loss of muscular function and feeling caused by nervous system injury. It can be caused by a variety of illnesses, including spinal cord damage, stroke, multiple sclerosis, and cerebral palsy. Paralysis can affect one or more limbs, making walking or standing difficult or impossible for the affected individual.

Muscle weakness can result from a number of illnesses, including muscular dystrophy, myasthenia gravis, and other neuromuscular disorders. Muscle weakness can make it difficult to walk or stand for long periods of time, necessitating the use of a wheelchair..

Balance and coordination issues can arise as a result of illnesses such as ataxia, Parkinson's disease, and cerebral palsy. These diseases can impair one's ability to walk with balance and coordination, increasing the danger of falling and making wheelchair use a safer alternative.

Chronic pain can be caused by a variety of illnesses such as arthritis, fibromyalgia, and other chronic pain syndromes. Pain might make it difficult or impossible to walk or stand for long periods of time, necessitating the use of a wheelchair.

Amputation: Traumatic traumas, vascular disease, and other medical disorders can all end in the amputation of one or more limbs. Amputation can make walking difficult without the aid of prosthetics or a wheelchair.

Cardiopulmonary diseases, such as heart failure, chronic obstructive pulmonary disease (COPD), and pulmonary hypertension, can impair oxygenation and circulation, resulting in weariness and shortness of breath. These symptoms might make it difficult to walk or stand for long periods of time, necessitating the use of a wheelchair.

Traumatic injuries, such as spinal cord damage, traumatic brain injury, and fractures, can result in temporary or permanent mobility limitation, necessitating the use of a wheelchair for movement.

Age-related disorders including osteoarthritis and osteoporosis can impair mobility by generating joint discomfort, weakness, and other symptoms. These diseases can make it difficult to walk or stand for long periods of time, necessitating the use of a wheelchair.

Cognitive impairment: Conditions such as Alzheimer's disease and other kinds of dementia can cause cognitive impairment, hindering navigation and making wheelchair usage a safer alternative.

1.3) Disabilities That Affect Mobility On Wheels

The numerous kinds of disabilities that can prevent someone from using a normal or smart wheelchair safely and independently are covered in this section. Regardless of disability, estimates of the number of persons with each type of disability who use a wheelchair are provided.

1.3.1) Physical Impairment involving Upper-Body

When deciding whether a person needs a wheelchair, physical disabilities that affect arm strength or coordination are frequently a deciding factor. Physical restrictions in the upper body may make using a remote controlled wheelchair challenging at times. Physical constraints might make it difficult to react to abrupt or unexpected things, travel for extended periods of time, or perform jobs requiring high coordination involving hand and eye..

Ataxia

A loss of muscle coordination is called ataxia. Ataxia can make it harder for a person to accomplish wheelchair navigational activities that call for quick reflexes or fine motor control. MS and CP are two conditions that can result in ataxia.

Bradykinesia

Bradykinesia is the medical term for diminished movement amplitude or rapidity. Bradykinesia might make it difficult to react to moving obstacles. Diagnoses include MSA, PSP, severe TBI, and PD can cause bradykinesia.

Dystonia

Dystonia is a disorder typified by abnormal postures or movements caused by involuntary muscular spasms. Tasks requiring fine motor control during wheelchair travel can be hampered by dystonia. Dystonia can be caused by MSA and CP diagnoses.

Fatigue or Weakness

The inability of a wheelchair user to react swiftly to a moving or abruptly appearing impediment can result in crashes due to muscle weakness or exhaustion. A wheelchair user may find it challenging to go long distances due to fatigue or weakness. MS, severe TBI, and ALS are three diagnoses that can cause weakness or weariness in the muscles.

Spasticity

Spasticity is a term used to describe a condition in which muscles are constantly tensed, causing stiffness that limits movement. Spasticity in the arms, neck, head, or trunk muscles can make it difficult to manoeuvre a wheelchair. CVA, CP, MSA, MS, and SCI are a few of the illnesses that can cause spasticity.

Tremor

A muscular contraction that is synchronous is referred to as a tremor. While certain types of tremor are only noticeable while the bodypart is resting, others are only noticeable when the affected limb is engaged in fine motor activity (intention tremor). The usage of a wheelchair is unlikely to be hampered by resting tremor. For instance, tremor is also seen in 75 to 85 percent of people with Parkinson's disease, but it usually only occurs while they are resting, preventing it from obstructing their use of a wheelchair. On the other hand, persistent tremor, or intention tremor, might obstruct fine motor control-required navigational activities or result in accidental object collisions.

1.3.2) Cognitive Dysfunction

Whether a wheelchair is powered or manual, using it effectively requires navigational, Organisational and problem-solving ability. Wheelchairs have the potential to endanger the user. and other neighbouring neighbours, requiring emotional and instinctual control. Deficits in cognitive function can result in difficulties planning or memorising a wheelchair navigation course, difficulty focusing on wheelchair navigation or dividing attention between wheelchair navigation and another job, or intentional accidents with objects or people.

Issues with attention, agitation, or impulse control refer to difficulties in focusing, restlessness, and struggles with controlling impulses or urges

Concentration, focus, and mood regulation issues can result from neurological abnormalities. Without these abilities, a wheelchair user may quickly become disoriented, irritated, or confused, which may result in anger or violence. Diagnoses like AD and severe TBI can result in these deficits

Executive reasoning issues

It refers to a set of intellectual abilities, including as judgement, reasoning, planning, solving problems, making decisions, and action sequencing, that are required for goal-directed activity.

One's capacity to successfully manage a wheelchair can be significantly reduced by impaired executive reasoning abilities.

1.3.3) Mobility with wheels and visual impairment

A person's ability to operate a manual or motorised wheelchair may be hampered by a vision impairment in a variety of ways. It may be challenging to detect obstacles or navigational indications when there is a vision impairment, regardless of the underlying clinical illness. The

+

difficulty of navigational tasks that require hand-eye coordination, such navigating a narrow doorway or docking at a table, can also be increased by a visual impairment.

Blindness or limited vision

Limited vision refers to those who have impaired vision but whose eyesight can be rectified to the point that they do not meet the criterion of legal blindness.. Even with corrective lenses, if a person's visual acuity is less than 20/200, they are considered legally blind. It is plainly challenging to use a wheelchair with limited or no functional eyesight. Some people can use a cane or a guiding dog to control a wheelchair, but this help is rarely seen in actual use.

Neck and Head Movement

A person can have vision problems without having any problems with their visual system. People in wheelchairs who have trouble turning their heads run the risk of running into something they can't see. When wheelchair users back up, it's especially crucial to limit head and neck movement since they have trouble seeing objects in the rear of the chair. SCI, ALS, and MS are three diagnoses that

Impaired Eye Movement

Eye movement problems include nystagmus, little eye movement, trouble beginning saccades, and poor postural pursuit. An individual using a wheelchair may have trouble seeing navigational indications or detecting obstacles if their eye movement is impaired. MSA and PSP are two diagnoses that can cause problems with eye movement.

Loss of Visual Field

A constrained or "spotty" perspective of the surroundings is the outcome of visual field loss. Loss of visual field loss in wheelchair users raises the possibility of running into objects or failing to notice essential cues for navigation that are not visible in the entire visual field. Right- or left-hemisphere CVA can cause visual field neglect, among other symptoms.

Neglect of the Visual Field

Neglect of the Visual Field, also known as unilateral neglect or hemi neglect, is a condition in which a person acts as if the disregarded half of his or her surroundings does not exist. Neglect of the visual field causes people to react to stimuli in that area more slowly and to search it for obstacles less frequently. Neglecting one side of the visual field increases the chance that wheelchair users will run into objects or fail to notice crucial navigational cues in that side. Visual field neglect is one of the diagnoses that can follow right-hemisphere CVA, left-hemisphere CVA, or severe TBI.

1.4) Benefits of smart wheelchairs for users:-

- Improved mobility: Smart wheelchairs are meant to assist individuals with mobility issues with increased mobility and freedom.

- Customization: Smart wheelchairs may be tailored to each user's individual needs and preferences, including seat, footrest, and control modifications.

- Assistive technology: To improve safety and functionality, smart wheelchairs can include a variety of assistive technologies such as sensors and GPS.

- Real-time monitoring: Smart wheelchairs can monitor the user's vital signs and other health information in real time, which is important for healthcare professionals and carers.

- Improved safety: To minimise accidents and injuries, smart wheelchairs can include safety functions such as object recognition and collision avoidance.
- Improved posture: Smart wheelchairs may be built to encourage good posture and minimise the chance of developing pressure ulcers or other health problems.

