DESIGN, FABRICATION AND ANALYSIS OF A ROBOTIC ARM

A Project report submitted in partial fulfilment of the requirements.
for the award of the degree of

Bachelor of Technology

in

Mechanical Engineering

P. MOHAN	**319126520105**
M. VIJAY SIMHADRI NAIDU	**320126520L10**
R. HITESH	**319126520107**
K. GURU KALYAN	**319126520087**
A. RAJESH	**319126520065**

Submitted by

Under the Esteemed Guidance of

Dr. RAJESH GHOSH Ph.D.

Associate Professor

DEPARTMENT OF MECHANICAL ENGINEERING

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES (A)

(Permanently Affiliated to Andhra University, Approved by AICTE, Accredited by NBA Tier-I, NAAC)

Sangivalasa, Visakhapatnam (District) Andhra Pradesh -India– 531162.

APRIL 2023

DEPARTMENT OF MECHANICAL ENGINEERING

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES

(UGC Autonomous & Permanently Affiliated to Andhra University)

PRAGNANAM BRAHMA
ANITS

CERTIFICATE

This is to certify that the Project Report entitled **"Design, Fabrication and Analysis of Robotic Arm"** being submitted by **P. MOHAN (319126520105), M. VIJAY SIMHADRI NAIDU (320126520L10), R. HITESH (319126520107), K. GURU KALYAN (319126520087), A. RAJESH (319126520065)** to the Department of Mechanical Engineering, ANITS is a record of the bonafide work carried out by them under the esteemed guidance of **Dr. RAJESH GHOSH.** The results embodied in the report have not been submitted to any other University or Institute for the award of any degree or diploma.

Project Guide

Dr. RAJESH GHOSH

Associate Professor
Dept. of Mechanical Engineering,
ANITS

18.4.23

Head of the Department

Dr. B. NAGA RAJU

Professor
Dept. of Mechanical Engineering
ANITS

PROFESSOR & HEAD
Department of Mechanical Engineering
ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES

THIS PROJECT WORK IS APPROVED BY THE BOARD OF EXAMINERS

INTERNAL EXAMINER: 18.4.23

PROFESSOR & HEAD
Department of Mechanical Engineering
ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES
Sangivalasa-531 162 VISAKHAPATNAM Dist. A.P.

18/4/2023

EXTERNAL EXAMINER:

ACKNOWLEDGEMENT

We express immensely our deep sense of gratitude to **Dr. RAJESH GHOSH**, Associate Professor, Department of Mechanical Engineering, Anil Neerukonda Institute of Technology & Sciences, Sangivalasa, Bheemunipatnam Mandal, Visakhapatnam district for his valuable guidance and encouragement at every stage of the work, which made it a successful fulfilment.

We were very thankful to **PROF. KAVALA SRIRAMA KRISHNA**, Principal, Anil Neerukonda Institute of Technology & Sciences for their valuable suggestions.

We were very thankful to **Dr. B. NAGA RAJU**, Professor, and Head of the Department of Mechanical Engineering, Anil Neerukonda Institute of Technology & Sciences for his valuable guidance and encouragement at every stage of the work made it a successful fulfilment.

We express our sincere thanks to the members of the non-teaching staff of Mechanical Engineering for their cooperation and support carrying on work.

Last but not least, we like to convey our thanks to all who have contributed either directly or indirectly to the completion of our work.

P. MOHAN	(319126520105)
M. VIJAY SIMHADRI NAIDU	(320126520L10)
R. HITESH	(319126520107)
K. GURU KALYAN	(318126520087)
A. RAJESH	(319126520065)

ABSTRACT

It is estimated that by the year 2030, 800 million workers all over the world be replaced by robots. This is evident that Robotic revolution is happening in a large scale. Humans no longer need to perform hazardous jobs because robots can work in those conditions. They can carry out repetitive tasks, lifting toxic materials and heavy loads. Numerous accidents have been avoided thanks to them, as well as time and money.

Robotic Arm consist of computer-controlled robotic arms that can be programmed to perform specific surgical tasks. The arms are equipped with specialized surgical instruments, such as scalpels, scissors, and graspers, which are controlled by the surgeon using a console or a joystick.

The robotic arms are designed to provide a range of motion and dexterity that surpasses that of the human hand. They can also filter out any tremors or small movements of the surgeon's hand, which can reduce the risk of accidental damage to surrounding tissue during the surgery.

In addition to providing greater precision and control during surgeries, robotic tool helpers can also improve surgical outcomes by reducing the risk of infection and minimizing the length of the hospital stay required after surgery.

However, it's important to note that the use of robotic arm helps in surgeries is still a relatively new technology, and not all surgical procedures can be performed using these tools. The decision to use a robotic tool helper during surgery is usually made by the surgeon in consultation with the patient and based on the specific needs of the surgical procedure.

This project aims to design a Robotic Arm with additive manufacturing process. Various parts of the robot are designed in the SOLID WORKS Software and then the parts are printed with the help of a 3-D printer(material-PLA), and then they are assembled with addition to various components like servo motors etc. Overall, the project aim is to make a fabrication of a Robotic Arm and to do analysis in ANSYS by applying various loads.

LIST OF CONTENTS

LIST OF FIGURES

NOMENCLATURE

PACU- Post-Anaesthesia Care Unit

ASIMO- Advanced Step in Innovative Mobility

DARPA- Defense Advanced Research Projects Agency

PLA- Polyactic Acid

PWM- Pulse Width Modulation

LED- Light Emitted Diode

CAD- Computer Aided Design

CATIA- Computer Aided Three- Dimensional Interactive Application

ABS- Acrylonitrile Butadiene Styrene

SCARA- Selective Compliance Assembly Robot Arm

STL- Standard Triangle Language/Standard tessellation Language

SPI- Serial Peripheral Interface

FEM- Finite Element Method

SXSW- South by South West

SPL- Standard Platform League

CHAPTER 1
INTRODUCTION

Robots are being deployed in health care sector to improve the accuracy as well as the efficiency of work. The use of robotics and automation also extends to operating rooms in hospitals, where they are used to automate manual, repetitive, and high-volume tasks so the medical team can focus more on strategic tasks which involved in a surgery.

Medical professionals have excellent intelligence, sensing, and not only execute work given but also respond to abnormality of peripheral equipment and can perform visible inspection of medical equipment. They are capable of dealing with change, uncertainty, critical thinking, fast reflexes, good reekdual and communicating skills. It is risky to replace these roles by robots. Before thinking of replacing these professionals with robots, each and everyone's responsibilities must be clearly understood.

Responsibilities of each medical professional in a surgery:

Scrub nurse: Scrub nurses dress in surgical scrubs and accompany the surgical patient and doctors into the operating room. They prepare the surgical room for the patient, make sure all the instruments are sterile and prepared for use, "hand tools to the doctor during the surgery," and carry out other tasks there.

Circulating nurses: A patient will first meet a circulating nurse before a procedure. This nurse will review consent forms, respond to inquiries about the procedure, perform preoperative evaluations, ensure that the equipment is ready to use, and may inform family members of the status of the surgery while it is being performed.

RN first assistants: These nurses assist surgeons during surgery by controlling bleeding, keeping an eye out for complications, stitching up wounds, putting on bandages, and more. They collaborate closely with a surgeon and provide help as needed during the procedure.

PACU nurses: Patients are taken to post-anesthesia care units after their surgery is finished. These nurses assist patients as they recover from anesthesia, stabilize, and get ready to be moved to another hospital unit or be discharged for outpatient procedures. update them on their status, work with family members, take vital signs, and ensure the patient is comfortable. They take vital signs, communicate with family members, give patients status updates, and check on their comfort.

Surgeons: Surgeons are in charge of the patient's preoperative diagnosis, the actual surgery, and the patient's postoperative surgical care and treatment.

Anaesthesiologist: The anaesthesiologist is responsible for patient safety and well-being throughout the surgery. The anaesthesiologist will stay with you during the whole surgery. He checks the breathing, heart rate, blood pressure, and other vital signs, and will adjust your anaesthesia level if needed.

Each and every one in the above medical team have individual roles and responsibilities. Hours of hard work of all these individuals makes the surgery successful. Among those, surgeons and anthesiologist are very critical, they are each and every step in surgical procedure involves different complexities. They have good adaptability to the situation. The possible errors done by them are small and can be identified and resolved quickly. With present technology in automation, replacing these professionals with robots will not only risk the error,but also can be potential mechanical failure which may injury or cost a life There are few tasks in the operating room where the environment and work suits for automation. Circulating nurse, scrub nurse and other assistants will work under the guidance of surgeons. These jobs are less risky as we compare with tasks perform by surgeons because there is no much direct contact with patients in their tasks and needs fewer professional skills. Replacing those with robots is not a bad idea and Few of these tasks are already successfully performing by robots like delivering medications and food to the patient room, robots which can assist nurses, taking blood from patient, recording temperature, or improving patient hygiene

These tasks may look simply but they are vital for patient health and it would give nurses more time to focus on reekdualized patient care and devising treatment plans. One of the tasks similar to these are handing tools or instruments to surgeons in a surgery that is what generally a scrub nurse does. This task does not need much self-intelligence because doctor will ask the nurse for required tool. The main job is to listen the tool name, identify the tool in tray and giving it to the doctor. This needs only organizing this job with her and this job does not need much workspace. Generally, robot’s task will be simplified if no other person or object comes into its work volume during its motion. This will make a huge problem to the designer because robot must consider the motion of the other objects in its work volume and have to plan the path according to it and the path changes each and every time the robot moves.

The main job of the robot in the scrub nurse role is to hand the tools. The whole task of handing the tool is divided into three subtasks:

1. Listening to the surgeon for what tool he is asking and understanding the required tool.
2. Identifying the tool position in the tray.
3. Pick and placing the tool to the desired position. The things in a right way.

1.1 DEFINITION OF HUMANOID ROBOT

A robot that resembles the human body in shape is called a humanoid robot. The design may be for experimental purposes, such as the study of bipedal locomotion, for functional purposes, such as interacting with human tools and the environment, or for other purposes. They are expert service robots designed to resemble human movement and interaction. They add value by automating processes in a way that boosts productivity and reduces costs, just like all service robots do. Humanoid robots are a relatively new form of professional service robot. Most people will say they picture a piece of machinery that resembles a human form when asked what they think of when they hear the word "robot." A robot that resembles the human body in its entirety is referred to as a humanoid robot. Although some types of humanoid robots may only model a portion of the body, in general, humanoid robots have a torso with a head, two arms, and two legs.

A humanoid robot is autonomous if it can adjust to changes in its surroundings or in itself and keep working toward its objective. A humanoid robot's torso has two main purposes. The first is that it typically houses both the robot's main computer and its power source, which is usually a battery. Second, the center of mass is found in the torso. This will be important when choosing where to put the robot's computer and power source. A head, arms, and legs are joined to the torso. Arms on robots can serve a variety of functions.

Arms are probably not necessary to carry out assigned Tasks when designing a robot whose primary goal is to walk. Instead, the robot could potentially be balanced using its arms. When a robot turns, its center of gravity may be off-center, which will start to cause it to lean. The robot's head houses the cameras and/or sensors that it uses to identify objects in front of it. and/or the robot's head houses sensors that allow it to recognize objects in front of it. The robot's head houses the cameras and/or sensors that it uses to identify objects in front of it. has the capability of having their heads be able to turn around a certain pivot point, i.e., a spine. Having the ability to discern objects around it and not just in front of the robot will allow it to better adapt to its surroundings. Some robots are also given the capability of showing emotions when given extra sensors and programs to help it recognize the emotions of people it is interacting with.

Legs are the final, and arguably most significant, feature that characterizes a humanoid robot. The robot can stand up and walk on two legs in a variety of ways. e method. A team from the Massachusetts Institute of Technology (MIT) demonstrated one technique using their Toddler robo. The Toddler was the name given to the object because it wobbled on two straight legs. In recent years, robots have begun to resemble humans more and more. Joints in the hip, knee, and ankle form the legs. The way these legs are built for each robot varies depending on the job that it is intended to perform. The shape of the foot is another crucial factor to consider, especially in light of how it interacts with the ankle joint. While some robots rely on the motors in their upper legs to move, others are designed to push off with their feet in an effort to move forward.

The robot's mechanical features play a significant role in classifying it as a humanoid robot. But the software is also special. Humanoid robots are well known for their capacity for social interaction and environmental adaptation. In addition, they have a reputation for being able to learn new information and then apply it later, whether it be for face recognition or perhaps remembering a previous route.

1.2 HISTORY OF ROBOTS

Greek Times

According to some historians, Zeus gave Europa a bronze creature (either a man or a bull) by the name of Talos, a giant creature mentioned in ancient Greek literature.

Fig 1.1. Talos

He was supposedly created in Sardinia by Hephaestus at Zeus' command and given to the Cretan king Minos, according to one of the myths. In a different version, Talos traveled to Crete with Zeus to keep an eye on his beloved Europa, and she gave him to Minos as a gift. There are theories that Zeus was known in Crete by the name Zeus Tallaios, and that Zeus' name Talos in the ancient Cretan language meant the "Sun." They believed Talos' blood, which was lead because he was a bronze man, to be ichor, the divine fluid that flows through the veins of the gods. Talos had a single vein that ran from his neck down through his body and was fastened to one of his heels by a bronze nail, bronze peg, or bronze pin.

77-100 BC

A diver discovered the remains of what could only be described as a mechanical computer in 1901, halfway between the islands of Crete and Kythera. The apparatus, which consists of a complicated jumble of gears, probably calculated the positions of the sun, moon, and other celestial bodies. The Antikythera Device is a 2000-year-old artifact that is generally accepted to have Greek origins.

10-70AD

A book called Automata, which translates to "moving itself" in Arabic, was written by the mathematician, physicist, and engineer Hero of Alexandria (10–70 AD). It contains a variety of devices that might have been used in temples. The Hero of Alexandria designed an odometer to be mounted on a cart and measure distances travelled. He also created the Aeolipile, an animated statue, and a wind-powered organ. The Aeolipile, despite being designed as merely a trinket, is regarded as the origin of contemporary steam engines.

Medieval times

Automatons, human-like figures controlled by secret mechanisms, were employed to persuade rural churchgoers to accept the existence of a superior force. [These mechanisms] produced the appearance of self-motion (moving independently). The clock jack was a mechanical character that could use its axe to sound the time on a bell. In the 13th century, this technology was essentially unheard of.

1495

Though it is unknown whether Leonardo da Vinci's design for the first humanoid robot was ever implemented, it is possible. The robot's head and neck are flexible, allowing it to move its head and open and close its jaw while sitting up and waving its arms.

1738

In Grenoble, France, Jacques de Vaucanson begins creating automata. He totals three structures. The flute player who could play twelve songs was his first accomplishment. His second automaton, which played a flute and a drum or tambourine, came in second place, but his third automaton was by far the most well-known of them all. The duck served as an illustration of Vaucanson's attempt at "moving anatomy," or the mechanics-based modeling of human or animal anatomy. ” The duck moved, quacked, flapped its wings and even ate and digested food

1801

A device (basically a loom) that could be programmed to produce patterns that could be printed on cloth or tissue was created by Joseph-Marie Jacquard.

1847

Boolean algebra, developed by George Boole, is a mathematical representation of logic.

1898

At Madison Square Garden, Nikola Tesla constructs and shows off a remote-controlled robot boat.

1921

The word "robot" was first used by Czech playwright Karel Capek in his production of Rossum's Universal Robots. The word "robot" in Czech, which means "compulsory labor," comes from the word "robota."

1937-1938

Westinghouse creates ELEKTRO a human-like robot that could walk, talk, and smoke.

The world's fair in 1939 was where ELEKTRO made its debut.

1940

Beginning with A Strange Playfellow (later renamed Robbie), Isaac Asimov creates a collection of short stories about robots for Super Science Stories magazine. The plot centers on a robot's love for and duty to guard an innocent child. He writes more robot-related stories over the ensuing ten years, and they are eventually collected in 1950's volume I, Robot.

