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Modeling and Fabrication of the Four Wheeled Smart Robot

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ABSTRACT: *This work aims to design, prototype, assemble, and program a smart, four-wheeled robot that can be operated using an Android application via Bluetooth. The robot will have sensors that allow it to detect its environment and avoid obstacles. The work will require knowledge and skills in mechanical design, electronics, programming, and robotics. The fabrication of a 4-wheeled smart robot involves the creation of a mobile robotic platform that can perform various tasks autonomously or under remote control. The process typically involves the following steps: design and planning, material selection, assembly, programming, testing, and optimization. The result is a powerful and versatile robotic platform that can be used in a variety of applications, from industrial automation to educational robotics.*

KEY WORDS: *Modelling, Fabrication, robot, robotics, Arduino mega, obstacle detection, Catia v5, Arduino software, human*

I. INTRODUCTION

Robotics is a field of engineering and technology that involves the design, construction, programming, and operation of robots. A robot is a machine that can carry out complex actions automatically or remotely, typically by being programmed to perform specific tasks or respond to certain stimuli. The field of robotics is constantly advancing and expanding, and robots are being used in an ever-increasing number of industries and applications. Some of the most common uses of robotics include manufacturing, agriculture, healthcare, transportation, and entertainment. Robotics involves many different disciplines, including mechanical engineering, electrical engineering, computer science, and artificial intelligence. Robotics engineers must have a strong understanding of these fields, as well as programming languages and software tools, in order to design and operate robots effectively. The potential applications of robotics are vast, and as the technology continues to evolve and improve, we can expect to see even more exciting and innovative uses for robots in the future. There are several types of robots, each designed for specific tasks and functions. Industrial robots are used in manufacturing industries for tasks such as welding, painting, and assembly, medical robots are used in healthcare for tasks such as surgery, diagnosis, and rehabilitation, service robots are used in various service industries, military robots are used in the military for tasks such as reconnaissance, surveillance, and bomb disposal, educational robots are used in educational settings to teach students about robotics and programming, entertainment robots are used in entertainment industries such as theme parks and movies, and personal robots are designed to be used in homes for tasks such as cleaning, cooking, and companionship. There are also many other types of robots that are designed for specific tasks and industries. Robot locomotion is the process of moving robots from one place to another. There are various types of robot locomotion methods, such as wheeled locomotion, leg locomotion, flying locomotion, swimming locomotion, crawling locomotion, rolling locomotion, and snake-like locomotion. Wheeled locomotion is the most common type of locomotion, as it provides good speed and stability. Leg locomotion is used in search and rescue missions, exploration, and military applications. Flying locomotion is used for aerial surveillance, mapping, and delivery services. Swimming locomotion is used in underwater exploration, oceanography, and search and rescue missions. Crawling locomotion is used in construction, inspection, and mining applications. Rolling locomotion is used in space exploration, where the low-gravity environment allows them to move more easily. Snake-like locomotion is used in medical applications. The choice of locomotion method depends on the specific application and the environment in which the robot will operate. The development of robotics has been growing rapidly in recent years, and it has opened up new possibilities in various fields. Robotics technology has revolutionized the manufacturing, medical, and scientific industries, among others. One of the most significant advancements in robotics technology is the development of smart four-wheeled robots. These robots have a wide range of applications, including exploration, inspection, and transportation. In this work, we aim to design, prototype, assemble, and program a smart four-wheeled robot that can be operated using an Android application via

Bluetooth. The robot will have sensors that allow it to detect its environment and avoid obstacles. The robot's mobility, communication, and sensor capabilities will be optimized to ensure optimal performance. The work will require knowledge and skills in mechanical design, electronics, programming, and robotics. The final product will be a smart four-wheeled robot that demonstrates the potential of modern robotics technology and its applications.

The fabrication of a 4-wheeled smart robot involves the creation of a mobile robotic platform that can perform various tasks autonomously or under remote control. The process typically involves the following steps: design and planning, material selection, assembly, programming, testing, and optimization. Design and planning involve determining the robot's size, weight, and shape, as well as the type of sensors, motors, and controllers that will be used. Material selection includes aluminum, steel, plastic, and carbon fiber. Assembly involves connecting the motors to the wheels, attaching the sensors and controllers, and installing the power source. Programming involves writing software that controls the robot's movement, sensors, and other functions. Testing and optimization involves testing the robot to ensure that it functions as intended. The end result is a powerful and versatile robotic platform that can be used in a variety of applications, from industrial automation to educational robotics.