- Easier navigation: Smart wheelchairs can have navigation technologies to assist users in navigating interior and outdoor locations.

- Improved communication: Smart wheelchairs can include communication equipment such as voice synthesisers to enable users speak more successfully with others.

- Less tiredness: Smart wheelchairs may be designed to need less physical effort to use, which can assist decrease fatigue and increase comfort.

- Greater independence: Smart wheelchairs can provide users more independence and control over their movement, which can improve their quality of life.

- Cost-effective: Smart wheelchairs can be more cost-effective in the long run than ordinary wheelchairs because they eliminate the need for extra healthcare services and assistance.

- Improved accessibility: Smart wheelchairs can assist enhance accessibility in public areas and other surroundings, allowing individuals with mobility disabilities to engage in daily activities more easily.

- Lower environmental impact: By adding energy-efficient components and decreasing waste, smart wheelchairs may be built to be more ecologically friendly than standard wheelchairs.

- Innovation: Smart wheelchairs are the result of technology developments and innovation, which can lead to additional improvements in mobility and accessibility for individuals with disabilities.

CHAPTER 2
ANALYSIS

2.1) Types of Wheelchairs for different users

Smart wheelchairs include a wide range of potential features. These abilities are loosely separated into autonomous navigation and obstacle avoidance for this discussion. Our project focuses on the wheelchairs that lie in the 2nd category that is obstacle avoidance.

1. Manual Wheelchairs : Manual wheelchairs are self-propelled, which means that the user moves the chair by pressing the back wheel rims. These are appropriate for people who have enough upper body strength and coordination to operate the chair on their own. Manual wheelchairs are lightweight and simple to operate, making them suitable for daily usage..

2. Electric Wheelchairs: Electric wheelchairs are battery-powered and operated by a joystick or other electronic device. These are appropriate for people who have poor upper body strength or coordination and require movement help. Electric wheelchairs are made for both indoor and outdoor usage, and many versions include adjustable seats and footrests, as well as the option to recline.

3. Transport Wheelchairs: Transport wheelchairs are intended for those who are unable to push themselves and need the aid of a carer or attendant. Because these chairs are lightweight and easy to fold, they are great for travelling in a car or on public transit.

4. Sports Wheelchairs: Sports wheelchairs are developed for those who play sports like basketball, tennis, and rugby. The lower centre of gravity of these chairs increases stability and manoeuvrability. Sports wheelchairs are also lightweight and have unique features like anti-tip bars and adjustable footrests.

5. Paediatric Wheelchairs: Paediatric wheelchairs are built specifically for children and come in a variety of sizes and colours. Footrests and headrests are adjustable on these chairs to accommodate the child's development and comfort. Depending on the child's needs, paediatric wheelchairs might be manual or electric.

6. Bariatric Wheelchairs: Bariatric wheelchairs are intended for those weighing more than 300 pounds. These chairs feature a larger seat and can support more weight than ordinary wheelchairs. There are manual and electric bariatric wheelchairs available.

7. Standing Wheelchair: Standing wheelchairs enable users to transfer their weight and stand up, which can bring health advantages such as increased circulation and muscular tone. These chairs feature specialised frames and mechanisms that allow the user to securely and easily stand up and sit down.

8. Reclining Wheelchair: Reclining wheelchairs feature an adjustable backrest that allows the user to recline and rest comfortably. These chairs are appropriate for those who spend a lot of time in their wheelchair and need to change positions regularly to avoid pressure sores and pain.

Who needs an obstacle-avoiding wheelchair?
An intelligent wheelchair that can avoid obstacles but doesn't help with course planning gives the user more control at the expense of more work from them. Wheelchair users with—

- Visual disabilities who are not able not perceive surroundings but can navigate without using visual signals may find benefit from smart wheelchairs in this group.
- Physical conditions that could temporarily impede their ability to manage the chair.
- Intellectual conditions that make driving risky.

Spina bifida

Individuals with spina bifida may experience varied degrees of paralysis, weakness, and other mobility limitations, making it difficult for them to walk and conduct everyday activities independently. As a result, wheelchairs are used by many persons with spina bifida to increase their mobility and independence.
It is critical for wheelchair users with spina bifida to have a wheelchair that is correctly adjusted to their unique needs and preferences. This can aid in the prevention of pressure ulcers, the improvement of posture, and the enhancement of comfort and mobility. A physical therapist or occupational therapist can help you choose, fit, and train for a wheelchair.
Individuals with spina bifida may benefit from different mobility aids and assistive equipment, such as crutches, canes, walkers, and braces, in addition to utilising a wheelchair. Physical therapy can

help improve strength, flexibility, and coordination, increasing mobility and lowering the risk of falls and other accidents.

A healthy lifestyle, including a balanced diet, frequent exercise, and proper skin care, is equally vital for wheelchair users with spina bifida. This can aid in the prevention of health concerns such as pressure sores, urinary tract infections, and obesity, all of which can have an impact on mobility and general health.

Level of Neural Tube Defect	Muscle Function	Anticiapted Mobility
Group 1 Thoracic High Lumbar	No Quadriceps Function	Household ambulator till approx. 13 years, with use of Hip-Knee-Ankle-Foot-Orthosis (HKAFO) or Reciprocating Gait Orthosis 95%-99% are wheelchair users as adults, although exceptions are seen Manual Wheelchair main form of mobility Power Wheelchair may be used due to impairments such as poor cardiovascular fitness, shoulder pain, severe scoliosis / kyphosis
Group 2 Low Lumbar	• Have Quadriceps Function • Have Medial Hamstring Function • No Gluteus Medius Function • No Gluteus Maximus Function	Ambulation requires ankle-foot orthoses (AFO) and crutches 79% retain community ambulation as adults Most use wheelchairs for long-distance mobility Significant difference in ability to walk between L4 and L3 level Lesions Medial hamstring function is needed for community ambulation
Group 3 High Sacral	• No Gastronemius Function • No Soleus Function	Walks with and without support but uses AFO Braces; Has characteristic gluteus lurch with excessive pelvic obliquity and rotation during gait
Group 3 Low Sacral	• Good Gastrocnemius Function • Good Soleus Function • Normal Gluteus Medius Function • Normal Gluteus Maximus Function	Walks without the need for AFO's; Gait is close to normal

Table 2.1)

Spinal Cord Injury

A spinal cord injury (SCI) occurs when the spinal cord is damaged, often due to a traumatic injury, such as a fall, car accident, or sports injury. Depending on the location and severity of the injury, SCI can cause varying degrees of paralysis, loss of sensation, and other complications.

Many people with SCI use wheelchairs to improve their mobility and independence. Wheelchair selection and fitting are crucial for maximizing comfort, mobility, and function. A physical therapist or occupational therapist can assist with the process of selecting and fitting a wheelchair.

There are different types of wheelchairs available for individuals with SCI, including manual and power wheelchairs. Manual wheelchairs require the user to propel the wheelchair by pushing the wheels with their hands, while power wheelchairs are operated with a joystick or other control device.

In addition to using a wheelchair, individuals with SCI may also benefit from other mobility aids and assistive devices, such as braces, canes, walkers, and standing frames. Physical therapy can help improve strength, flexibility, and coordination, which can also enhance mobility and reduce the risk of falls and other injuries.

It is important for wheelchair users with SCI to maintain a healthy lifestyle, including regular exercise, a balanced diet, and good skin care. This can help prevent health complications, such as pressure sores, urinary tract infections, and obesity, which can affect mobility and overall health.

Level of Injury	Type of Wheelchair Mobility
C1 - C4 Tetraplegia	• mobilize in a chin-control, sip and puff or head array power wheelchair • use attendant operated manual wheelchairs that have been specifically set-up for their needs • are unable to self propel a manual wheelchair
C5 Tetraplegia	• mobilize in a hand-control power wheelchair • can propel a manual wheelchair on flat smooth surfaces with the assistance of adaptive equipment such as plastic push rims and textured gloves, however this is not their main form of mobility • are dependent on an attendant for propelling a manual wheelchair on uneven surfaces and slopes
C6 - C8 Tetraplegia	• mobilize independently in a manual wheelchair over most surfaces and terrains with varying degrees of skill • may find the assistance of adaptive equipment such as plastic push rims and textured gloves useful • mobilize in a hand-control power wheelchair as an alternate form of mobility
T1 - T12 Paraplegia	• mobilize in a manual wheelchair with varying degrees of skill • use power mobility if they are not functional in a manual wheelchair due to impairments such as poor cardiovascular fitness and shoulder pain

Table 2.2)

Muscular Dystrophy

Muscular dystrophy (MD) is a set of hereditary illnesses characterised by increasing muscular weakening and degradation. Many people with MD may require the use of a wheelchair to increase their mobility and independence, depending on the kind of MD and its course.