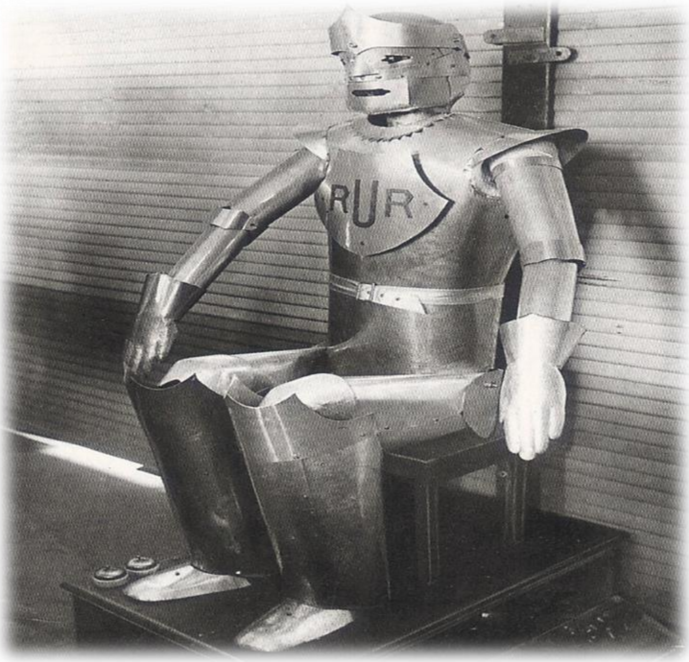


Fig 1.2. Rossum's Universal Robots

1941

Author of science fiction Isaac Asimov coined the term "robotics" to describe robot technology and foresaw the development of a significant robot industry. The scientist and author Isaac Asimov coined the term "robotics" in 1941 to describe the study and application of robots. The following "Laws of Robotics" were also put forth by Asimov in his 1942 short story Run-around.

1948

W. Grey Elmer and Elsie, also referred to as the turtle robots, were Walter's first creations. When their batteries ran out, the robots could locate their charging station.

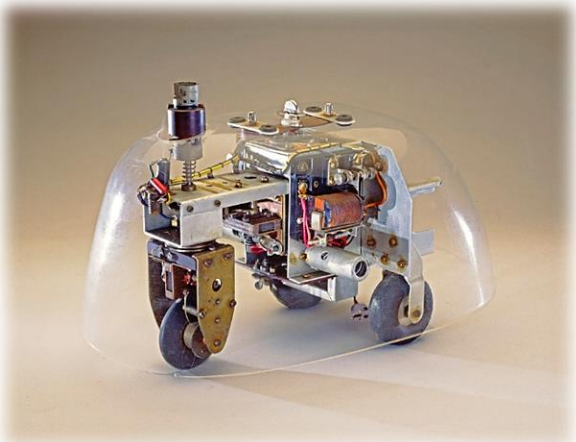


Fig 1.3 Elmer_Elsie Robots

1950

In Computing Machinery and Intelligence, published by Alan Turing, he suggests a test to determine whether or not a machine has developed the capacity to think for itself. The "Turing Test" is then coined.

1954

The first fully programmable robot was created by George Devol, and it was given the name UNIMATE for "Universal Automation." (US patent 2 998 237) Later, in 1956, George Devol and Joseph Engelberger founded "Unimation," which stands for "universal automation," to become the Engelberger has earned the moniker "father of robotics" as a result. alled the ‘father of robotics’ Unimation is still in production today, with robots for sale.

1960’S

Early in the 1960s, a candy factory in Kitchener, Ontario, housed one of the first working industrial robots in North America.

1966

Shakey, the first mobile robot to understand and respond to its own actions, is developed by the Stanford Research Institute (later to be known as SRI Technology). In addition to its other accomplishments, SRI was the research center that assisted in the creation of Tide, the modern laundry detergent.

1968

Mcgee and Frank at the University of South Carolina developed the first computer-controlled walking machine.

1968

R. Mosher created the first manually operated walking truck. It had a top walking speed of four miles per hour.

1969

The Stanford Arm, which was developed by Victor Scheinman, was the first effective electrically powered, computer-controlled robot arm.

1969

Ichiro Kato's WAP-1 was the first bipedal robot ever created. In order to stimulate the artificial muscles, air bags attached to the frame were used. WAP-3, which was created later, could ascend and descend stairs and slopes in addition to walking on flat surfaces. It might even turn while moving.

1970

Stanford University produces the Stanford Cart. It is designed to be a line follower but can also be controlled from a computer via radio link.

1971

Bruce Dern appears in the movie Silent Running, which is released. Huey, Dewey, and Louie, three robot drones, serve as Dern's co-stars.

1974

Starting his own business, Victor Scheinman begins selling the Silver Arm. It is capable of assembling small parts together using touch sensors.

1976

The Soft Gripper was created by Shigeo Hirose at the Tokyo Institute of Technology. It is intended to snake-like wrap around an object.

1977

The movie Star Wars debuts. R2-D2 and C-3PO are introduced to viewers in George Lucas' film about a world where the Force is in control. The movie inspires a new generation of researchers and paints the clearest picture of a human future with robots since the 1960s.

1978

ACMVI (Oblix) robot was created by Shigeo Hirose. It had abilities like a snake. Later, the Oblix evolved into the industrial MOGURA robot arm.

1979

Without assistance from people, the Stanford Cart moved across a room full of chairs. A TV camera that was mounted on the rail of the cart took pictures from various angles and sent them to a computer. The computer analyzed the distance between the cart and the obstacles.

1996

The P2, which Honda created, was the first significant step in the development of their ASIMO. The first self-regulating, bipedal humanoid robot was the P2.

1997

On Mars, NASA's Pathfinder made landfall. The wheeled robotic rover sent images and data about Mars back to Earth

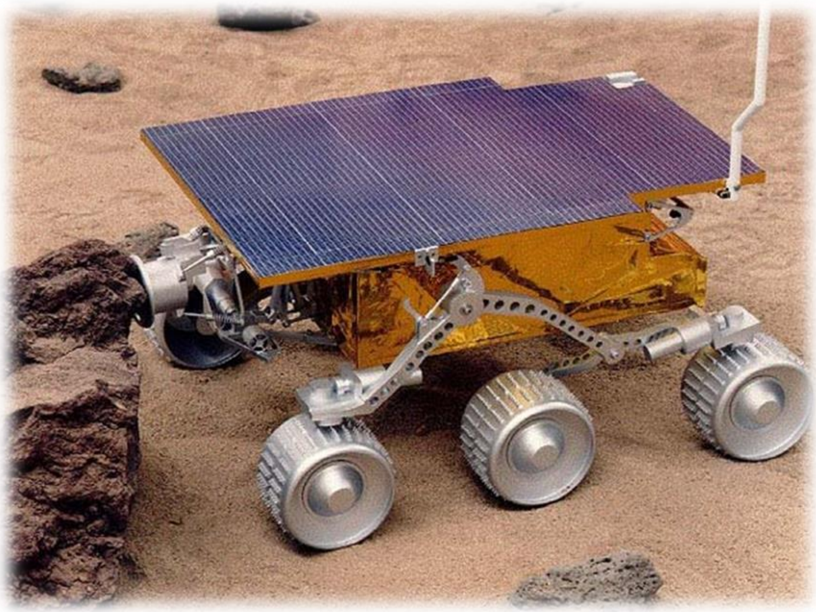


Fig 1.4 Nasa's Path Finder

1997

The second crucial stage in the creation of Honda's ASIMO was the P3. Honda's first fully autonomous humanoid robot was the P3.

1999

The first Aibo robotic dog was released by Sony. It uses cameras and facial recognition technology to interact differently with each person it comes into contact with, makes vaguely dog-like noises, walks around, plays with toys, obeys commands, occasionally misbehaves, and responds to commands.

Fig 1.5 Aibo Robotic Dog

2002

The Advanced Step in Innovative Mobility (ASIMO) was developed by Honda. It is meant to serve as your personal assistant. It can identify the name, voice, and face of its owner. is able to read email and stream video from its camera to a PC.

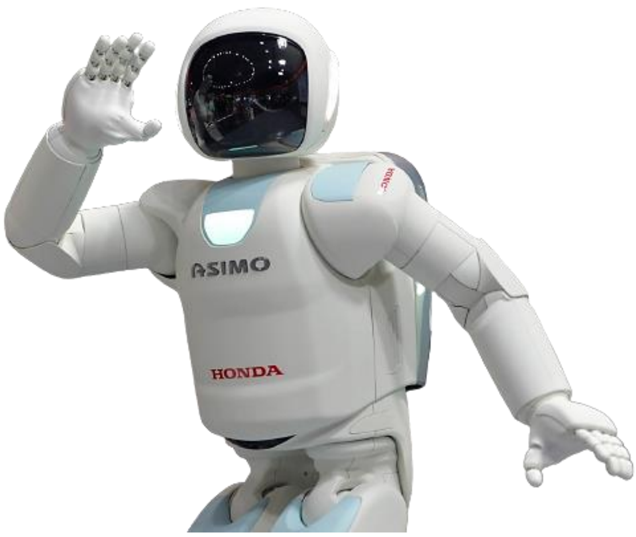


Fig 1.6 ASIMO

2005

The world's smartest mobile robot, according to the Korean Institute of Science and Technology (KIST), is HUBO. This robot is connected to a computer by a fast wireless connection, and the computer makes all of the robot's decisions.

2006

A new generation of robotics enthusiasts at home and in schools is brought about by the release of the second generation of LEGO MINDSTORMS.

ADVANTAGES OF ROBOTS

SAFETY

The most obvious benefit of using robotics is safety. Sharp objects, hot machinery, and heavy machinery are all easily dangerous to people. By giving dangerous tasks to a robot, you're less likely to face a significant medical bill or legal trouble and more likely to face a repair bill. Robots' ability to reduce some risks will be appreciated by workers who perform hazardous tasks.

Fig 1.7 Robot performing welding operations

SPEED

Robots do not need breaks or are easily distracted. They do not ask for a day off or to leave an hour earlier. A robot can never become anxious and begin to move more slowly. Additionally, they are not required to be invited to staff meetings or training sessions. Since robots can work continuously, production is accelerated. They prevent your staff from overworking themselves to meet tight deadlines or impossibly high standards.

JOB CREATION

Jobs are not eliminated they simply alter the jobs that already exist. Robots require human oversight and supervision. More people will be needed to build the robots as our needs increase. The more robots we need, the more people we will need to build those robots.

Fig 1.8 Man monitoring a robot

You can keep your employees motivated in their roles at your company by training them to work with robots. They will witness the developments and have the exceptional chance to learn fresh technical or engineering-related skills.

CONSISTENCY

Robots don't have to split their attention between numerous tasks. Never is their work dependent on the work of others. They won't experience unforeseen emergencies or need to relocate to finish a different urgent task. They are constantly present and carrying out their assigned duties. Generally speaking, automation is much more dependable than human labor.

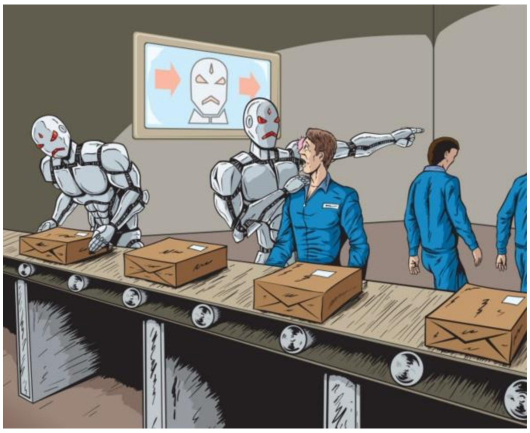
PERFECTION

Quality work will always be produced by robots. Since they're programmed for precise, repetitive motion, they're less likely to make mistakes. In some ways, robots serve as both a quality assurance system and an employee. The absence of preferences and quirks along with the elimination of human error will always result in a product that is predictably flawless.

1.3 DISADVANTAGES OF ROBOTS:

THEY LEAD HUMANS TO LOSE THEIR JOBS

In a capitalist system, business owners must take whatever steps are necessary to maximize profits, even though robots have a nasty habit of stealing people's jobs. And given their ruthless efficiency, robots are ideal for the job.



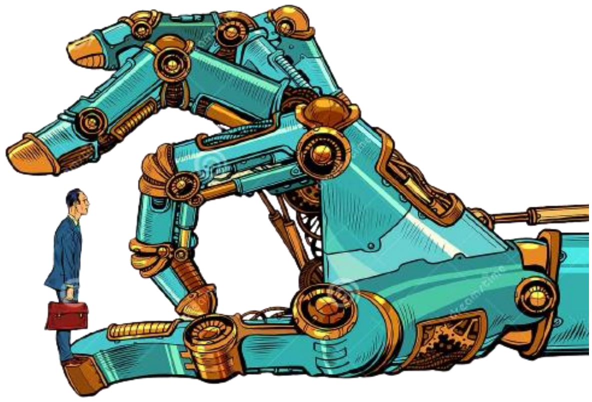


Fig 1.9 Humans losing job

A robot that can work nonstop for 24 hours without making a mistake simply outperforms humans in every way. People may be forced to leave jobs they have held their entire lives due to this fact.

THEY NEED CONSTANT POWER

Robots require a ton of electricity to function. This makes them potentially harmful to the environment and costly to operate (more on this later). The increasing demand for robots in society could cause more problems with global warming and greenhouse gas emissions unless we switch to greener sources of energy.

THEY PERFORM RELATIVELY FEW TASKS

Similar to humans, robots are currently only appropriate for a limited range of tasks. They excel in the workplace, in academia, in the medical field, and in the military. However, they are only really useful within those domains. Our daily activities are progressively becoming more focused on robots. However, there is still work to be done before robots are widely used for household tasks.

THEY IMPACT HUMAN INTERACTION

As robots take over more and more aspects of life, human interaction will suffer. Already. This slippery slope was created by the proliferation of mobile phones. You only need to look around you in any public area to notice how many people are glued to their screens.

THEY CAUSE CYBER SECURITY ISSUES

Robots also let a host of cyber security issues in. Even now, the proliferation of computers has made many organizations and people vulnerable to attack. Potential risks include identity theft, ransomware, and hacks. Now, fast-forward a few decades to a time when people live their daily lives around robots. They might be doing household chores, providing for people's health, and managing a variety of important duties. Imagine if someone gained access to their system and installed malicious software.

1.4 APPLICATIONS OF ROBOTS

AGRICULTURE

The sector that serves as the foundation for human civilization is agriculture. Agriculture, however, is a seasonal industry that depends on favorable weather, ideal soil, etc. Additionally, there are numerous repetitive tasks in agriculture that waste farmers' time and are better handled by robots. These include planting seeds, eliminating weeds, harvesting, etc. Crop harvesting is typically done by robots, which makes farmers more productive.

Fig1.10 Robot in agriculture

HEALTH CARE

The healthcare industry has undergone significant change thanks to robots. And everything has improved! They can assist doctors in performing procedures with greater precision, serve as prosthetic limbs, give patients therapy, etc. There are countless options. The Da Vinci Robot is one example of this, which can assist surgeons in carrying out difficult procedures on the heart, head, neck, and other delicate areas.