An ultrasonic sensor is a commonly used sensor for obstacle detection in robotics and automation. It emits high-frequency sound waves that bounce off objects and return to the sensor, allowing it to detect the distance to an object in front of it. Ultrasonic sensors are easy to use, relatively inexpensive, and can detect a wide range of objects, including solid surfaces, liquids, and even some gases. They are typically rated for a maximum range, which can be adjusted by changing the frequency of the sound waves or adjusting the sensitivity of the sensor. They are relatively easy to program and integrate into a control system, and can be connected to a microcontroller or other control system using a simple interface. However, they may not be able to detect very small objects or objects that are very close to the sensor. Environmental factors such as temperature, humidity, and wind can affect the accuracy of the distance readings, so ultrasonic sensors should be used in conjunction with other sensors and control systems for maximum effectiveness.

"Development of mobile robot for measuring distance using optical quadrature encoder" article written by Madiha Zahari et al. this article represents the design and development of a measuring tool using a mobile robot.[1] "Obstacle Detection and Avoidance Methods for Autonomous Mobile Robot" article written by R. Gowtham this article represents sensor that help to feedback the system to detect obstacle and the actuator to avoid the obstacle.[2] "Wheeled Mobile Robots: A review" article written by Ramon Silva Ortigoza et al. this article points out main considerations to be taken into account when designing this class of robots. [3] "Remote-Controlled Two-Wheeled Self-Balancing Robot" article written by Przemysław Filipek this article represents the design and fabrication of a remotely controlled two-wheeled self-balancing robot, along with its mobile control by means of an application on a phone displaying basic parameters in a terminal.[4] "Design, Fabrication and Modelling of Four-Wheeled Mobile Robot Platform with Two Differential and Two Caster Wheels" article written by M. SAWAL. A. R et al. this article presents design and modeling of wheeled mobile robot (MWR) when navigating autonomously in environment such as road and factory. It needs a good and robust design and control for wheeled mobile robot to move from one to other points with smooth moving and small tracking errors.[5] "Addressing Collision Avoidance and Nonholonomic Constraints of a Wheeled Robot: Modeling and Simulation" article written by Muhammad Zohaib et al. this article presents kinematic model of two configurations of a wheeled mobile robot. Two-wheeled robot with castor and four-wheeled robot are considered for modeling.[6] "Reconfigurable and Agile Legged-Wheeled Robot Navigation in Cluttered Environments with Movable Obstacles" article written by Vignesh Sushrutha Raghavan et al. This article reviews the legged-wheeled footprint reconfiguring global planner and its two incremental prototypes. The primary goal of the algorithms is to reduce the search space of possible footprints so that plans that expand the robot over all of the algorithms is to reduce the search space of possible footprints so that plans that expand the robot over low-lying, wide obstacles or narrow it into passages can be computed with speed and efficiency. The second part of the article presents the work on local obstacle pushing, which increases the number of tight scenarios the planner can solve. The goal of the new local push-planner is to place any movable obstacle of unknown mass and inertial properties, obstructing the previously planned trajectory from the global planner, at a location devoid of obstruction.[7] "Intelligent Tracking Obstacle Avoidance Wheel Robot Based on Arduino" article written by Zhen Feng Li et al. this article uses Arduino as the core control system, combined with infrared tracking module. Four modules, such as ultrasonic obstacle avoidance module, motor drive module and power module, have designed a good control scheme, thus realizing the intelligent tracking and obstacle avoidance function of the wheeled robot[8]. "Obstacle Avoidance and Navigation Planning of a Wheeled Mobile Robot using Amended Artificial Potential Field Method" article written by Priyanka Sudhakara et al. this paper presents an efficient obstacle avoidance based action has been performed in the chosen navigable trajectory. Trajectories that have been generated using the proposed E-APF satisfy constraints approach of the direction on both the starting and goal points. Consequently, the trajectories that are generated by the Wheeled Mobile Robot are geometrically and dynamically feasible. Simulation results performed confirm the viability of the proposed E-