Individuals with MD who use wheelchairs must have a wheelchair that is adequately adapted to their specific needs and preferences. This can aid in the prevention of pressure ulcers, the improvement of posture, and the enhancement of comfort and mobility. A physical therapist or occupational therapist can help you choose, fit, and train for a wheelchair.

Individuals with MD may benefit from different mobility aids and assistive equipment, such as braces, canes, walkers, and scooters, in addition to utilising a wheelchair. Physical therapy can assist in the maintenance of muscular strength and flexibility, which can improve mobility and minimise the risk of falls and other accidents.

Wheelchair users with MD must also maintain a healthy lifestyle, which includes a balanced diet, frequent exercise, and proper skin care. This can aid in the prevention of health concerns such as pressure sores, respiratory infections, and obesity, all of which can have an impact on mobility and general health. Individuals with MD and their families may also benefit from genetic counselling, as some kinds of MD can be inherited.

Type	Prevalence	Common Symptoms
Duchenne Muscular Dystrophy	1 in 3,500	• Difficulty walking, running or jumping • Difficulty standing up • Learn to speak later than usual • Unable to climb stairs without support • Can have behavioural or learning disabilities
Facio-Scapulo-Humeral Muscular Dystrophy	1 in 7,500	• Sleeping with eyes slightly open • Cannot squeeze eyes shut tightly • Cannot purse their lips
Myotonic Dystrophy	1 in 8000	• Muscle stiffness • Clouding of the lens in the eye • Excessive sleeping or tiredness • Swallowing difficulties • Behavioural and learning disabilities • Slow and irregular heartbeat
Becker Muscular Dystrophy	Varies; 1 in 18,000 – 1 in 31, 000	• Learn to walk later • Experience muscle cramps when exercising
Limb-Girdle Muscular Dystrophy	Estimated to be in a range of 1 in 14,500 – 1 in 123,000	• Muscle weakness in hips, thighs and arms • Loss of muscle mass in these same areas • Back pain • Heart palpitations / irregular heartbeats
Oculopharyngeal Muscular Dystrophy	1-9 in 100,000	• Does not usually appear until age 50-60 • Dropped eyelids • Trouble swallowing • Gradual restriction of eye movement • Limb weakness, especially around shoulders and hips
Emery-Dreifuss Muscular Dystrophy	1 in 100,000	• Develop symptoms in childhood and adolescence • Muscle weakness • Trouble on stairs • Tendency to trip • Slow, irregular heartbeat

Table 2.3)

Cerebral Palsy

Cerebral palsy is a group of disorders that affect movement and muscle tone. Individuals with cerebral palsy may require wheelchairs for mobility. Smart wheelchairs can provide these individuals with a greater degree of independence and freedom. Many smart wheelchairs are equipped with advanced technology that allows users to control the wheelchair with their eyes, mouth, or other movements. This technology can be especially helpful for individuals with cerebral palsy who have limited mobility in their arms or hands.

Multiple Sclerosis

Multiple sclerosis (MS) is a chronic autoimmune disease of the central nerve system. Multiple sclerosis patients may have a variety of symptoms, including muscular weakness, stiffness, and weariness. Smart wheelchairs can give these people with increased independence and freedom. Many smart wheelchairs are outfitted with cutting-edge technology that allows users to steer the wheelchair with their eyes, tongue, or other gestures. Individuals with multiple sclerosis who have limited movement in their arms or hands may benefit most from this device

.

Age Related Disabilities

As individuals age, they may experience a wide range of mobility impairments, including arthritis, Parkinson's disease, and stroke. Smart wheelchairs can provide these individuals with a greater degree of independence and freedom. Many smart wheelchairs are equipped with advanced technology that allows users to control the wheelchair with their eyes, mouth, or other movements. This technology can be especially helpful for individuals with age-related disabilities who have limited mobility in their arms or hands. In addition, many smart wheelchairs are designed to be more comfortable and ergonomic than traditional wheelchairs, which can help reduce pain and discomfort for users.

Tremor

Tremor is a disorder characterised by uncontrollable shaking or trembling of the hands, arms, or legs. Individuals with tremor may struggle to regulate their limb movement, making it difficult to utilise a standard wheelchair. Smart wheelchairs can give these people with increased independence and freedom. Many smart wheelchairs are outfitted with cutting-edge technology that allows users to steer the wheelchair with their eyes, tongue, or other gestures. This technology can be especially beneficial for people who have tremors and have difficulties controlling their wheelchair with their hands or fingers.

Ataxia

Ataxia is a disorder that impairs coordination and balance. Individuals with ataxia may struggle to regulate their limb movement, making it difficult to utilise a typical wheelchair. Smart wheelchairs can give these people with increased independence and freedom. Many smart wheelchairs are outfitted with cutting-edge technology that allows users to steer the wheelchair with their eyes, tongue, or other gestures. This technology can be especially beneficial for those with ataxia who have difficulties controlling their wheelchair with their hands or feet.

Fatigue/Weakness

Weakness is a disorder that impairs muscular strength and makes it difficult to move one's limbs. Individuals with disabilities may find it difficult to utilise a typical wheelchair, which demands substantial upper body power to manoeuvre. Smart wheelchairs can give these people with increased independence and freedom. Many smart wheelchairs are outfitted with cutting-edge technology that allows users to steer the wheelchair with their eyes, tongue, or other gestures. This technology can be especially beneficial for those who have trouble controlling their wheelchairs with their hands or arms.

Potential Smart Wheelchair Users

Diagnosis	Prevalence		% Need Wheelchair		Symptom	% with Symptom		No. Need Smart Wheelchair	
	Lowest Estimate	Highest Estimate	Lowest Estimate	Highest Estimate		Lowest Estimate	Highest Estimate	Lower Boundary	Upper Boundary
AD	2,300,000	4,000,000	15.0	15.0	Executive reasoning	41.0	41.0	141,450	246,000
ALS	25,000	30,000	46.0	80.0	Fatigue/weakness	26.0	26.0	2,990	6,240
CP	750,000	750,000	86.0	86.0	Executive reasoning	30.0	41.0	193,500	264,450
CVA (right-hemisphere)	1,200,000	1,200,000	15.0	25.0	Visual field neglect	13.0	82.0	23,400	246,000
					Visual field loss	20.0	20.0	36,000	60,000
CVA (left-hemisphere)	1,200,000	1,200,000	15.0	25.0	Visual field neglect	0.0	76.0	0	228,000
					Visual field loss	20.0	20.0	36,000	60,000
Legally Blind	1,057,389	1,057,389	9.6	9.6	Blindness	100.0	100.0	101,615	101,615
Low Vision	5,315,541	5,315,541	5.3	5.3	Low vision	100.0	100.0	279,066	279,066
MS	250,000	350,000	69.0	69.0	Fatigue/weakness	43.0	90.0	74,175	217,350
					Executive reasoning	30.0	70.0	51,750	169,050
MSA	5,543	14,602	60.0	60.0	Nystagmus	10.0	37.0	333	3,242
					Restricted down gaze	23.0	23.0	765	2,015
					Executive reasoning	0.5	17.0	17	1,489
PD	894,000	894,000	10.0	10.0	Visual field neglect	90.0	90.0	80,460	80,460
					Executive reasoning	23.0	44.0	20,562	39,336
PSP	4,142	4,142	70.0	70.0	Impaired eye movement	6.0	6.0	174	174
					Executive reasoning	50.0	50.0	1,450	1,450
Severe TBI (AIS 5 or GCS < 9)	530,000	530,000	9.0	9.0	Visual field neglect	45.2	45.2	21,560	21,560
					Fatigue/weakness	37.0	50.0	17,649	23,850
					Executive reasoning	55.0	55.0	26,235	26,235
Total*	—	—	—	—	—	—	—	973,706	1,700,107

Table 2.4)

Potential smart wheelchairs users, organized by symptom.