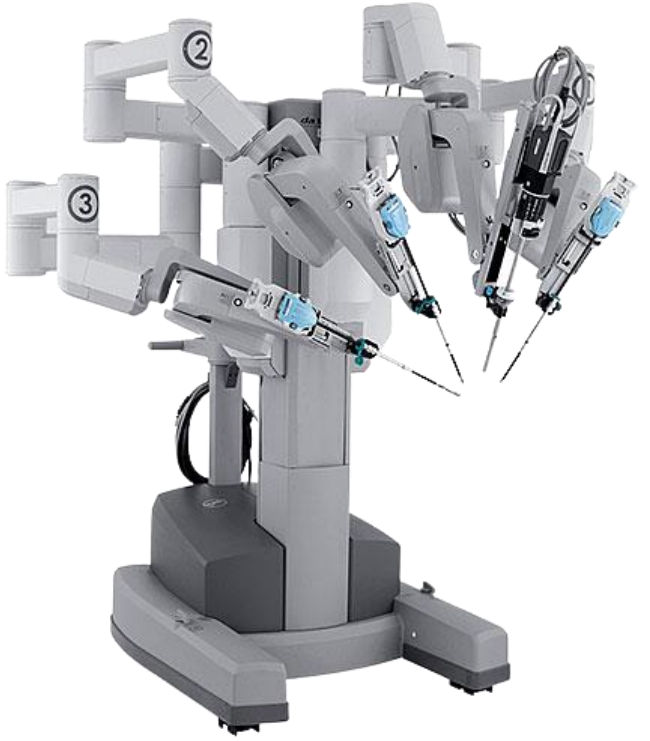


Fig 1.11 Da Vinci Robo

MANUFACTURING

Welding, assembly, packing, and other routine tasks in the manufacturing sector don't call for the use of the mind at all. Robots can efficiently complete these tasks, leaving humans to handle mentally demanding and creative tasks. Under the direction and supervision of a human, these robots can be taught to carry out these monotonous and repetitive tasks with accuracy. This choice is also the best for hazardous manufacturing procedures that might harm people.

Fig1.12 Robots in industries

MILITARY

There are numerous uses for robots in the military as well. They can be used as medics to assist friendly forces, as armed systems to attack the opposing forces, or as drones to keep watch on the enemy. MAARS (Modular Advanced Armed Robotic System), a popular robot used in the military, is designed to resemble a tank.

Fig1.13 DOGO Robot

SECURITY

Imagine if all the security guards are robots? Even thieves would be scared! That's why robots are being proposed as security agents as they can protect humans, and they wouldn't be in danger like human security guards would be. Robotics companies are presently experimenting with pairing human security consultants with robot guards.

American company Knight Scope, a leader in this industry, has autonomous security robots that can provide real-time, actionable intelligence to human security guards. Robots like these can assist in solving crimes like armed robberies, burglaries, domestic abuse, fraud, hit-and-runs, etc. Both submersibles and humans are limited in their ability to descend to that depth. Now that specialized robots have been created, it is possible to finally explore the mysterious depths of the ocean. These remote-controlled robots can explore the ocean's depths and gather information and pictures of the aquatic plant and animal life.

Fig 1.14 Security Robot by Knight Scop

SPACE EXPLORATION

There are numerous activities in space that astronauts should avoid at a Humans are unable to spend all day on Mars collecting soil samples or working on spacecraft repairs from the outside while they are in the void of space. Robots are a great option in these circumstances because there is no risk of human life being lost. Robots are a great option in these circumstances because there is no risk of human life being lost. Therefore, NASA and other space agencies frequently use robots and autonomous vehicles to perform tasks that humans cannot. For example, Mars Rover is an autonomous robot that travels on Mars and takes pictures of Martian rock formations that are interesting or important and then sends them back on Earth for the NASA scientists to study.

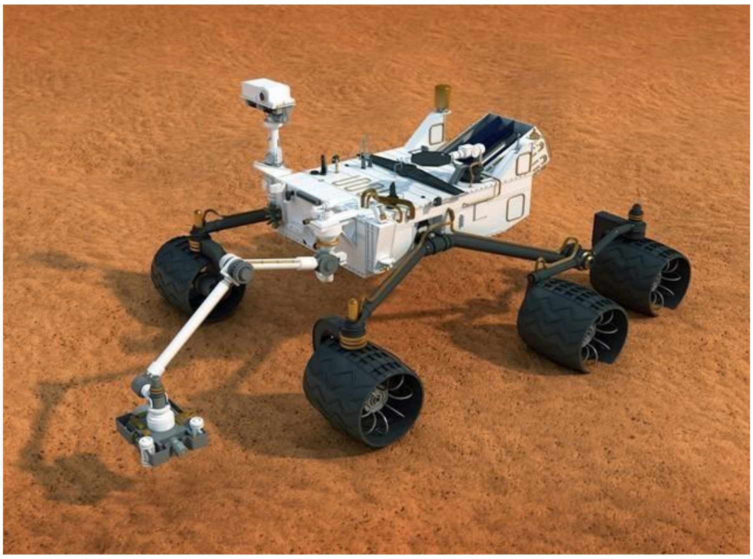


Fig 1.15 Mars Rover

ENTERTAINMENT

Another popular topic in the entertainment sector is robots. They can be used behind the scenes in movies and television shows to manage the camera, provide special effects, etc., but they can't exactly become actors and actresses. They can be employed for dull, routine tasks that are unsuitable for humans because, after all, the film industry is a creative one. Robots can also perform stunts that are extremely dangerous for people to perform but look really cool in an action movie. The magical experiences of visitors are being improved by the use of autonomous robots in theme parks like Disney World.

UNDERWATER EXPLORATION

Robots are a fantastic option for exploring locations that are difficult for humans to access, like the ocean's depths! Because of the high-water pressure in the deep ocean, neither humans nor machines like submarines can travel all the way down there. Now that specialized robots have been created, it is possible to finally explore the mysterious depths of the ocean. These remote-controlled robots can explore the ocean's depths and gather information and pictures of the aquatic plant and animal life

CUSTOMER SERVICE

There are robots created specifically to resemble humans for aesthetic reasons. These robots are primarily used in the field of customer service in high visibility areas to promote robotics.
One such example is Nadine, a humanoid robot in Singapore that can recognize people from previous visits, make eye contact, shake hands, continue chatting based on previous meetings, etc.
Another such customer service robot is Junko Chihira in Japan, a humanoid robot working at the tourist information centre in Aqua City Odaiba, a shopping centre on Tokyo's waterfront.

Fig 1.16 Junko Chihira Robot

1.4 REAL LIFE ROBOTS :

SOPHIA

Nations Hanson Robotics, a Hong Kong-based company, created Sophia, a social humanoid robot. After being activated on February 14, 2016, Sophia made her first public appearance at South-by-South West (SXSW) in Austin, Texas, in the United States, in mid-March.

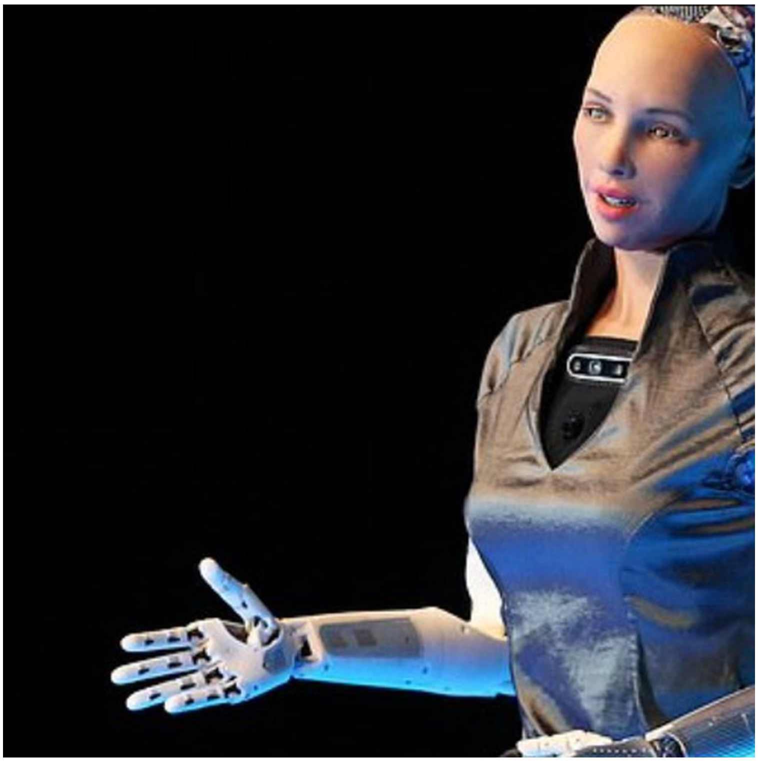


Fig 1.17 SOPHIA Robot

Sophia has been featured in numerous high-profile interviews and has been covered by media outlets all over the world. Sophia became the first robot to be granted citizenship of any nation when she received Saudi citizenship in October 2017. Sophia became the first non-human to receive a unified title when she was named the United Nations development program's first Innovation Champion in November 2017.

ASIMO

Honda developed the humanoid robot ASIMO (Advanced Step in Innovative Mobility) in 2000. It is currently displayed in the Miraikan museum in Tokyo, Japan. On July 8, 2018, Honda published the final ASIMO update on their official page, announcing that they would no longer be developing or manufacturing ASIMO robots in favor of concentrating on more useful applications for the technology they had developed over the course of ASIMO's existence.

Fig 1.18 ASIMO Robot

PEPPER

One of the first robots in the world capable of recognizing faces and emotions is called Pepper. The Pepper robots were developed by Softbank, a Japanese company, and were instantly sold out upon their initial release in 2014. They are built to interact with people, providing customer service, making product recommendations to retail customers, assisting with banking transactions, and supporting active learning in classrooms.

Fig 1.19 PEPPER – Nursing Home Robot

ROOMBA

Possibly sitting in your home right now is one of the most well-known AMR robots in the entire world. Robotic vacuum cleaner Roomba, created by iRobot in 2002, uses sensors to find its way around your house. The first of their kind, there are currently more than 40 million Roombas in residences all over the world.

Fig 1.20 ROOMBA – Home cleaning robot

You may have encountered a Da Vinci robot, but you probably were not aware of it. This is because surgical procedures use these articulated robots. When you think of medical procedures, your mind probably immediately conjures images of doctors using handheld instruments, but many surgeons actually work with such robots. Robotic surgery is not a novel concept, even though the tools have improved over time. Intuitive, the company that creates the Da Vinci surgical systems, has actually existed since the mid-1990s.

The system mimics a surgeon's movements in real time thanks to an "arm" and "wrist" that combine the best features of human anatomy with a robot's wider range of motion. For minimally invasive procedures like laparoscopic surgery and coronary artery bypass surgery, the instruments are used.

Fig 1.21 Da Vinci systems – Robot technology for surgery

ATLAS

Atlas is a bipedal humanoid robot that was primarily created by the American robotics company Boston Dynamics under the direction and funding of the DARPA. The robot, which was unveiled to the public on July 11, 2013, was initially created for a variety of search and rescue tasks.

Fig 1.22 ATLAS Robot NAO

Aldebaran Robotics, a French robotics company with headquarters in Paris that was acquired by Softbank Group in 2015 and rebranded as Softbank Robotics, developed NAO (pronounced now), an autonomous, programmable humanoid robot. With the beginning of Project Nao in 2004, the robot's development got underway. On August 15, 2007, Nao took over as the robot used in the Robo Cup Standard Platform League (SPL), an international robot soccer competition, from Sony's robotic dog Aibo.

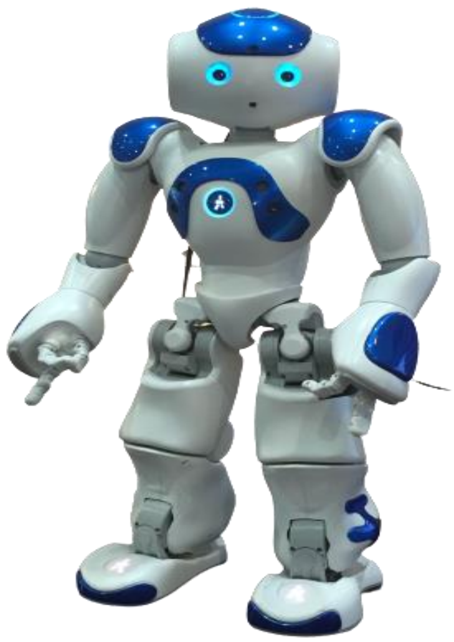


Fig 1.23 NAO Robot

The Nao was utilized for Robo Cup 2008, 2009, and 2010, and the NaoV3R was selected as the platform for the SPL. Several versions of the robot have been released since 2008. The Nao Academics Edition was developed for universities and laboratories for research and education purposes. It was released to institutions in 2008.

CHAPTER 2

LITERATURE REVIEW

Morteza Shariatee, eta1. : They discussed the mechanical design process of an industrial and cost-effective SCARA robot in this paper. A unique test trajectory was created, in which the robot accelerates to its top speed. Simulations were contrasted with experimental results of robot motion using a traditional controller and the test trajectory. It is demonstrated that the test trajectory is tracked very accurately in terms of position and speed. Additionally, using larger, more powerful motors was a result of their selection. According to the authors, the FUM SCARA is one of the most affordable SCARA robots with distinct and competitive industrial specifications.

Rahul Kumar, Sunil Lal, Sanjesh Kumar and Praneel Chand: Two classifiers for object recognition and detection, as well as the modeling and implementation of the feature extraction algorithm, were presented by the authors in this paper. The primary obstacle to the creation of this image processing algorithm was that of making the test subjects in compliance with the classifier parameters, resizing of the images conceded in the loss of pixel data. Therefore, a centered image approach method was applied.

Priyambada Mishra, Riki Patel, Trushit Upadhyaya, Arpan Desai: In this study, the robotic arm's joints were made using four servo motors, and an Arduino was used to control the movement. The controller uArduino UNO is the controller in use. The servo receives the analog input signals from theCardboard was used to construct the arm, and each component is fastened to the appropriate servo motor. The arm is specifically created to pick and place lightweight objects. Therefore, low torque servos with rotational angles between 0 and 180 have been employed. Arduino is used for programming. Thus, the paper's main focus was on building a robotic arm out of ineffective materials and using it for modest goals.

Jack Toporovsky and Harshavardhan Reddy Kunchala: For manipulator control, the author of this paper used a programmable logic controller along with two position-based and image-based artificial intelligence algorithms. There are 5 degrees of freedom for the manipulator being used. The main goal of this paper was to control the movement of the robot while performing a specific task using information from images taken by the camera and space coordinates to a specific object. The X and Y coordinates in the image frame captured by the integrated camera are output by the position determining algorithm along with a scaling factor. Measurements for grippers are made using a scaling factor.

Rahul Kumar, Sunil Lal, Sanjesh Kumar and Praneel Chand: Two classifiers for object recognition and detection, as well as the modeling and implementation of the feature extraction algorithm, were presented by the authors in this paper. Making the test subjects comply with the classifier parameters was the main difficulty in developing this image processing algorithm, as resizing the images resulted in the loss of pixel data. A centered image approach method was therefore used.

Virendra Patidar, Ritu Tiwari: The components of a robotic arm are the subject of this research paper. They provided a technical overview of some of the most recent robotic arm research. Axis, degree of freedom, working envelope, kinematics, payload, accuracy, and repeatability are the parameters they concentrated on. There is an ongoing development in the field of number of axes but this field has experienced very little progress

Sonick Suri , Anjali Jain , Neelam Verma: They covered the fundamental procedures involved in designing the SCARA robot in They claimed that SCARA robots can address current trends in manufacturing, such as short commodity cycles, small volumes, and a wide variety of orders. The paper outlines the potential applications for SCARA robot and focuses on its study. The paper focuses on the study of SCARA robot and outlines the possibilities of use of SCARA robot. The paper tells us on the pick and place operation of SCARA robot in industrial automation and offers comparison of SCARA robot with Cartesian robots.

CHAPTER 3

DESIGN OF ROBOTIC ARM

3.1 DESIGN OF ROBOTIC ARM IN SOLID WORKS

Dassault Systems owns the computer-aided design (CAD) program Solidworks. The part, the assembly, and the drawing are three types of interconnected files that are produced using the parametric design principle. This means that any changes made to one of these three files will also be seen in the other two. You can perform 2D and 3D modeling with the aid of Solidworks, and this CAD program is renowned for its simplicity and intuitiveness. The Solidworks software's user interface is depicted in figure 3.1.