Symptom	Diagnosis	Prevalence		% Need Wheelchair		% with Symptom	
		Lowest Estimate	Highest Estimate	Lowest Estimate	Highest Estimate	Lowest Estimate	Highest Estimate
Ataxia	CP	750,000	750,000	—	86.0	5.0	10.0
	MS	250,000	350,000	—	69.0	23.0	84.0
	MSA	5,543	14,602	—	60.0	56.0	86.8
Bradykinesia	MSA	5,543	14,602	—	60.0	71.0	97.6
	PD	894,000	894,000	—	10.0	—	12.5
	Severe TBI	530,000	530,000	—	9.0	—	26.0
	PSP	4,142	4,142	—	70.0	22.0	91.0
Dystonia	CP	750,000	750,000	—	86.0	—	17.6
	MSA	5,543	14,602	—	60.0	31.0	43.0
Fatigue/Weakness	ALS	25,000	30,000	46.0	80.0	—	26.0
	Severe TBI	530,000	530,000	—	9.0	37.0	50.0
	MS	250,000	350,000	—	69.0	43.0	90.0
Spasticity	CVA (right-hemisphere)	1,200,000	1,200,000	15.0	25.0	35.0	51.0
	CVA (left-hemisphere)	1,200,000	1,200,000	15.0	25.0	35.0	51.0
	CP	750,000	750,000	—	86.0	70.0	90.0
	SCI (≤C4)	46,000	66,240	—	100.0	12.0	37.0
	MS	250,000	350,000	—	69.0	65.0	90.0
	MSA	5,543	14,602	—	60.0	—	10.0
Tremor	CP	750,000	750,000	—	86.0	10.0	20.0
	MS	250,000	350,000	—	69.0	—	6.0
	MSA	5,543	14,602	—	60.0	52.0	84.3
	PD	894,000	894,000	—	10.0	—	63.0
	Severe TBI	530,000	530,000	—	9.0	—	26.0
	PSP	4,142	4,142	—	70.0	5.0	21.0
Attention, Agitation, & Impulse Control	AD	2,300,000	4,000,000	—	15.0	—	48.0
	Severe TBI	530,000	530,000	—	9.0	23.0	60.0
Executive Reasoning	CP	750,000	750,000	—	86.0	30.0	41.0
	MS	250,000	350,000	—	69.0	30.0	70.0
	MSA	5,543	14,602	—	60.0	0.5	17.0
	AD	2,300,000	4,000,000	—	15.0	—	41.0
	PD	894,000	894,000	—	10.0	23.0	44.0
	Severe TBI	530,000	530,000	—	9.0	—	55.0
	PSP	4,142	4,142	—	70.0	—	50.0
Low Vision	Difficulty seeing	5,315,541	5,315,541	—	5.3	—	100.0
Blindness	Legally blind	1,057,389	1,057,389	—	9.6	—	100.0
Head/Neck Movement	SCI (≥C4)	46,000	66,240	—	100.0	—	100.0
	ALS	25,000	30,000	46.0	80.0	—	26.0
	Severe TBI	530,000	530,000	—	9.0	37.0	50.0
	MS	250,000	350,000	—	69.0	43.0	90.0
Impaired Eye Movement	PSP	4,142	4,142	—	70.0	—	6.0
	MSA	5,543	14,602	—	60.0	10.0	37.0
Visual Field Loss	CVA (right-hemisphere)	1,200,000	1,200,000	15.0	25.0	—	20.0
	CVA (left-hemisphere)	1,200,000	1,200,000	15.0	25.0	—	20.0
Visual Field Neglect	CVA (right-hemisphere)	1,200,000	1,200,000	15.0	25.0	13.0	82.0
	CVA (left-hemisphere)	1,200,000	1,200,000	15.0	25.0	0.0	76.0
	Severe TBI	530,000	530,000	—	9.0	—	45.2
	PD	894,000	894,000	—	10.0	—	90.0

Table 2.5)

CHAPTER 3

SMART WHEELCHAIR COMPONENT SYSTEM

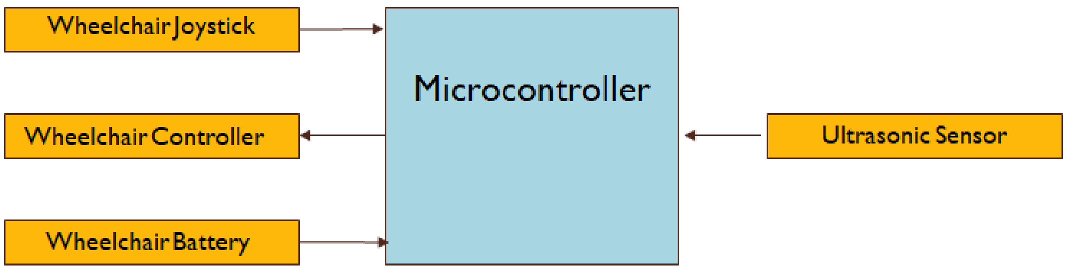
While remote controlled wheelchairs may often meet with the requirements of physically disabled people with disabilities, some disabled people who can't or are not able to utilise a standard wheelchair controlled wheelchaisr. Researchers have created "smart wheelchairs" that require fewer intellectual, auditory, and physical abilities to operate in order to serve this population. These technologies were initially created for mobile robots. We are developing a Smart Wheelchair Component System (SWCS) that will require just modest alterations to be included into a range of commercial motorised wheelchairs, making it cost effective.

3.1) Literature Review

Table 3.1

System	Sensors	Description
Smart Wheelchair component System[1]	Infrared. Ultrasonic, Bumper	Provides obstacle avoidance, which can help people with disabilities who, It is difficult or impossible for them to use a standard wheelchair.
The Intelligent Wheelchair[2]	Vision sensor, infrared sensor, sonar sensor	Was inspired by tin man. Investigating landmark detection for autonomous navigation.
Omni[3]	Ultrasonic, infrared sensor, bump, dead reckoning sensor	Provides task-specific operating modes and obstacle avoidance
Robchair[4]	Ultrasonic, bump infrared	Was inspired by tinman. Aids local residents in avoiding obstacles.

3.2) Block diagram



3.3) Hardware

The Smart Wheelchair Component System (SWCS) consists of sensors, computational hardware (microcontroller), control electronics (motors, batteries, etc).

3.3.1) Sensors

Ultrasonic sensors

These are electronic devices that employ ultrasonic sound waves to measure needed distances before converting those waves into electrical data. When travelling, ultrasonic waves travel faster than audible sound. The transmitter and receiver are the two most important components. The transmitter generates sound, which is subsequently sent to the target and returned to the receiving component.

Distance Calculation:

Distance = 1/2 * Time (sec) * Speed of sound (m/sec^2)

Working Principal:

Similar to sonar and radar, ultrasonic sensors analyse the received echoes of sound or radio waves to determine a target's or item's characteristics. These microphones produce high-frequency sound waves and listen for echoes. The sensors assess the time difference between transmitted and received echoes to calculate the distance to the target.

Sensor used: HC - SR04

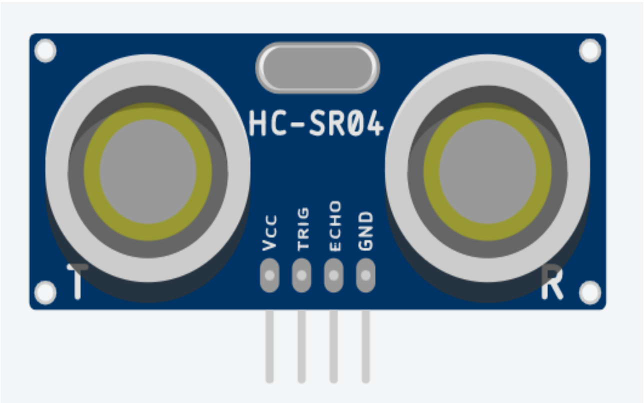


Figure 3.1) HC - SR04

Features

HC-SR04 offers a 2 cm to 400 cm measurement function, can approach 3 mm. The modules come with an ultrasonic receiver, transmitter, and control circuit. The fundamental rule of work:

- Using an IO trigger for a high-level signal of at least 10us.
- It automatically transmits eight pulses at 40 kHz and checks for a pulse response.
- The time between sending and receiving an ultrasonic signal is known as the output IO duration if the signal is returned at a high level.

  Test distance = 1/2 × (time × velocity of sound (340 m/sec))

Connectors

- 5V Vcc
- Trigger
- Echo
- Ground

Electric Parameters

Operative Voltage	5V DC
Operative Current	15 mA
Operative Frequency	40 Hz
Highest Range	400 cm
Lowest Range	2 cm
Assessing Angle	15º
Input Signal of Trigger	10micro sec TTL pulse
Output Signal of Echo	Input TTL lever signal and the range in proportion
Measurements	45×20×15 mm

3.3.2) Microcontroller

A microcontroller is a computer chip used to operate electrical devices and systems. It is a single-chip computer system that incorporates a central processing unit (CPU), memory, input/output (I/O) ports, and other peripherals.