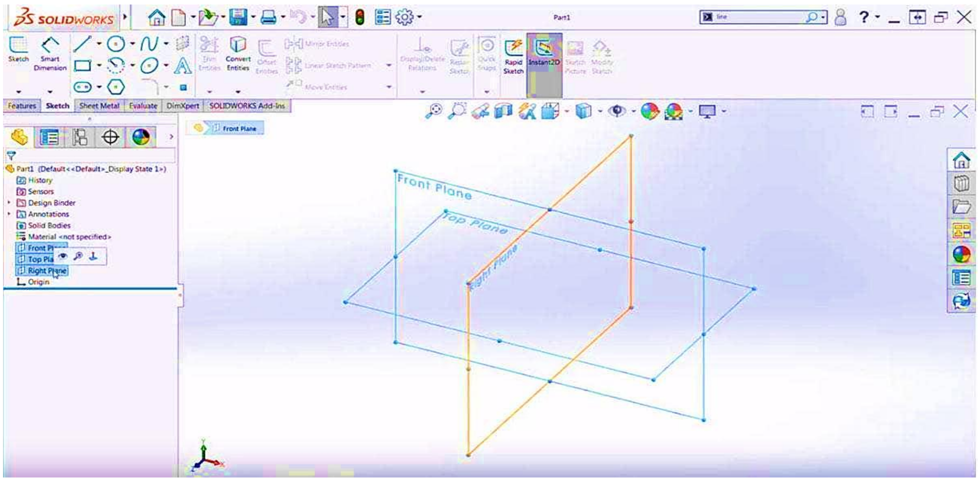


FIG : 3.1 SOLID WORKS INTERFACE

FEATURES:

1. Part and assembly modelling
2. 2D drawings
3. Design re-use and automation
4. Animation and visualization
5. Interference check
6. Collaborate and share CAD data (3D interconnect & e Drawings)
7. Advanced CAD file import
8. Basic analysis tools (Simulation Xpress & Flo Xpress)
9. Design for manufacturing.

APPLICATIONS:

1. Designing: Direct or parametric solid modeling of surfaces.
2. Manufacturing is the process of creating products, such as machine modules.
3. Engineering analysis includes such things as thermal analysis, fluid analysis, and electromagnetic analysis.

3.2 DESIGN OF ROBOTIC ARM IN SOLIDWORKS:

The Solidworks software is used to design various components of the Robotic Arm. In the "part modelling section," various parts are initially designed using the standard dimensions. The "Assembly section" of the Solidworks software is where the final assembly is carried out after all the parts and necessary sub-assemblies have been designed. The proper mating is provided during the Assembly. In the part modeling section, a number of parts are designed, including Base, Robot gripper, Link 1, Link 2, servo holder, etc. These parts are all assembled in the Assembly section to produce the Final Assembly.

STEP 1:

The Part modelling section of the Solidworks software is where various components of the Robotic Arm, such as the Base, Robot gripper, Link 1, Link 2, servo motor, eThe 2D shapes are drawn using a variety of commands, such as line, rectangle, arc, etc., and are then extruded to the necessary size using the extrude command. the required size. The designs for the Base, Robot gripper, Link 1, Link 2, and servo motor in Solidworks are shown in Figures 3.2, 3.3, and 3.4. In the similar all the Robot parts are designed in the Solidworks software.

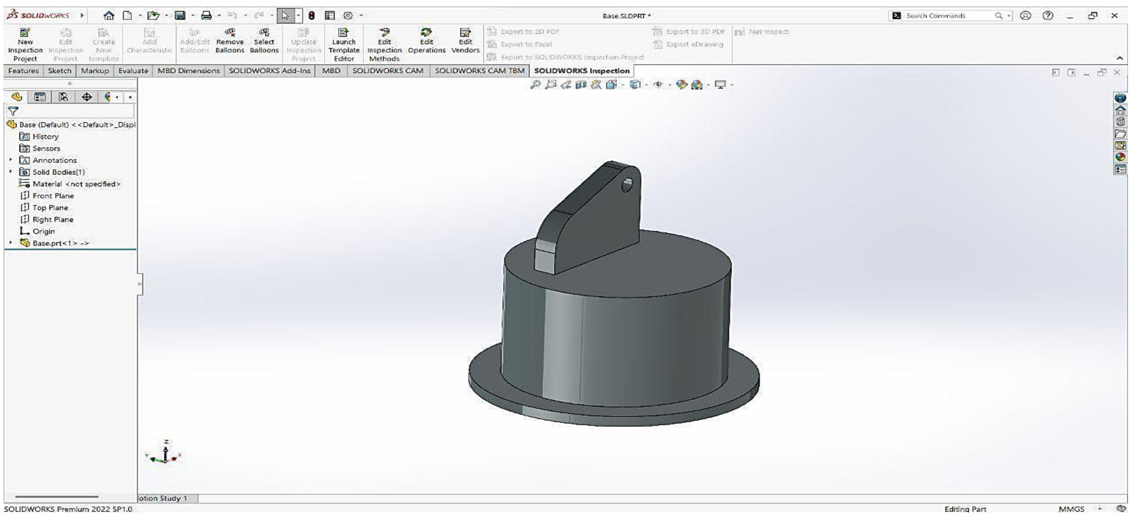


FIG 3.2 BASE

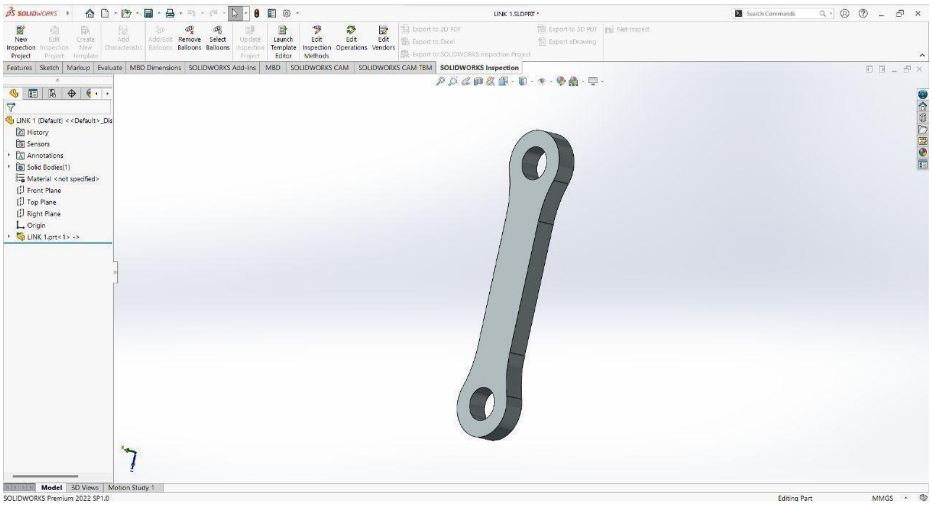


FIG 3.3 LINK 1

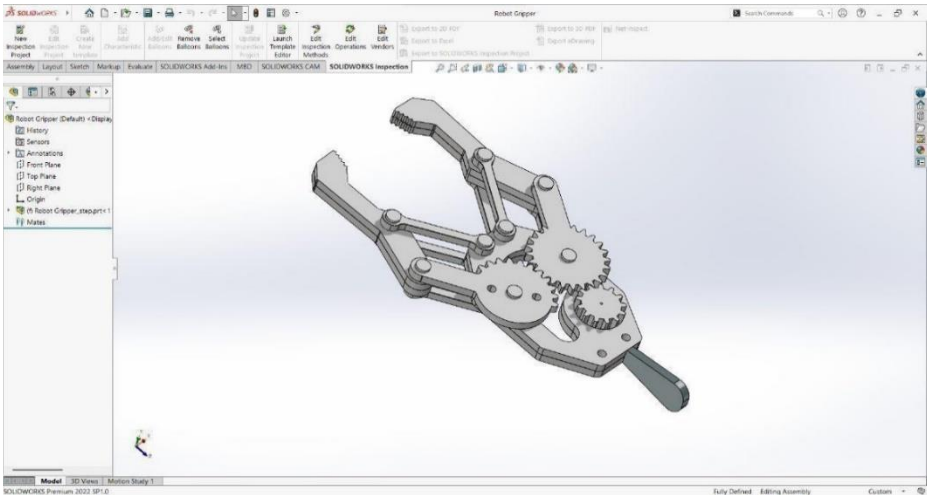


FIG 3.4 ROBOT GRIPPER

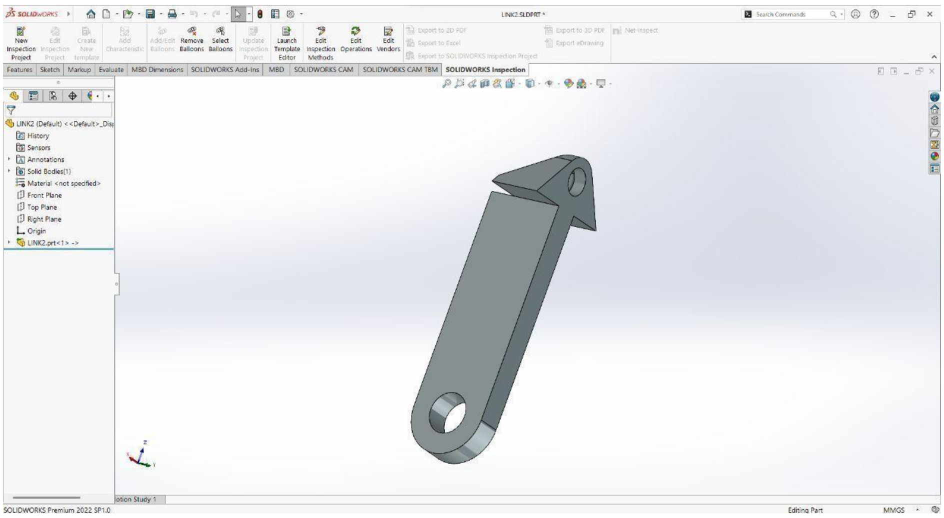


FIG 3.5 LINK 2

STEP 2:

The Solidworks software's Assembly section is where the necessary sub-assemblies are created after the individual parts have been designed in the Part Modeling section. The design of the final Assembly is greatly simplified by these sub-assemblies. The "Mate" command is used to pair up components. The sub-assemblies are designed with proper mating in mind.

STEP 3:

Finally, using the "Insert Components" command, all necessary individual parts and sub-assemblies are added to the Assembly section, and certain commands, such as "Coincident," "Concentric," etc., are correctly used to design the final assembly. The figure 3.5 shows the Final assembly of the Robotic Arm.

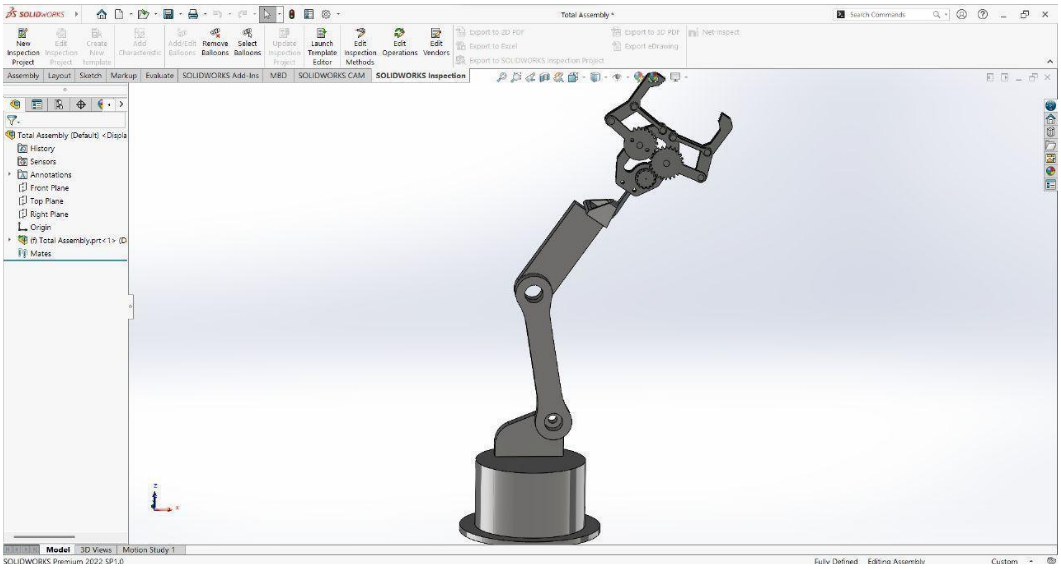


FIG 3.6 TOTAL ASSEMBLY

3.3 PARTS OF ROBOTIC ARM

FLASH FORGE DREAMER 3D PRINTER

1. Dreamer is a trustworthy 3D printer that can reliably produce prints of the highest quality at resolutions as small as 100The build plate is made of 6.5mm thick alloy of aluminum, the same grade used in the aerospace industry, and it has an adaptable printing chamber for printing with different filaments. It also has excellent heat distribution and Dreamer is a more dependable 3D printer thanks to premium components and cutting-edge assembly lines.Dreamer a more reliable 3D printer

2. Temperature is essential for printing with ABS filament. Dreamer has a door that can be closed and a top lid that can be removed to keep out dust and foreign objects while removing temperature interference from the outside environment. For high-quality ABS Prints, the built-in heat-controlling sensor automatically turns on fans to stabilize the printing temperature.

Figure 3.7. Flash forge Dreamer 3-D Printer

3. The Dreamer build plate is constructed from 6.5mm thick aluminum that is the same grade as that used in the aerospace industry. It is the highest-grade alloy ever used and has excellent heat distribution. A few crucial elements have been shown to produce accurate and dependable prints.

4. With a patent nozzle structure, filament loading is smooth and steady, and it suitable for most mainstream printing filaments in the market. The side is equipped with turbofan to provide air which can effectively improve the modelling effect Being expert in dual colour printing and dual filament printing

PLA FILAMENT

Polylactic acid, also known as PLA plastic, is a vegetable-based plastic substance that frequently uses cornstarch as a raw material. The monomer is usually made from fermented plant starch. The main natural raw material used in 3D printing is this thermoplastic aliphatic polyester. A thermoplastic polymer made of renewable raw materials; PLA is fully biodegradable. Among all 3D printing materials, PLA is part of the most popular materials used in filament production in additive manufacturing.

Figure 3.8. PLA Filament

In comparison to ABS and nylon, PLA is a more user-friendly thermoplastic with greater strength and stiffness. PLA is one of the materials that 3D printers can successfully use the most because it has a low melting point and little warping.

PRINTING OF PARTS

1. The files in the Solidworks program are first saved in the STL format, which is necessary for the flash print.
2. The file is then opened in the flash print and sent to the dreamer 3D printer as the next step.
3. Now the 3D printer automatically prints the required parts with the required dimensions.
4. Fill Density, Fill Pattern, Print Speed, Travel Speed, Left Extruder Temperature, Platform Temperature, and other input instructions are provided to the printer.
5. Finally, using PLA filament and the Dreamer 3D printer, all the components are printed.
6. Now the 3D printer automatically prints the required parts with the required dimensions.
7. Fill Density, Fill Pattern, Print Speed, Travel Speed, Left Extruder Temperature, Platform Temperature, and other input instructions are provided to the printer.
8. Finally, using PLA filament and the Dreamer 3D printer, all the components are printed.

Figure 3.9. File transfer from Flash print software to Printer

PRINTED PARTS:

Before starting the printing operation, we need to place the PLA filament in the Extruder as shown in the figure 3.9.

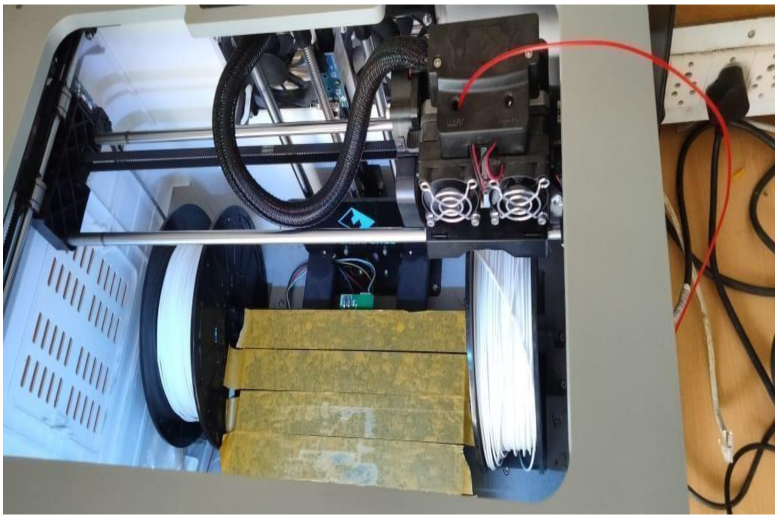


Figure 3.10. PLA filament placed in the left Extruder

Once the setup is done, we need to start the printer and start the printing operation.

DURING PROCESS:

The figures 3.10 and 3.11 show the 3D printing process of the Robot foot and some other parts. All the parts are similarly printed using the Flash forge Dreamer 3D printer. The Nozzle gets heated upto 200 ºC and it melts the filament and then it makes layers on the printer platform as shown in the figure 3.10. Once the printing is completed, we need to let the platform cool for some time and then collect the part from the printer.

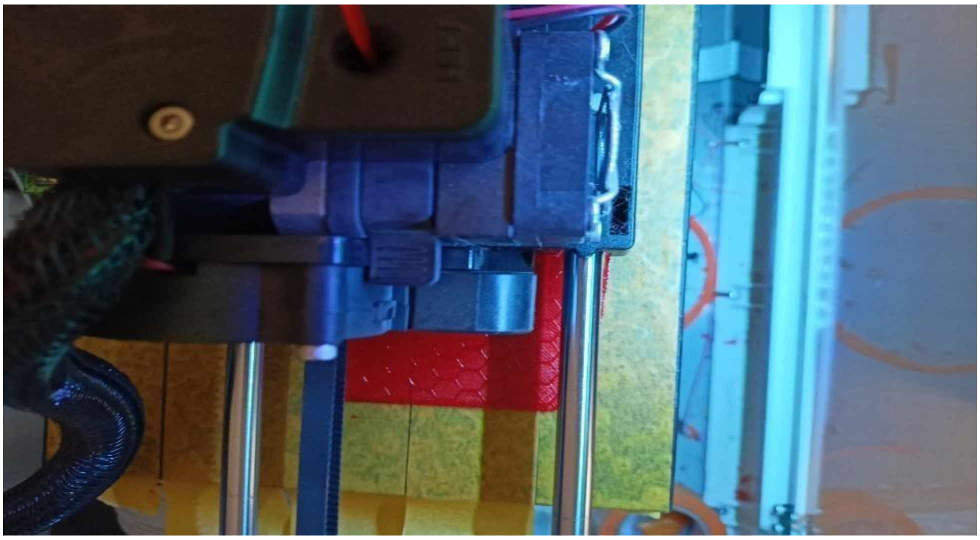


Figure 3.11. Layer by Layer printing on printer platform

COMPONENTS USED

MG995 SERWOMOTOR:

A high-speed standard servo, the MG995 Metal Gear Servo Motor is used in many RC models, including RC cars, helicopters, and airplanes. It can rotate approximately 180 degrees (60 in each direction). delivers 12kg/cm at 6V and 10kg/cm at 4.8V. It is a digital servo motor that more quickly and effectively receives and processes PWM signals.

Figure 3.12. MG995 Servo Motor

It is outfitted with sophisticated internal circuitry that offers strong holding power, good torque, and quick updates in response to outside forces. They are protected by a tight, durable plastic case that keeps them dry and dust-free, which is a very helpful quality in RC boats, monster trucks, and other vehicles. It comes with a 3-wire JR servo plug that works with Futaba connectors.

WIRE DESCRIPTION:

1. RED – Positive
2. Brown – Negative
3. Orange – Signal

SPECIFICATIONS:

1.Weight: 55g

2. Dimension: 40.7 × 19.7 × 42.9 mm

3.Operating Speed (4.8V no load): 20 seconds at 60 degrees

4. Operating Speed at 6.0 volts without a load: 16 seconds at 60 degrees

5. Stall Torque (10kg/cm, 4.8V)

6. Stall Torque (12 kg/cm, 6.0V)

7. 4.8 - 7.2 volts for operation

8. All-metal gears as the gear type

9. Double ball bearing design that is stable and shockproof.

10. Dead band width: 5 µs

11. 0°C to 55°C is the temperature range.

12. Analog Control System

12. Operational Angle: 120 degrees

14. Needed Pulse: 900us to 2100us

FEATURES:

1. There is a thicker connection cable.
2. Equips high-quality motor.
3. High resolution
4. Accurate positioning
5. Rapid control reaction
6. Constant torque over the full range of the servo
7. Outstanding holding power.

ARDUINO UNO

1. Arduino UNO is a low-cost, flexible, and easy-to-use programmable open-sourcemicrocontroller board that can be integrated into a variety of electronic projects. Relays, LEDs, servos, and motors can be controlled by this board as output devices, and it can interface with other Arduino boards, Arduino shields, and Raspberry Pi boards.

2. AVR microcontroller Atmega328, six analog input pins, and 14 digital I/O pins, six of which are used for PWM output, are all included in the Arduino UNO.

3. This board has a USB interface, which enables it to be connected to a computer using a USB cable and programmed using the Arduino IDE (Integrated Development Environment) program.

4. While the SRAM is 2KB and the EEPROM is 1KB, the device has 32KB flash memory, which is used to store the number of instructions.

5. The operating voltage of the unit is 5V which projects the microcontroller on the board and its associated

6. The input voltage ranges from 6V to 20V, with 7V to 12V being the recommended range, while the circuitry operates at 5V.

ARDUINO UNO COMPONENTS:

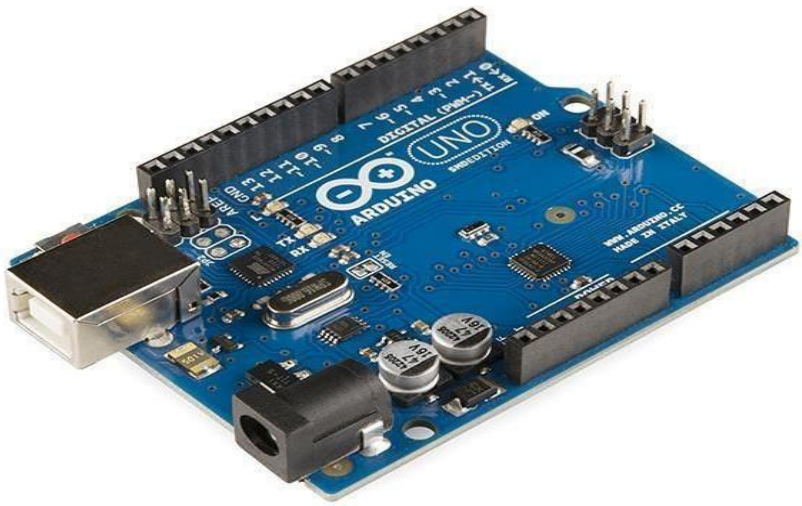


Figure 3.13. Arduino UNO board

The following features and parts are found on the Arduino UNO board:

1. ATmega328: This is the brain of the board where the program is stored.

2. Ground Pin: there are several ground pins incorporated on the board.

3.PWM: There are six PWM pins on Pulse width modulation, or PWM, is a technique that allows us to regulate the speed of servo and DC motors as well as the LED's brightness**.**

4. Digital I/O Pins: The board has 14 digital (0–13) I/O pins that can be connected to outside electronic devices.

5. Analog Pins: Six analogue pins have been integrated onto the board. The analogue sensor can be read by these pins and converted into a digital signal.

6. AREF: It is an Analog Reference Pin used to set an external reference voltage.

7. Reset Button: Pressing this will clear the board's code. Pressing this button will bring the board back to its initial state, which is helpful if it hangs.

8. USB Interface: The board is connected to the computer using this interface, which is also used to upload Arduino sketches (an Arduino sketch is a program).

9. DC Power Jack: This is used to power the board with a power supply.

10. Power LED: When the board is connected to a power source, this power LED turns on.

11. Micro SD Card: The UNO board is compatible with a micro-SD card, which enables the board to store more data.

1. 3.3V: This pin is used to power your projects at 3.3 volts.

2. 5V: Your project is powered at 5V using this pin.

13. VIN: The voltage applied to the UNO board.

14. Voltage Regulator: This device regulates the voltage that enters the circuit board.

15. SPI: Serial Peripheral Interface is what SPI stands for. For this communication, four pins—10(SS), 11(MOSI), 12(MISO), and 13(SCK)—are used.

16. TX/RX: Serial communication is conducted using pins TX and RX**.** A transmit pin (TX) is used to send serial data, and a receive pin (RX) is used to receive serial data.

BREAD BOARD:

1. A breadboard serves as the foundation for building electronic prototypes. The term "bread board" originally referred to a polished piece of wood used for slicing bread.
2. To create temporary circuits for testing or to try out an idea, use a breadboard. It is simple to change connections and replace components because no soldering is necessary. Parts are not damaged and can be re-used afterwards.
3. Almost all the Electronics Club website projects started life on a breadboard to check that the circuit worked as intended.
4. A breadboard makes it simple and quick to build temporary electronic circuits or conduct circuit design experiments.
5. Breadboards allow programmers to quickly connect wires or components due to the rows and columns of internally connected spring clips underneath the perforated plastic enclosure.

JUMPER WIRES

Simply put, jumper wires are wires with connector pins at each end that can be used to connect other wires.

Without soldering, attach two points to one another. With breadboards and other prototyping tools, jumper wires are frequently used to make it simple to change a circuit as required.

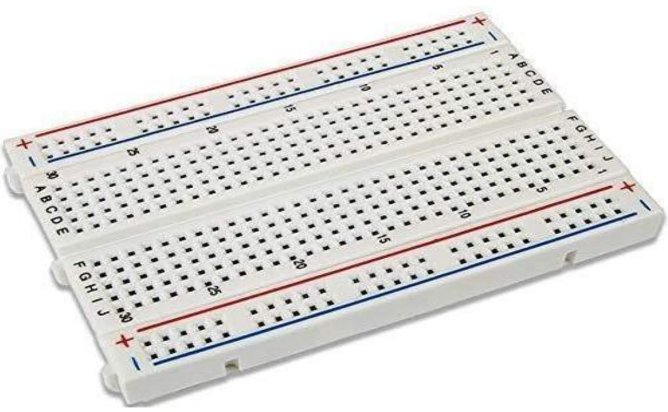


Fig 3.14 Bread Board

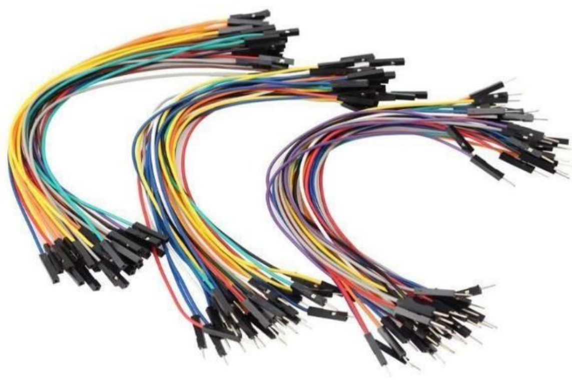


Fig 3.15 Jumper wire

CHAPTER 4

ANALYSIS OF ROBOTIC ARM

Introduction to finite element analysis:

Approximate solutions to a wide variety of engineering problems Although it was initially created to research stresses in intricate airframe structures, continuum mechanics has since been expanded upon and uses it extensively. It is getting a lot of attention in engineering schools and industry due to its diversity and adaptability as an analytical tool. For the numerical resolution of numerous engineering problems, the finite element method has developed into a potent tool. The use of FEM in research and industry has increased as a result of developments in computer technology and CAD systems because complex problems can now be modeled and published with relative ease.

Basic Steps in the Finite Element Analysis:

The basic steps involved in finite element analysis consist of the following

a) Pre-Processing Phase:

Create and divide the real continuum into nodes and elements in order to discretize the solution domain.

Assume a shape function to represent an element's physical behavior, which entails assuming a roughly continuous function to represent the element's solution.

- Create equations for each component of the mesh.

- Typically, these take shape
- [K]{U} = {F}
- Where '[K]' is a square matrix, known as stiffness matrix
- '{U}' is the vector of (unknown) nodal displacements or temperature
- '{F}' is the vector of applied nodal forces
- The equations for the entire problem can be obtained by assembling the fundamental equations. Create the matrix of global stiffness.
- Apply loading, initial conditions, and boundary conditions.

(B) Solution Phase:

To obtain nodal results of primary degrees of freedom or unknowns, such as displacement values at various nodes in a structural problem or temperature values at various nodes in a heat transfer problem, one must simultaneously solve a set of linear or nonlinear algebraic equations.

b) Post processing phase:

- Computation of any secondary unknowns or variables e.g., the gradient of the solution.
- Interpretation of the results to check whether the solution makes sense.

Introduction to ANSYS Workbench:

The foundation upon which the industry's most comprehensive suite of advanced engineering simulation technology is built is ANSYS Workbench. The entire simulation process is tied together by an inventive project schematic view, which leads the user through each step. Drag-and-drop simplicity allows even complex multi-physics analysis to be completed.

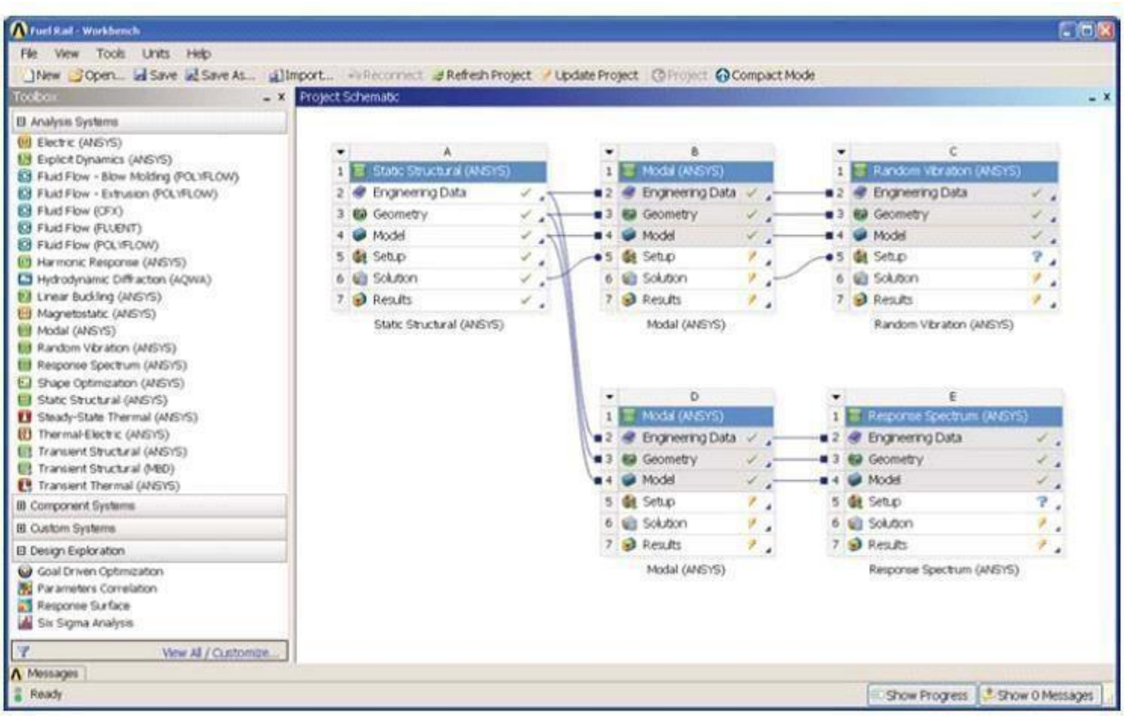


Fig 4.1: Workbench 21 R2 Interface

In order to minimize data storage and make it simple to study the effects of geometry changes on both analyses, the ANSYS Workbench platform automatically creates a connection to share the geometry for both the fluid and structuraFurthermore, a link is established to automatically transfer pressure loads from the fluid analysis to the structural analysis.