Microcontrollers are widely utilised in applications like as consumer electronics, industrial automation, and robotics. They are often used to operate sensors, motors, displays, and other electronic components.

Microcontrollers' small size and low power consumption are two of its primary features. As a result, they are perfect for usage in tiny and portable devices, as well as systems that require battery power.

Microcontrollers may be programmed using a number of programming languages and tools, including C and Assembly. They may also be programmed with the use of specialised programming environments and software, such as the Arduino or Raspberry Pi.

Microcontrollers provide a variety of benefits over traditional computer systems, in addition to their small size and low power consumption. They may, for example, be customised and modified for individual applications, providing increased flexibility and capability. They may also be combined with other electrical components like sensors and actuators to form complicated systems and devices.

Atmel AVR, Microchip PIC, and Texas Instruments MSP430 are examples of popular microcontroller families. These microcontrollers are widely utilised in a wide range of applications and are well-known for their dependability, flexibility, and usability.

Working:

A microcontroller is integrated into a system to control a specific device function. It receives data from its I/O ports and that data is analysed in its core CPU. The processor of the microcontroller accesses the temporary data stored in its data memory, where it is processed using programme memory instructions to decode and apply the incoming data. It then utilises its I/O ports for communication and performs the required action.

Elements of microcontroller:

i. Processor or CPU

1. The brain of the gadget is supposed to be a CPU. Several commands that regulate how the microcontroller functions are interpreted and handled by it. This requires doing simple arithmetic, I/O, and logic operations. CPU also performs tasks that deliver instructions to other components.
2. Memory

Stores the information received by the processor which is further used to execute the instructions that it was created to carry out. A microcontroller's two primary memory types are:

a) Program Memory – The job of program memory is to keep long instrucyions that are to be executed by CPU. It is able to store indefinite data because of its non-volatile nature without any power supply.
b) Data Memory – Stores temporary data while instructions are executed by CPU. Its volatile nature allows it to store current instructions only while connected to power supply.

3. I/O ports

The processor's connection to the outside world is made through its input and output devices. Information is received by the input ports and sent as binary data to the CPU. After receiving the data, the processor transmits the appropriate instructions to output devices that carry out activities not controlled by the microcontroller

Arduino Uno

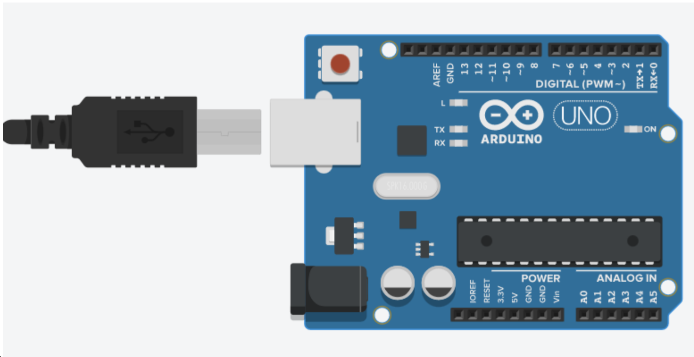
The Arduino Uno is a well-known open-source microcontroller board based on the ATmega328P. It is intended for use in a variety of electronics and robotics projects. Input/output pins are provided for attaching sensors, actuators, and other electronic components, as well as a USB interface for programming and power supply.

The Arduino Uno's simplicity and ease of use are two of its key features. The Arduino integrated development environment (IDE) provides a user-friendly interface for creating, developing, and uploading code to the board. The board may also be powered by USB, making it simple to operate without extra power sources.

Uno includes 14 digital I/O pins, six analogue I/O pins, and a number of extra power, ground, and communication pins. LEDs, motors, sensors, and other electrical components can be controlled using these pins. The board also has an LED and a reset button for simple troubleshooting and testing.

The Arduino Uno also supports a variety of communication protocols, including I2C, SPI, and UART. This allows the board to communicate with other devices like as sensors, displays, and microcontrollers.

The Arduino Uno is also extremely configurable, with a significant developer and user community developing libraries and add-ons for the board. This enables simple integration with other applications and hardware, making it an excellent choice for prototyping and experimentation.



.

Figure 3.2) Arduino Uno R3

3.3.3) Motor Driver

L293D

The L293D is a common motor driver IC (integrated circuit) for controlling tiny DC motors. It's a flexible and simple-to-use microcontroller that lets you regulate motor speed and direction using just a few input inputs.

The L293D includes two H-bridge circuits that allow you to adjust the motor's direction by altering the polarity of the voltage provided to it. The chip also includes built-in protective diodes, which assist prevent chip or motor damage from voltage spikes or other difficulties.

TTL (transistor-transistor logic) and CMOS (complementary metal-oxide-semiconductor) logic signals can be used to operate the L293D. As a result, it is compatible with a broad range of microcontrollers, including the Arduino and Raspberry Pi.

Simply connect the motor to the output pins and power the chip to utilise the L293D. The input pins may then be used to regulate the motor's speed and direction. For example, you may make the motor move in one direction by applying a high voltage to one input pin and a low voltage to the other, and vice versa.

With a maximum current rating of 600mA per channel, the L293D is ideal for driving tiny DC motors. Larger motors, on the other hand, may need the adoption of a separate motor driver chip.

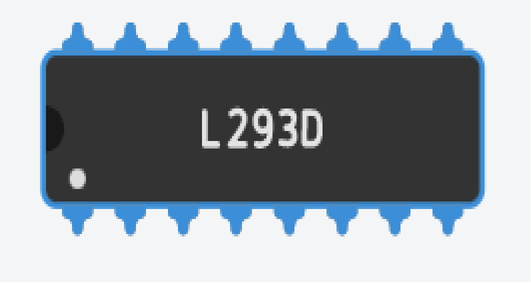


Figure 3.3) L293D Dual H-Bridge Motor Driver 3.3.4) Motors

DC motors

DC motors operate by creating a magnetic field using direct current, which then converts electrical energy into mechanical energy. Once the motor is switched on, a magnetic field is formed in the stator. The rotor's magnets are then attracted and repelled by this magnetic field, leading to its rotation. The commutator, which is linked to both the brushes and the power supply, ensures that the rotor rotates consistently while supplying energy to the motor's wire windings.

Direct current motors (DC motors) are electrical devices that transform electrical energy into mechanical energy. They have a wide range of applications, including industrial machinery, automotive systems, robotics, and consumer electronics. These are made up of a stationary component called the stator and a spinning component called the rotor. The stator is made up of a set of magnets that produce a magnetic field, whilst the rotor is made up of a wire coil that is energised by an electrical current. When an electrical current travels through the coil, a magnetic field is created that interacts with the magnetic field of the stator, causing the rotor to revolve.

DC motors are classified into two types: brushed and brushless. Brushes and a commutator are used in brushed DC motors.

DC motors offer a number of advantages over other types of motors, including high efficiency, high torque, and variable speed control. They are also relatively easy to control and operate, making them well-suited for a wide range of applications. However, they do have some limitations, such as limited speed range and the need for regular maintenance, especially in the case of brushed motors.

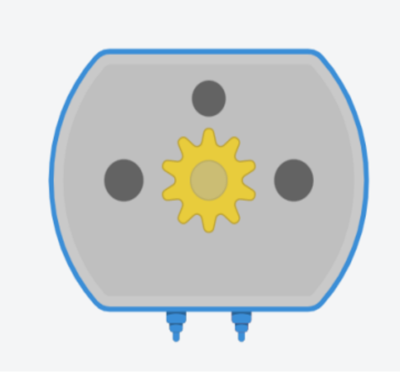


Figure 3.4) DC motor

CHAPTER 4

RESULTS AND DISCUSSION

We used an online simulation website called Tinkercad to test our circuits and run simulations using it.

Software used: **Tinkercad**

Circuit:

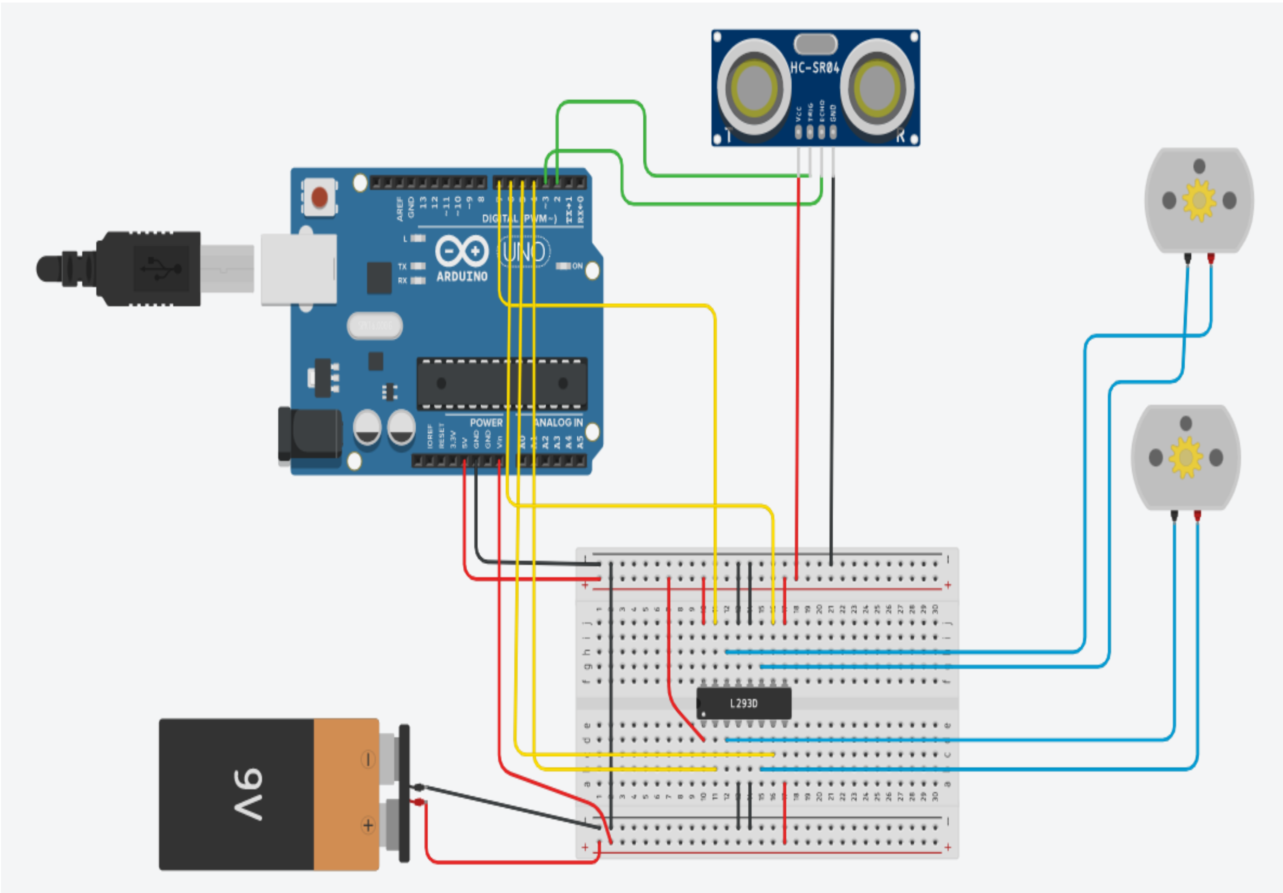
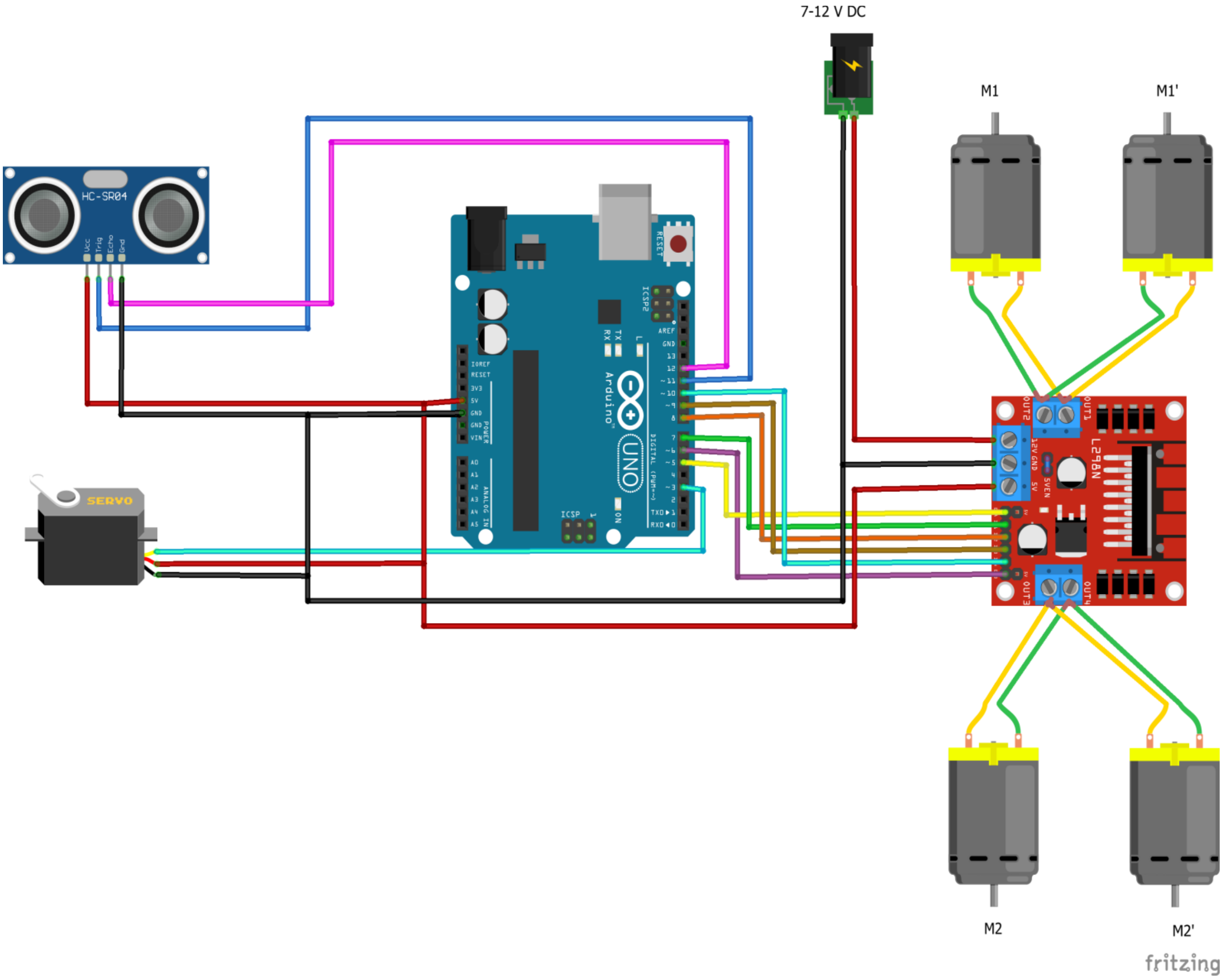