The toolbox and the project Schematic are the two main sections of the ANSYS Workbench interface. The system templates that can be used to build a project are in the toolbox. The section of the interface where we can manage our project is called the project Schematic. An overview of the entire simulation project can be seen in the new project schematic view. Even for complex analyses involving multiple physics, engineering intent, data relationships, and the status of the entire project are visible at a glance. You will also see a toolbar with frequently used functions and a menu bar. Additionally, you can use the context menus that appear when you right-click on cells and schematic elements. Project addition and modification options are offered by context menus. The entire procedure is tenacious.

ANSYS Workbench Features:

Links that are parametric and bidirectional with all popular CAD systems.

- ANSYS Design Modeler-based geometry modeling, repair, and simplification that is integrated and analysis-focused.
- Physics-aware meshing that is highly automated.
- Automatic detection of contacts.
- Unmatched breadth of expertise within each physics discipline.
- Unmatched variety of simulation-related technologies.
- Complete analysis systems that walk the user through the process from beginning to end.
- With drag-and-drop simplicity, a comprehensive multi-physics simulation is provided.
- Tools can be deployed to best suit engineering intent thanks to flexible components.
- Innovative project schematic views make it possible to quickly understand engineering data relationships and the status of the project.
- Schematics for complicated projects can be saved and reused.
- Pervasive, project-level parameter management across all physics.
- Automated what-if studies with built-in design point functionality.

- An adaptable architecture with scripting, journaling, and API capabilities enables the quick integration of new and outside solutions.

Structural Analysis:

The finite element method is probably used the most frequently in structural analysis. In addition to civil engineering structures like bridges and buildings, the term "structural" also refers to mechanical, aeronautical, and naval structures like ship hulls, aircraft bodies, and machine housings, as well as mechanical parts and tools like pistons.

1. Static Analysis:

Used to calculate displacements, stresses, etc. under the conditions of static loading. Both linear and nonlinear static analysis are included. Plasticity, stress stiffening, large deflection, large strain, hyperelasticity, contact surfaces, and creep are examples of non-linearity.

2. Explicit Dynamics Analysis:

An interface to the LS-DYNA explicit finite element program is provided by ANSYS, which is used to quickly calculate solutions for complex contact issues and large deformation dynamics.

Additional to the aforementioned analysis types, a number of specialized features are available.

- Fracture
- Mechanics
- Composites
- Fatigue

STATIC STRUCTURAL ANALYSIS:

STEP 1: SELECTION OF ANALYSIS FEATURE STEP 2: ENGINEERING DATA

STEP 3: INSERTION OF

STEP 4: MODEL

STEP 5: MESHING

STEP 6: INSERTION OF SUPPORTS AND FORCES STEP 7: ANALYSIS

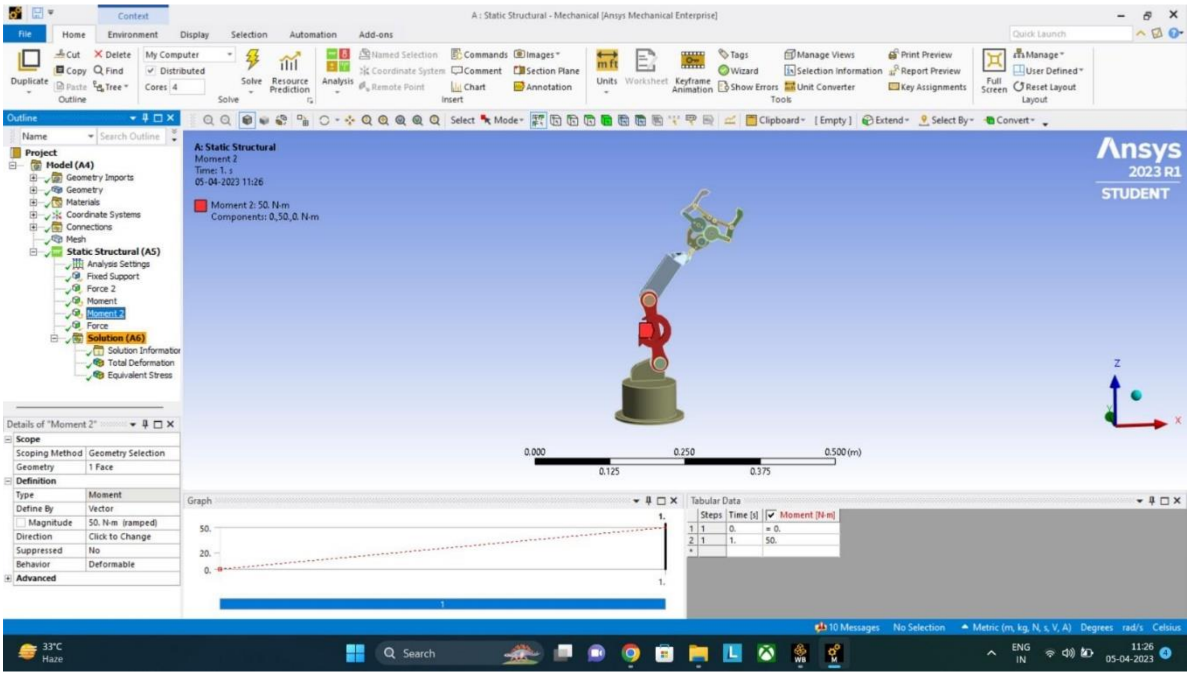


Fig 4.2 Static Structural Analysis

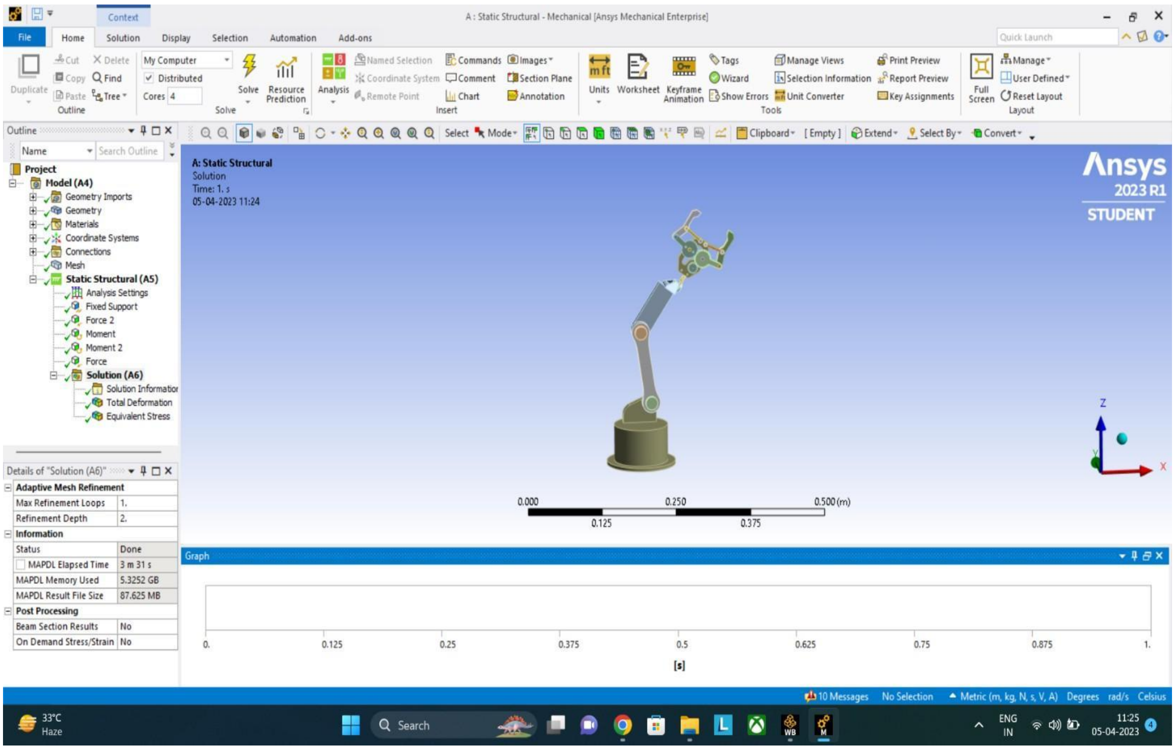


fig 4.3 structural analysis 2

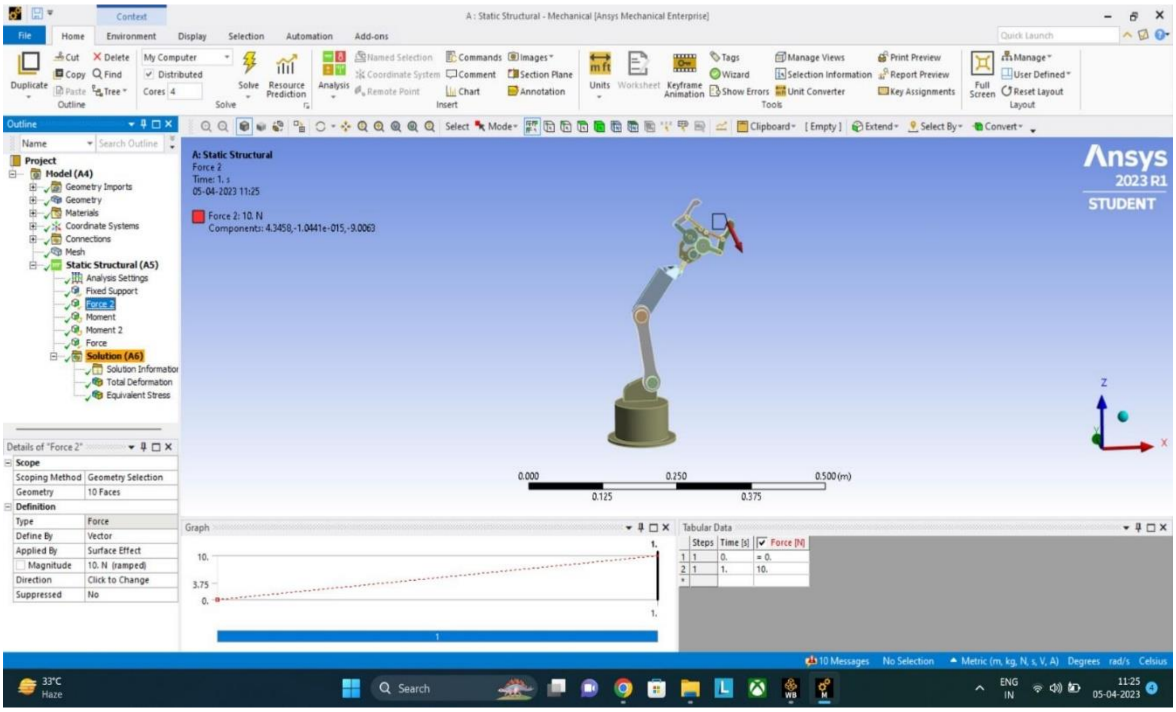


FIG 4.4 Force Analysis on Gripper

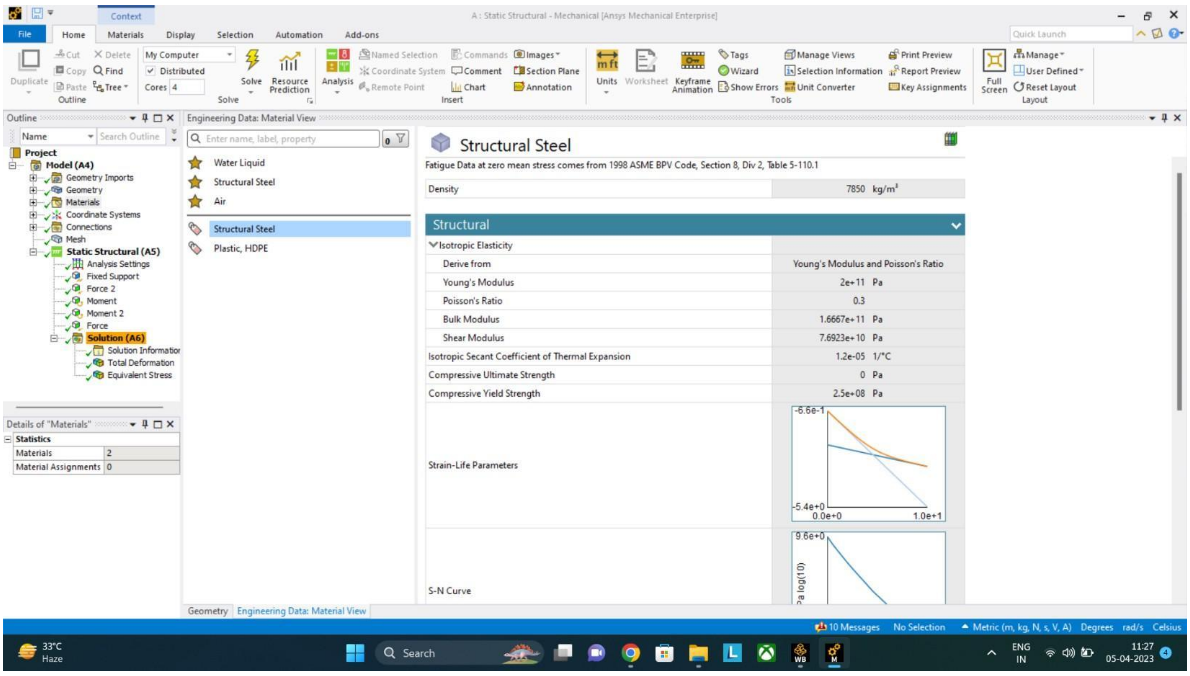


FIG 4.5 Young's Modulus and Poisson's Ratio

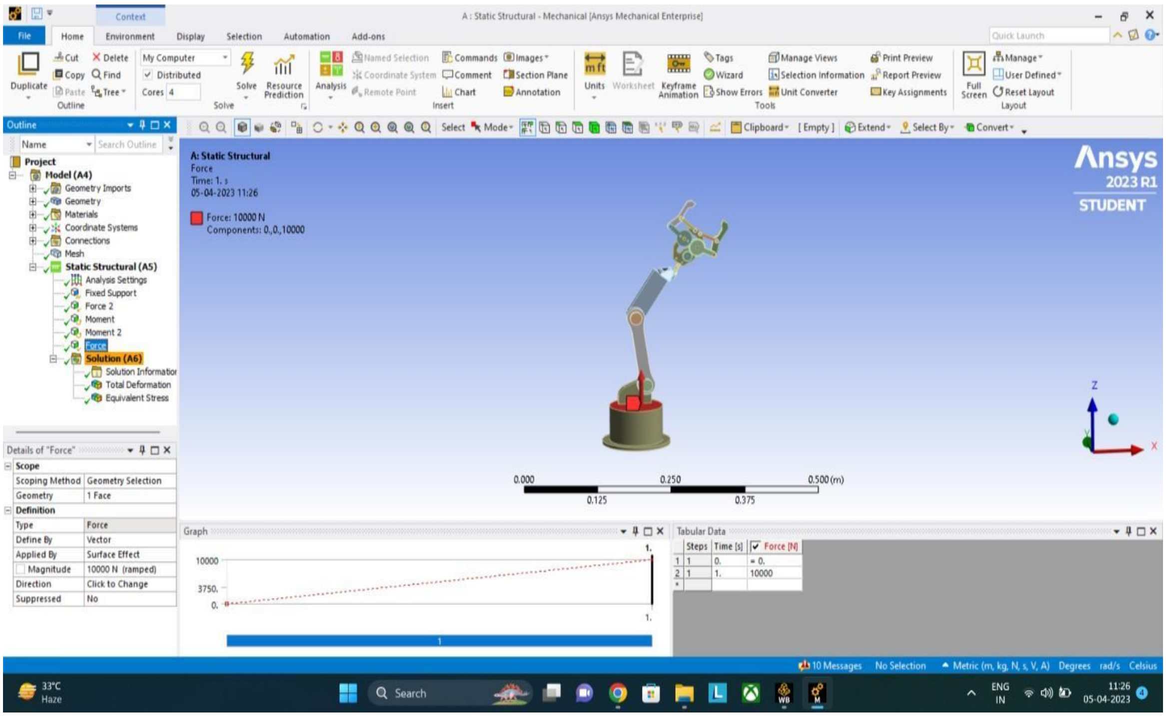


FIG 4.6 Force-10000N applied on Base

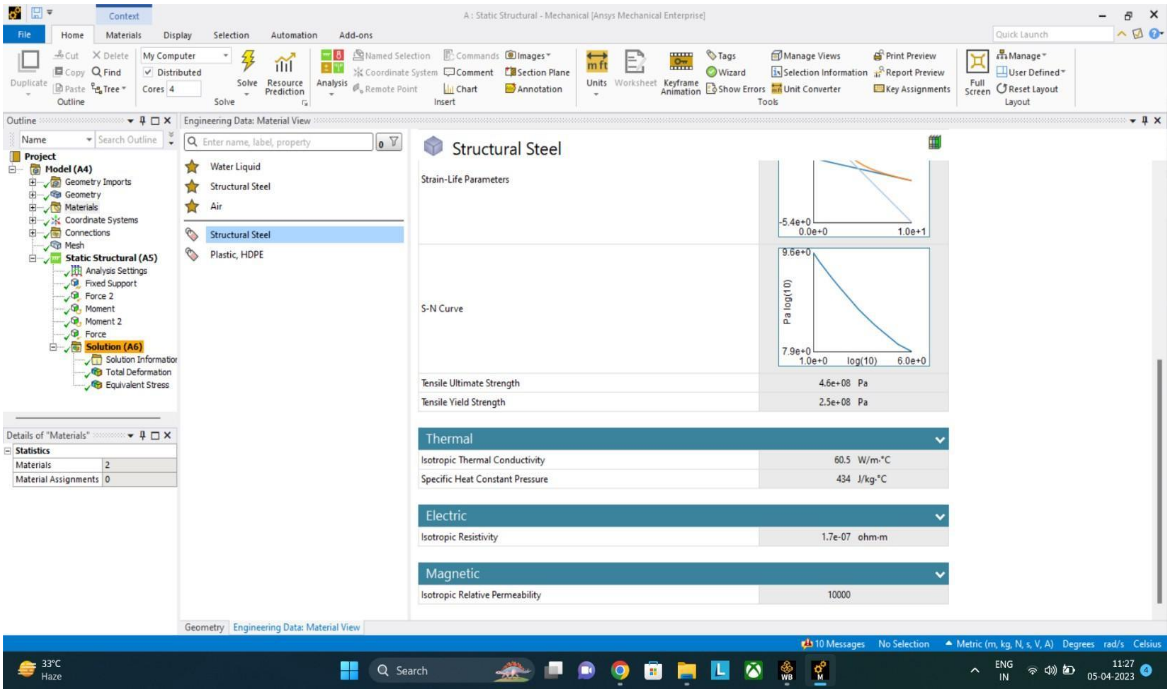


FIG 4.7 Thermal Electric Magnetic Properties

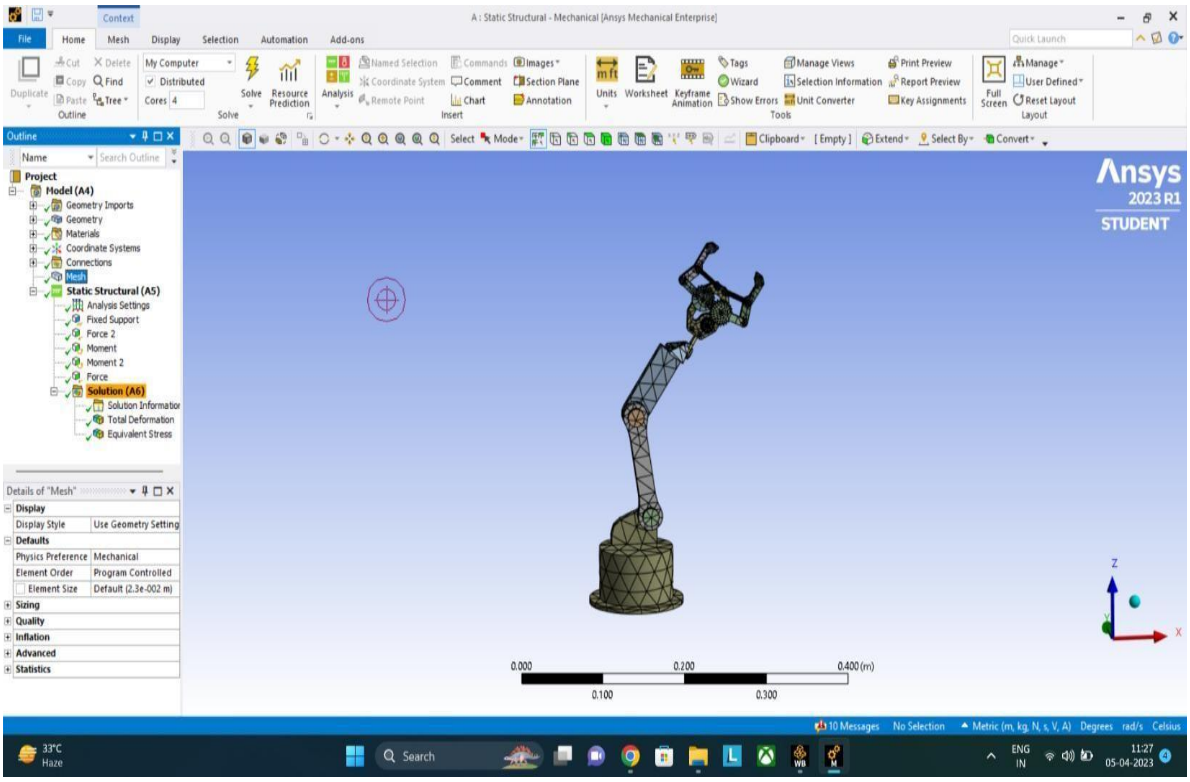


FIG 4.8 Mesh Analysis on Robotic Arm

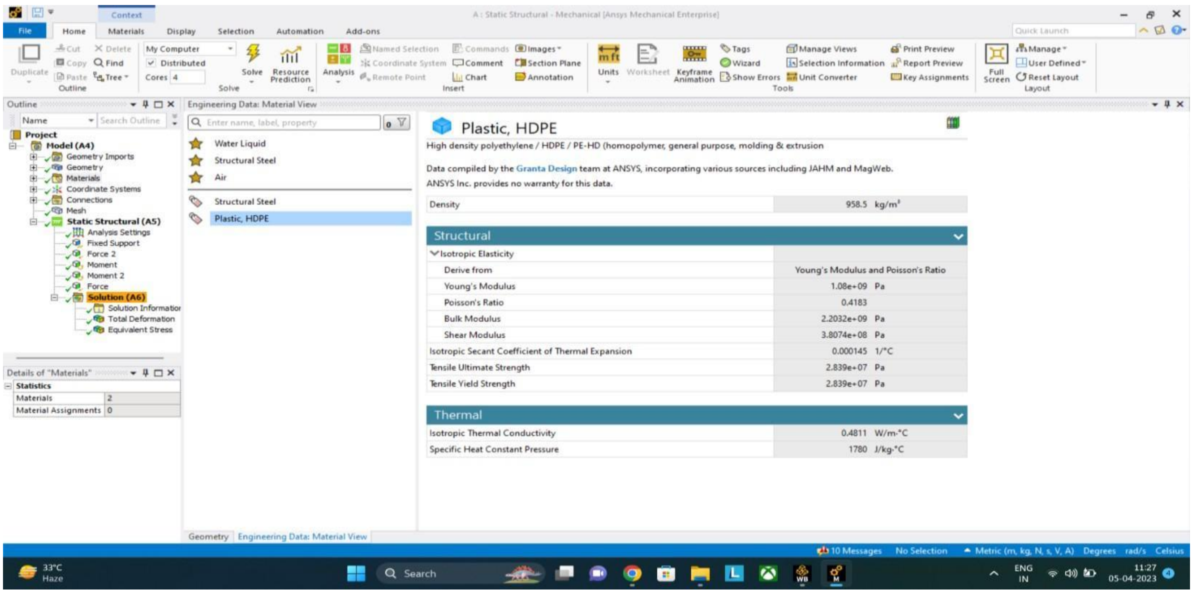


FIG 4.9 Plastic,Hdpe Properties

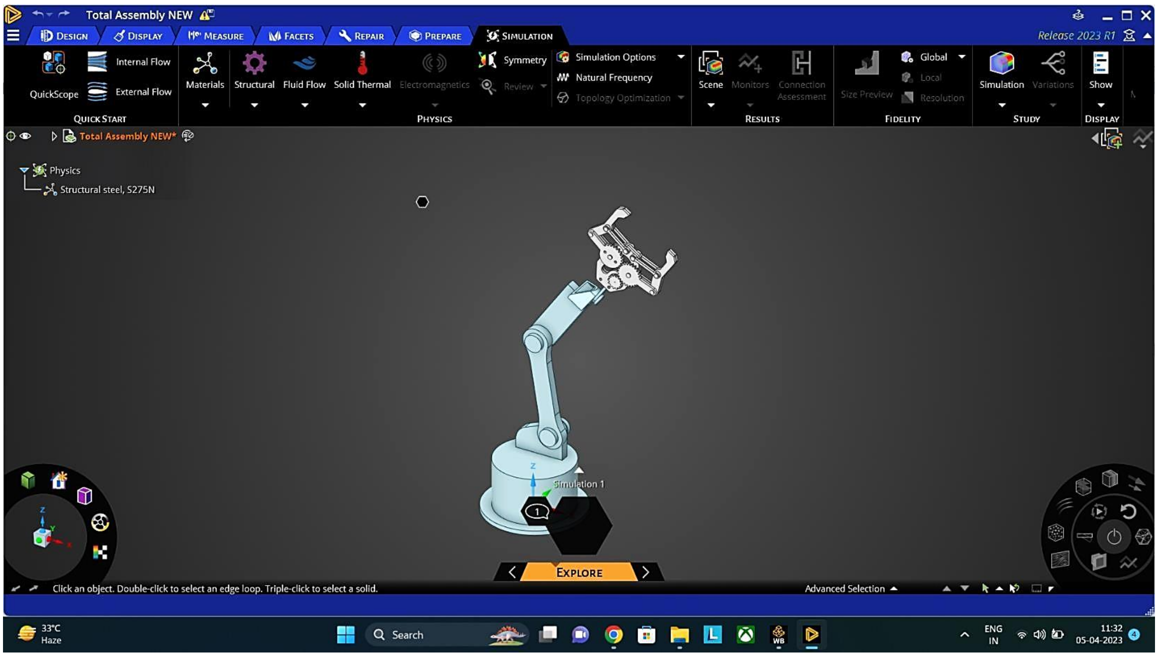


FIG 4.10 Total Assembly

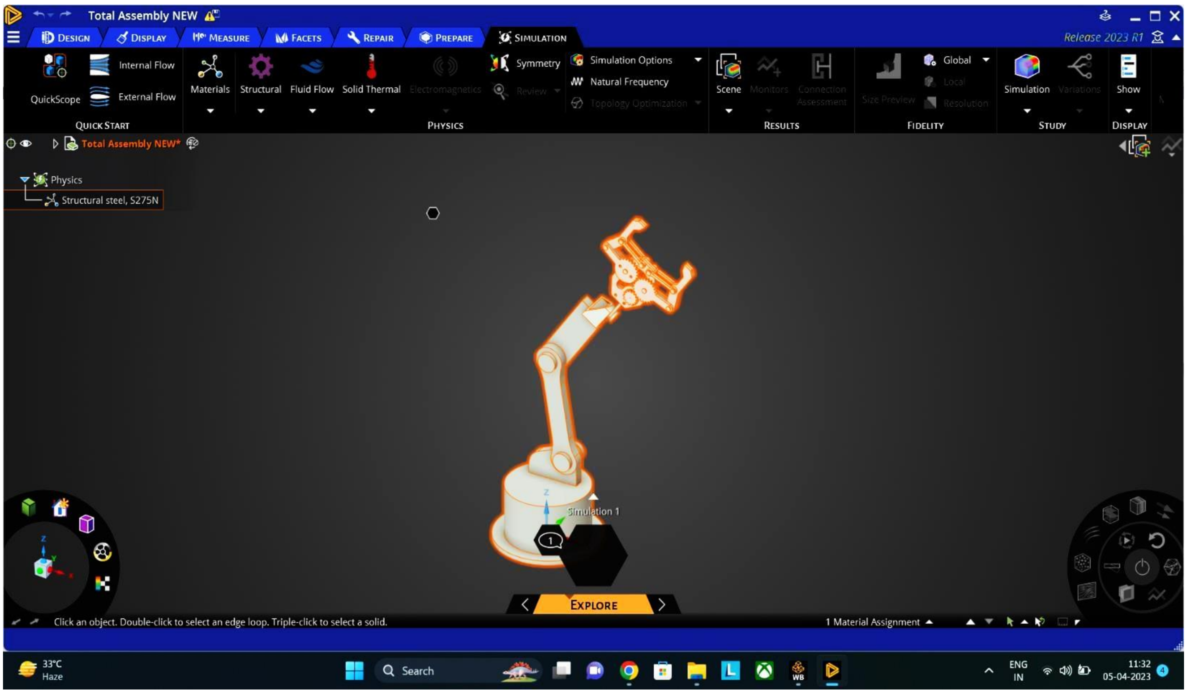


FIG 4.11 Deformation of Robotic Arm

CHAPTER 5

RESULTS AND DISCUSSIONS

STATISTICAL STRUCTURAL ANALYSIS FILES (A5)

SOLUTION OPTIONS

3D DEGREES OF FREEDOM, PROBLEM DIMENSIONALITY, UX UY UZ

ASSESSMENT TYPE

TEMPERATURE

FROM ABSOLUTE ZERO 273.15 TEMPERATURE

ELEMENT SOLVER OPTION SPARSE

GLOBALLY ASSEMBLY MATRIX SYMMETRIC

Symmetric Deformable: A contact element type 31-identified symmetric deformable-deformable contact pair has been established. The real constant set ID for the companion pair is 32. The behavior of both pairs ought to be the same.

Asymmetric contact will result from ANSYS deactivating the current pair while keeping its companion pair.

Linear contact is defined

Contact formula: Augmented Lagrange method Detection of contacts at: Integration point for Gauss

FKN, or contact stiffness factor, 10.000

Initial contact stiffness obtained is 0.72000E+14, and

default penetration tolerance factor is 0.10000.

The resulting penetration tolerance 0.30000E-0

It will open with OPSF, the default opening contact stiffness.

FKT 1.0000, the default tangent stiffness factor

Maintain constant contact stiffness.

Default TAUMAX maximum friction stress 0.10000E+21

Average contact pair depth is 0.30000E-02, Average contact surface length is 0.36910E-02.

PINB 0.25000 is the standard pinball region factor.

0.75000E-03 is the resulting pinball region.

There are at least 92 target elements in one of the contact searching regions. You may reduce the pinball radius.

Initial penetration or gaps are not considered. The term "bonded contact" is defined.

Between contact element 99613 and target element 100438, there was a maximum initial penetration of 3.469446952E-18.