Figure (4.1) Circuit for SWCS

Circuit Diagram



Code:

```
#include <Servo.h>
#include <NewPing.h>

#define SERVO_PIN 3
#define ULTRASONIC_SENSOR_TRIG 11
#define ULTRASONIC_SENSOR_ECHO 12
#define MAX_REGULAR_MOTOR_SPEED 150
#define MAX_MOTOR_ADJUST_SPEED 200
```

```
#define DISTANCE_TO_CHECK 25

//Right motor
int enableRightMotor=5;
int rightMotorPin1=7;
int rightMotorPin2=8;

//Left motor
int enableLeftMotor=6;
int leftMotorPin1=9;
int leftMotorPin2=10;

NewPing mySensor(ULTRASONIC_SENSOR_TRIG, ULTRASONIC_SENSOR_ECHO, 400);
Servo myServo;
void setup()
{
  // put your setup code here, to run once:
  pinMode(enableRightMotor,OUTPUT);
  pinMode(rightMotorPin1,OUTPUT);
  pinMode(rightMotorPin2,OUTPUT);

  pinMode(enableLeftMotor,OUTPUT);
  pinMode(leftMotorPin1,OUTPUT);
  pinMode(leftMotorPin2,OUTPUT);

  myServo.attach(SERVO_PIN);
  myServo.write(90);
  rotateMotor(0,0);
```

```
}

void loop()
{

  int distance = mySensor.ping_cm();

  //If distance is within 30 cm then adjust motor direction as below
  if (distance > 0 && distance < DISTANCE_TO_CHECK)
  {
    //Stop motors
    rotateMotor(0, 0);
    delay(500);

    //Reverse motors
    rotateMotor(-MAX_MOTOR_ADJUST_SPEED,                              -
MAX_MOTOR_ADJUST_SPEED);
    delay(200);

    //Stop motors
    rotateMotor(0, 0);
    delay(500);

    //Rotate servo to left
    myServo.write(180);
    delay(500);

    //Read left side distance using ultrasonic sensor
    int distanceLeft = mySensor.ping_cm();
```

```
  //Rotate servo to right
  myServo.write(0);
  delay(500);

  //Read right side distance using ultrasonic sensor
  int distanceRight = mySensor.ping_cm();

  //Bring servo to center
  myServo.write(90);
  delay(500);

  if (distanceLeft == 0 )
  {
    rotateMotor(MAX_MOTOR_ADJUST_SPEED, -MAX_MOTOR_ADJUST_SPEED);
    delay(200);
  }
  else if (distanceRight == 0 )
  {
    rotateMotor(-MAX_MOTOR_ADJUST_SPEED, MAX_MOTOR_ADJUST_SPEED);
    delay(200);
  }
  else if (distanceLeft >= distanceRight)
  {
    rotateMotor(MAX_MOTOR_ADJUST_SPEED, -MAX_MOTOR_ADJUST_SPEED);
    delay(200);
```

```
    }
    else
    {
      rotateMotor(-MAX_MOTOR_ADJUST_SPEED,
MAX_MOTOR_ADJUST_SPEED);
      delay(200);
    }
    rotateMotor(0, 0);
    delay(200);
  }
  else
  {
    rotateMotor(MAX_REGULAR_MOTOR_SPEED,
MAX_REGULAR_MOTOR_SPEED);
  }
}


void rotateMotor(int rightMotorSpeed, int leftMotorSpeed)
{
  if (rightMotorSpeed < 0)
  {
    digitalWrite(rightMotorPin1,LOW);
    digitalWrite(rightMotorPin2,HIGH);
  }
  else if (rightMotorSpeed >= 0)
  {
    digitalWrite(rightMotorPin1,HIGH);
    digitalWrite(rightMotorPin2,LOW);
```

```
}

void loop()
{

  int distance = mySensor.ping_cm();

  //If distance is within 30 cm then adjust motor direction as below
  if (distance > 0 && distance < DISTANCE_TO_CHECK)
  {
    //Stop motors
    rotateMotor(0, 0);
    delay(500);

    //Reverse motors
    rotateMotor(-MAX_MOTOR_ADJUST_SPEED,
MAX_MOTOR_ADJUST_SPEED);
    delay(200);

    //Stop motors
    rotateMotor(0, 0);
    delay(500);

    //Rotate servo to left
    myServo.write(180);
    delay(500);

    //Read left side distance using ultrasonic sensor
    int distanceLeft = mySensor.ping_cm();
                                                          }
```

```
  mySservo.write(0);
  delay(500);

  //Read right side distance using ultrasonic sensor
  int distanceRight = mySensor.ping_cm();

  //Bring servo to center
  myServo.write(90);
  delay(500);

  if (distanceLeft == 0 )
  {
    rotateMotor(MAX_MOTOR_ADJUST_SPEED, -
MAX_MOTOR_ADJUST_SPEED);
    delay(200);
  }
  else if (distanceRight == 0 )
  {
    rotateMotor(-MAX_MOTOR_ADJUST_SPEED,
MAX_MOTOR_ADJUST_SPEED);
    delay(200);
  }
  else if (distanceLeft >= distanceRight)
  {
    rotateMotor(MAX_MOTOR_ADJUST_SPEED, -
MAX_MOTOR_ADJUST_SPEED);
    delay(200);
```

```
  if (leftMotorSpeed < 0)
  {
    digitalWrite(leftMotorPin1,LOW);
    digitalWrite(leftMotorPin2,HIGH);
  }
  else if (leftMotorSpeed >= 0)
  {
    digitalWrite(leftMotorPin1,HIGH);
    digitalWrite(leftMotorPin2,LOW);
  }

  analogWrite(enableRightMotor, abs(rightMotorSpeed));
  analogWrite(enableLeftMotor, abs(leftMotorSpeed));
}
```

Case 1: for distance > 30cm, Motor speed = 16174 rpm (forward rotation)

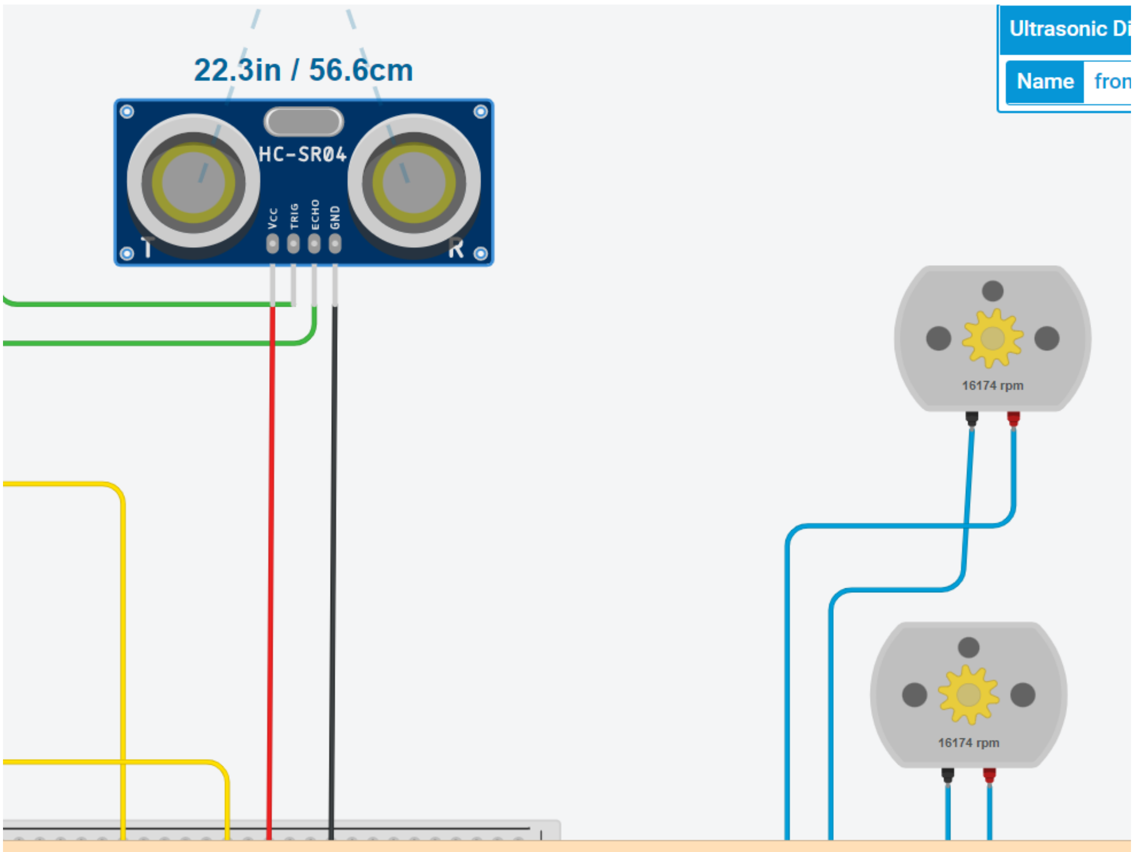


Figure 4.2) Case 1

Case 2: for distance < 30cm, Motor speed = -16174 rpm (backward rotation)

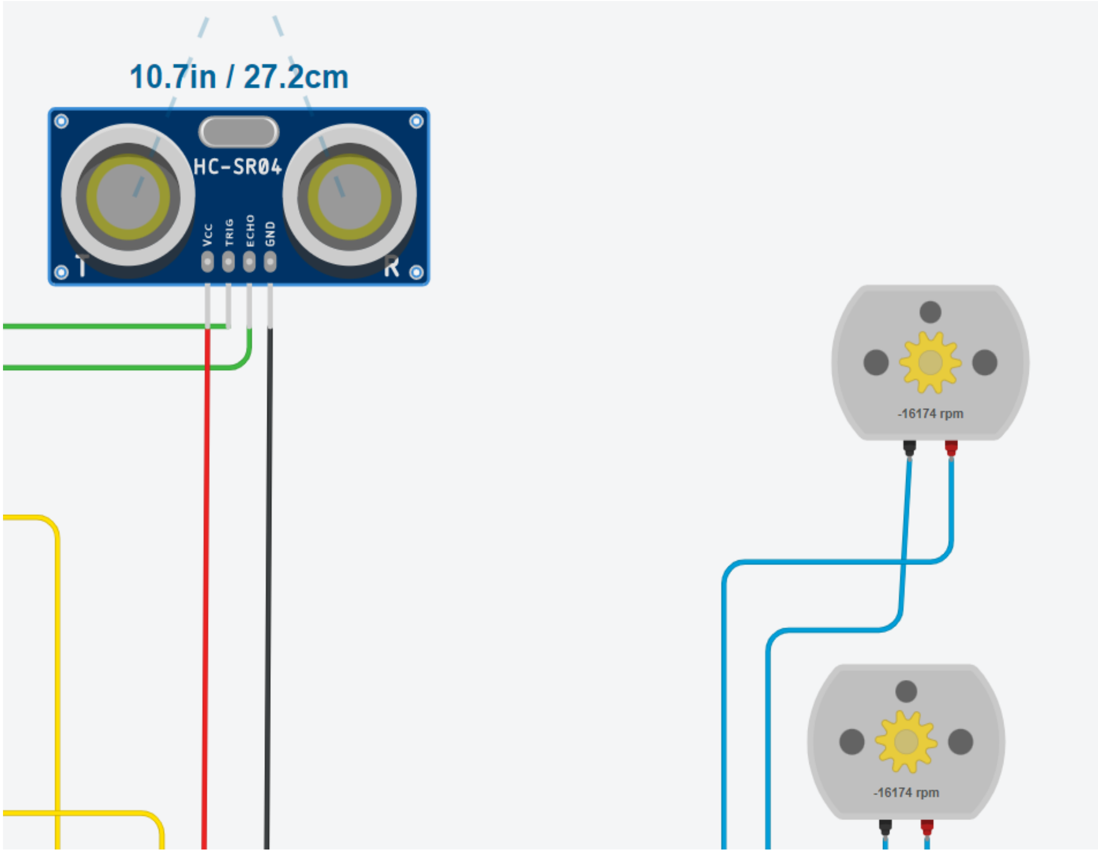


Figure 4.3) Case 2

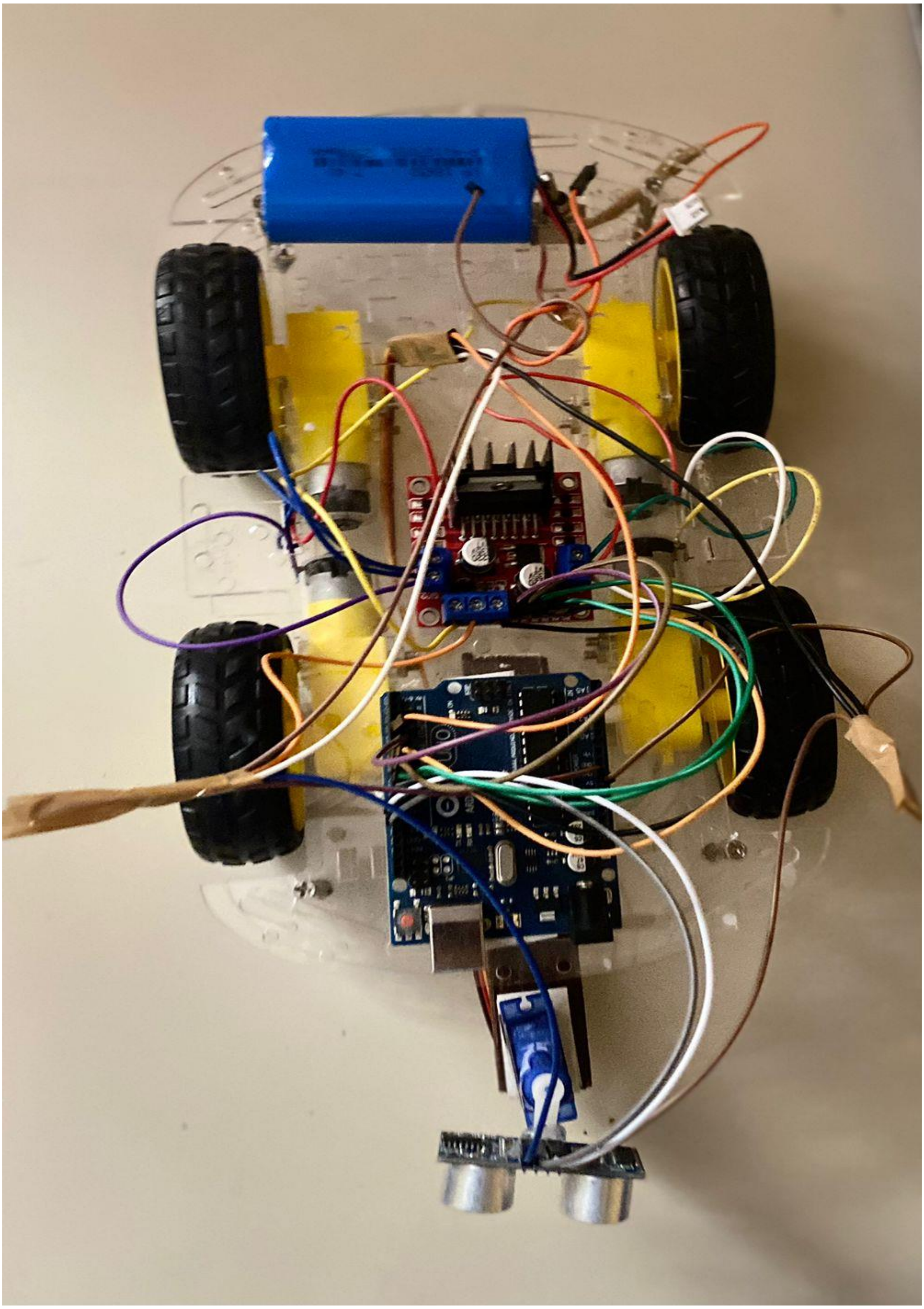


Figure 4.4)

REFERENCES

[1] Richard Simpson, Edmund LoPresti, Steve Hayashi, "*Illah Nourbakhsh, David Miller, (2004). Journal of Rehabilitation Research and Development*", Volume 41, Number 3B, Pages 429–442.

[2] Tuck-Voon How, Rosalie H Wang, Alex Mihailidis; " *Intelligent Wheelchair System for older adults with cognitive impairments*", (2013). Journal of NeuroEngineering and Rehabilitation.

[3] Ananda Sankar Kundua, Oishee Mazumdera, Prasanna K. Lenkab, Subhasis Bhaumik, (2017); "*Design and Performance Evaluation of 4 Wheeled Omni Wheelchair with Reduced Slip and Vibration*"; Procedia Computer Science 105 , Pages 289 – 295.

[4] Gabriel PIres, Rui Araujo, Urbano Nunes, A.T. de Almeida, (July 1998); "*Robchair: A Powered Wheelchair using a Behaviour-Based Navigation*" .

[5] Arreguin, J., (2008). *Automation and robotics*. 4th ed. Vienna: I-Tech Education and Publishing.

[6] Ullman, L. and Signer, A., (2006). *C++ programming*. Berkeley, Calif.: Peachpit Press.

Plagiarism Report

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT <u>PLAGIARISM VERIFICATION REPORT</u>

Date: ………………………….

Type of Document (Tick): PhD Thesis M.Tech Dissertation/ Report B.Tech Project Report
Name: ___________________________ __Department: _________________ Enrolment No _________
Contact No. ______________________________E-mail. _______________________________________
Name of the Supervisor: ____
Title of the Thesis/Dissertation/Project Report/Paper (In Capital letters): ________________________
____
____
____
________________ **<u>UNDERTAKING</u>**

I undertake that I am aware of the plagiarism related norms/ regulations, if I found guilty of any plagiarism and copyright violations in the above thesis/report even after award of degree, the University reserves the rights to withdraw/revoke my degree/report. Kindly allow me to avail Plagiarism verification report for the document mentioned above.

<u>Complete Thesis/Report Pages Detail:</u>

- Total No. of Pages =
- otal No. of Preliminary pages =
- Total No. of pages accommodate bibliography/references =

(Signature of Student)

<u>FOR DEPARTMENT USE</u>

We have checked the thesis/report as per norms and found **Similarity Index** at ……………….(%). Therefore, we are forwarding the complete thesis/report for final plagiarism check. The plagiarism verification report may be handed over to the candidate.

(Signature of Guide/Supervisor) Signature of HOD

<u>FOR LRC USE</u>

The above document was scanned for plagiarism check. The outcome of the same is reported below:

Copy Received on	**Excluded**	**Similarity Index (%)**	**Generated Plagiarism Report Details** (Title, Abstract & Chapters)	
	· All Preliminary Pages · Bibliography/Images/Quotes · 14 Words String		Word Counts	
			Character Counts	
Report Generated on				
		Submission ID	Total Pages Scanned	
			File Size	

Checked by
Name & Signature Librarian
………