Symmetric Deformable: Set up is a pair of symmetric deformable-deformable contacts identified by the real constant set 32 and the contact element type 31. The real constant set ID for the companion pair is 31. The behavior of both pairs ought to be the same.

Asymmetric contact results from ANSYS keeping the current pair while deactivating its companion pair.

The definition of linear contact

Contact algorithm: Lagrange technique

At the Gauss integration point, contact detection

Contact stiffness factor FKN 10.000

Initial contact stiffness obtained is 0.72000E+14, and default penetration tolerance factor is 0.10000.

The resulting tolerance for penetration is 0.14641E-04. It will open with OPSF, the default opening contact stiffness. FKT 1.0000, the default tangent stiffness factor

keep the contact stiffness constant.

Default TAUMAX maximum friction stress 0.10000E+21 0.30687E-03 is the average contact surface length.

0.14641E-03 is the average contact pair depth. PINB 0.25000 is the standard pinball region factor.

0.36603E-04 is the resulting pinball region. Initial penetration or gaps are not considered.

The term "bonded contact" is defined.

Between contact element 99829 and target element 99597, a maximum initial penetration of 5.204170428E-18 was found.

A maximum geometric gap of 7.768765738E-06 between contact element 99620 and target element 99597 has been found.

Symmetric Deformable: A contact element type 33 and symmetric deformable-deformable contact pair, identified by real constant set 34, have been established. The real constant set ID for the companion pair is 33. The behavior of both pairs ought to be the same.

ANSYS will deactivate the current pair and keep its companion pair,

resulting in asymmetric contact. The definition of linear contact

Contact formula: Augmented Lagrange method Detection of contacts at: Point of Gauss integration

FKN 10.000, the contact stiffness factor

Initial contact stiffness obtained is 0.72000E+14, and default penetration tolerance factor is 0.10000.

The resulting tolerance for penetration is 0.30000E-03. It will open with OPSF, the default opening contact stiffness. FKT 1.0000, the default tangent stiffness factor

keep the contact stiffness constant.

Default TAUMAX maximum friction stress 0.10000E+21

Average contact surface length 0.36092E-02

Average contact pair depth 0.30000E-02

PINB 0.25000 is the standard pinball region factor.

The resulting pinball region 0.75000E-03 Initial penetration/gap is excluded.

The term "bonded contact" is defined.

Symmetric Deformable: A contact element type 35-identified symmetric deformable-deformable contact pair has been established. The real constant set ID for the companion pair is 36. Both pairs should have the same behavior.

ANSYS will keep the current pair and deactivate its companion pair,

resulting in asymmetric contact. Linear contact is defined

Contact formula: Augmented Lagrange technique

Contact detection at: integration point of Gauss

FKN, or Contact stiffness factor 10.000

The default penetration tolerance factor, FTOLN 0.10000, is 0.68321E+14 as a result of the initial contact stiffness.

As a result, the penetration tolerance is 0.31615E-03. It will open with OPSF, the default opening contact stiffness. FKT 1.0000, the default tangent stiffness factor

keep the contact stiffness constant.

Default Max. friction stress TAUMAX 0.10000E+21 0.27044E-02

for the average contact surface length 0.31615E-02 is the average contact pair depth

PINB 0.25000 is the standard pinball region factor.

The resulting pinball region is 0.79038E-03. Initial penetration or gaps are not considered.

The term "bonded contact" is defined.

Symmetric Deformable:It has been set up to have a symmetric deformable-deformable contact pair identified by the real constant set 36 and the contaThe real constant set ID for the companion pair is 35**.** Both pairs should have the same behavior.

ANSYS will deactivate the current pair and keep its companion pair,

resulting in asymmetric contact. Linear contact is defined

Contact formula: Augmented Lagrange technique

Contact detection at: Integration point at Gauss FKN, or Contact stiffness factor 10.000

The default penetration tolerance factor, FTOLN 0.10000, is 0.68321E+14 as a result of the initial contact stiffness.

The resulting tolerance for penetration 0.15378E-03 It will open with OPSF, the default opening contact stiffness. FKT 1.0000, the default tangent stiffness factor

keep the contact stiffness constant.

Default Max. friction stress TAUMAX 0.10000E+21

Average contact pair depth is 0.15378E-02,

Average contact surface length is 0.19027E-02

PINB 0.25000 is the standard pinball region factor.

0.38445E-03 is the resulting pinball region. Initial penetration/gap is excluded.

The term "bonded contact" is defined.

Symmetric Deformable: A contact element type 37-identified symmetric deformable-deformable contact pair has been established. The companion pair hasThe real constant set ID for the companion pair is 38.

ANSYS will deactivate the current pair and keep its companion pair,

resulting in asymmetric contact. Linear contact is defined

Contact formula: Augmented Lagrange technique

Contact detection at: integration point at Gauss FKN, or Contact stiffness factor 10.000

Initial contact stiffness obtained is 0.72000E+14, and default penetration tolerance factor is 0.10000.

The resulting tolerance for penetration is 0.30000E-03. It will open with OPSF, the default opening contact stiffness. FKT 1.0000, the default tangent stiffness factor

keep the contact stiffness constant.

Default Max. friction stress TAUMAX 0.10000E+21 Average contact pair depth is 0.30000E-02 Average contact surface length is 0.33272E-02 PINB 0.25000 is the standard pinball region factor.

0.75000E-03 is the resulting pinball region.

At least 94 target elements are found in one of the contact searching regions. You may reduce the pinball radius.

Gaps or initial penetration are not taken into account. The term "bonded contact" is defined.

Max. Initial penetration 1.734723476E-18 was detected between contact element 101480 and target element 102304.

Max. Geometric gap 8.036323349E-07 has been detected between contact

element 101495 and target element 102145.

D I S T R I B U T E D D O M A I N   D E C O M P O S E R

...Total No. of elements: 105781

...Total No. of nodes: 290732

...Decompose done to 2 CPU domains

… ratio of Element load balanc = 1.003

LOAD STEP NUMBER 1

TIME AT THE END OF THE LOAD STEP. 1.0000

TOTAL NUMBER OF SUBSTEPS 1

BOUNDARY CONDITIONS AT STEP CHANGE NO

PRINT OUTPUT CONTROLS NO PRINTOUT

DATABASE OUTPUT CONTROLS TEM FREQUENCY COMPONENT

ALL NONE

NSOL ALL

RSOL ALL

EANG ALL

ETMP ALL

VENG ALL

STRS ALL

EPEL ALL

EPPL ALL CONT ALL

MISC ALL

Symmetric Deformable: A contact element type 39-identified symmetric deformable-deformable contact pair has been established. The real constant set ID for the companion pair is 40. The behavior of both pairs ought to be the same.

Asymmetric contact results from ANSYS keeping the current pair while deactivating its companion pair.

The definition of linear contact

Contact formula: Augmented Lagrange technique

Contact detection at: integration point at Gauss FKN, or Contact stiffness factor 10.000

The default penetration tolerance factor (FTOLN) is 0.10000 due to the initial contact stiffness of 0.73628E+14.

The penetration tolerance that resulted was 0.29337E-03 It will open with OPSF, the default opening contact stiffness. FKT 1.0000, the default tangent stiffness factor

keep the contact stiffness constant.

Maximum friction stress by default TAUMAX 0.10000E+21 Average contact surface length 0.2704Depth of the typical contact pair isPINB 0.25000 is the standard pinball region factor.

The resulting pinball region 0.73341E-03 Initial penetration/gap is excluded.

Bonded contact (always) is defined.

Symmetric Deformable: A contact element type 39 and symmetric deformable-deformable contact pair identified by real constant set 40 have been established**.** The real constant set ID for the companion pair is 39. The behavior of both pairs ought to be the same.

Asymmetric contact will result from ANSYS deactivating the current pair while keeping its companion pair.

The definition of linear contact

Contact formula: Augmented Lagrange method Detection of contacts at: Gauss integration point Contact stiffness coefficient FKN 10.000

The resulting default penetration tolerance factor FTOLN 0.10000 and initial contact stiffness of 0.73628E+14

The resulting tolerance for penetration 0.15378E-03 It will open with OPSF, the default opening contact stiffness. FKT 1.0000, the default tangent stiffness factor

keep the contact stiffness constant.

Default TAUMAX maximum friction stress 0.10000E+21

Average contact surface length 0.19027E-02

Average contact pair depth 0.15378E-02

Default pinball region factor PINB 0.25000

The resulting pinball region	0.38445E-0

Initial penetration or gaps are not considered. The term "bonded contact" is defined.

A contact element type 39 and symmetric deformable-deformable contact pair identified by real constant set 40 have been established. The real constant set ID for the companion pair is 39. The behavior of both pairs ought to be the same.

Asymmetric contact will result from ANSYS deactivating the current pair while keeping its companion pair.

The definition of linear contact

Contact formula: Augmented Lagrange method Detection of contacts at: Gauss integration point FKN 10.000, the contact stiffness factor

The resulting default penetration tolerance factor FTOLN 0.10000 and initial contact stiffness of 0.73628E+14

The resulting tolerance for penetration 0.15378E-03 It will open with OPSF, the default opening contact stiffness. FKT 1.0000, the default tangent stiffness factor

keep the contact stiffness constant.

Default Max. friction stress TAUMAX	0.10000E+21
Average contact pair depth is	0.15378E-02,
Average contact surface length is	0.19027E-02
Default pinball region factor PINB	0.25000
The resulting pinball region	0.38445E-03

Initial penetration or gaps are not cThe term "bonded contact" is defined.is defined.

There are 528 elements that are in contact out of the total 804 contact elements. 528 components make up sticking.

Area contacted:	4.027344629E-05.
Pinball distance maximum:	5.295508375E-05.

At least eight target elements can be found in one of the contact searching regions.

Max. Pressure/force	-0.13436425.
Max. Normal stiffness	1.535605693E+14.
Min. Normal stiffness	1.535605693E+14.
Max. Tangential stiffness	8.079224661E+13.
Min. Tangential stiffness	8.079224661E+13.

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

Translational mass

Coupled translational/rotational mass

0.49528	0.0000	0.0000	0.0000	0.32981E-01	0.77239E-03
0.0000	0.49528	0.0000	-0.32981E-01	0.0000	0.58152E-02
0.0000	0.0000	0.49528	-0.77239E-03	-0.58152E-02	0.0000

Rotational mass (inertia)

0.58978E-02	-0.32124E-04	-0.11780E-02
-0.32124E-04	0.62262E-02	-0.13850E-03
-0.11780E-02	-0.13850E-03	0.78560E-03

TOTAL MASS = 0.49528

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 0.11741E-01 -0.15595E-02 0.66590E-01

TOTAL INERTIA ABOUT CENTER OF MASS

0.37004E-02	-0.41193E-04	-0.79075E-03
-0.41193E-04	0.39618E-02	-0.18993E-03
-0.79075E-03	-0.18993E-03	0.71612E-03

PRINCIPAL INERTIAS = 0.38965E-02 0.39732E-02 0.50861E-03

MASS SUMMARY BY ELEMENT TYPE TYPE MASS

1 0.396952E-02

2 0.118613E-03

3 0.153332E-02

Range of element maximum matrix coefficients in global coordinates Maximum = 734075668 at element 114974.

Minimum = 194868.569 at element 134407.

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

CONCLUSION

The transport of the sheet from the stack to the shearing machine is the primary justification for choosing to design a robotic arm. The industry has a space constraint, which is the second issue. The shearing machine and the stack of sheets are situated close to one another. They are so close together that no other mode of transportation, like a conveyor or linear robot, can be used. The only option left to us is to create a robotic arm that can operate in confined spaces. We need to create a robot arm that works in this setting.

As we look over the document, we can see that we tested the robotic arm in all possible ways, including its joints, motion ranges, and load bearing capacity. The figures provided in the appendix can be used to visualize how the robotic arm moves. The main task was to design a machine which fits in the environment and serves the purpose which has been achieved. But this is not the ultimate design. In our work, we tried to address every aspect of design and structural analysis. However, there is still a good chance that the machine can be upgraded.

FUTURE SCOPE

The machine will be of great use to perform repetitive tasks of picking and placing of small parts (up to 500 gms) in an industrial production line.The tool will be very useful for picking and placing small parts (up to 500 gms) repeatedly in an industrial production line.

Its use can be extended and exploited by few modifications to do difficult and hazardous tasks for industrial applications.With a few modifications, it can be used for more difficult and dangerous tasks in industrial applications.

It can be used to do small assembly work effectively due to its great added accuracy for placement of parts, which is further extended scope of our projectDue to the high level of added accuracy for part placement, it can be used to complete small assembly tasks efficiently, which broadens the scope of our project.

The machine provides motion to the end effectors in the theta and Z directions. The machine moves the end effectors in both the theta and Z axes. A set of multiple grippers, a pair of pneumatic grippers, or a magnetic device can serve as the end effector.The control valve and reversible valve combination, which together make up the machine's essential component, together with the device's internal logic, control all of the machine's movements. One cycle of air admission to the two pneumatic cylinders occurs as a result of a single air pulse applied to the control valve, which also activates the reversible valve.

This causes to and fro linear motion of the common rack which is converted into the rotary motion of the pinion and ultimately imparts angular sweep (theta) and vertical motion (Z) at the end of each stroke to the head carrying the pickup arm with the end. This causes the to-and-fro linear motion of the common rack, which is then converted into the pinion's rotary motion and, at the end of each stroke, imparts angular sweep (theta) and vertical motion (Z) to the head carrying the pickup arm effecter.

Mechanical stoppers allow for adjustment of both the vertical motion (Z) and the angular sweep (theta). By turning the flow control valves on the two-cylinder heads, the pickup arm's operating speed can be adjusted to meet the needs. During one operatinThe pickup arm carrying the end effector begins in its home position, moves to the other end, picks up the part, and then returns to its starting position during one operating cycle is delivered to the home position when the next cycle is triggered.

CHAPTER 7

REFERENCES

[1] Kurt E. C. Shang Y, A Geometric Approach for the Robotic arm kinematics with hardware design. Electrical Design and implementation, Journal of robotics, 2010, Volume 10.

[2] Rahman A. Khan A. H. Dr. Ahmed T. Md Sajjad M. Design analysis and Implementation of Robotic arm -The Animator, American Journal of Engineering Research, 2013, Volume 2, Issue 10.

[3] Gautam R. Gedam A. Zade A, Mahawadiwar A. Review On Development of Industrial robotic arm, IRJET, March 2017, Volume 4, Issue 3.

[4] Omijeh B. O, Uhunmwangho R, Ehikhamenle M, Design Analysis of a remote-controlled "Pick and Place" Robotic Vehicle, International Journal of Engineering Research And Development, 2014, Volume 10, Issue

[5] Katal G, Gupta S, Kakkar K, Design and Operation of Synchronized Robotic Arm, IJRET, Aug 2013, Volume 2, Issue 8.

[6] Gunasekaran K, Design and analysis of articulated Inspection arm of a robot.

International journals for trends.

[7] Introduction and Objective Robotic Arm by (Abdul Zahier Ismail)

https://www.scribd.com/document/362905868/Introduction-and-Objective-Robotic-Arm

[8] Patil, C., Sachan, S., Singh, R. K., Ranjan, K., & Kumar, V. (2009). Self and Mutual learning in Robotic Arm, based on Cognitive systems. West Bengal: Indian Institute of Technology Kharagpur.

[9] Craig, J. J. (2005). Introduction to Robotics-Mechanics and Control (3rd ed.). (M. J. Horton, Ed.) Upper Saddle River, USA: Pearson Prentice Hall.

[10] Angelo, J. A. (2007). Robotics: A Reference Guide to the New Technology. Westport: Greenwood Press.

[11] Carlson, M., Donley, E., Graf, K., & Jones, T. (2013). Helping Hand: Senior Design Final Documentation. Orlando: University of Central Florida.

[12] ROBOT ARM CONTROL WITH ARDUINO by Aimn Mohamed Ahmed Ghiet MECHANICAL AND AERONAUTICAL ENGINEERING :

https://www.researchgate.net/publication/317277584