APF algorithm that it can be effectively utilized in trajectory planning of wheeled mobile robots and can be applied in real-time scenarios [9]. "An Android Based Mobile Robot for Monitoring and Surveillance" article written by Azeta J et al. this article presents the development of a surveillance robot that is cost effective using an Arduino microcontroller together with a moter shield and an Android smartphone that runs the operating system.[10] "Design and Construction of a Cost-Oriented Mobile Robot for Domestic Assistance" article written by Brayan S. Pallares O et al. this article presents the design and development of a cost oriented mobile robot for domestic assistance.[11] "Hand gesture recognition and voice-controlled robot" written by M. Meghana et al. This article addresses the robot controlled by hand gesture and voice control. In the technology era, the space between the physical and the digital world is brought closer by the introduction of gesture concept.[12] "Vision Based Navigation for Omni-directional Mobile Industrial Robot" article written by Shuai Guo et al. this paper presents r, an Omni-directional mobile industrial robot drilling system for aerospace manufacture is introduced. Mecanum wheels are used for the robot's maneuverability in congested workspace.[13] "Navigation of Self-Balancing Mobile Robot through Sensors" article written by Arbnor Pajazit et al. this paper presents the design, simulation, construction and programming of a selfbalancing (inverted pendulum) mobile robot, capable of obstacle avoidance through the MPU6050 sensor, and ultrasonic sensor.[14] and design of biped ambling mechanism using MATLAB explained by Roopsandeep Bammidi [15].

II. METHODOLOGY

To begin the process of building a four wheeled smart robot, it is necessary to formulate design assumptions:

- The robot will have four wide wheels to help it maintain its balance and four DC motors with encoders to help control the robot.
- The main controller of the robot is an Arduino mega 2560
- The robot will be powered by rechargeable batteries in the on the bot which can be recharged in case they are discharged.
- The robot will be remotely controlled by an application on your phone using a Bluetooth module HC-05.
- Lightweight components will be used for construction, which will give ease of balance and Movement.
- Electronics will be mounted as low as possible so that its center of gravity was just above the motors.
- The parameters of the robot will be displayed in the application terminal located on the phone.
- The robot will be small in size with a maximum height up to about 50 cm, width of about 32 cm and weight up to 3 kg.

Designing a four-wheeled smart robot using CATIA V5 software involves creating a 3D model of the robot with various features and functionalities. CATIA V5 is powerful software used for designing complex products, including robots, and it provides a wide range of tools and features for creating and editing models. To design the four-wheeled smart robot, you need to follow the below steps: The first step is to create a 2D sketch of the robot's basic shape, dimensions, and layout. This step involves defining the basic design of the robot, including its overall shape, size, and placement of wheels, sensors, and other features. After creating the sketch, you can use CATIA V5's modelling tools to convert the 2D sketch into a 3D model. You can add various components, such as wheels, sensors, motors, and other electronic components, to the model. In this step, you can assemble all the components together and make sure that they are correctly aligned and positioned. You can also check the fit and function of each component. Designing a four-wheeled smart robot using CATIA V5 software involves creating a 3D model of the robot, assembling its components

When sketching in CATIA V5, it is important to follow several criteria to ensure accurate, efficient, and easy to work with. These include sketching on the appropriate plane or face, using the appropriate sketch tools, maintaining proper sketch relationships, ensuring proper sketch continuity, applying proper sketch dimensions, using the sketch analysis tools, and keeping sketches simple. These criteria will help create accurate and efficient sketches that can be easily modified and updated throughout the design process. When modelling in CATIA V5, it is important to select the appropriate workbench, use proper modelling techniques, maintain proper part relationships, use proper feature control, ensure proper part design intent, use proper naming conventions, optimize model performance, and ensure the part is fully defined. By following these criteria, you can create accurate and efficient models that can be easily modified and updated throughout the design process. When creating assemblies in CATIA V5, it is important to select the appropriate assembly workbench, create proper assembly structure, use proper assembly techniques, ensure proper part relationships, use proper naming conventions, optimize assembly performance, ensure proper assembly behavior, and document the assembly. These criteria will help create accurate and efficient assemblies that can be easily modified and updated throughout the design process.

These are the components that can be used for the fabrication of a 4-wheeled smart robot:

- Arduino mega 2560: This is a microcontroller board that provides the computing power for the robot. It can control multiple sensors, motors, and other components simultaneously.
- HC-05 Bluetooth module: This module allows the robot to communicate wirelessly with other devices, such as a smartphone or a computer. It can be used to control the robot remotely or to receive data from sensors.
- MG995 servo motor: This motor can rotate up to 180 degrees and can be used to control the direction of the robot's movement. It is commonly used in robotics works due to its high torque and accuracy.
- HC-SR04 ultrasonic sensor: This sensor uses sound waves to measure distance and can be used to detect obstacles and avoid collisions.
- Aluminum sheet (4*4 sheet) 0.8 mm(thick): This material can be used to create the chassis of the robot. It is lightweight, durable, and easy to work with.
- Jumper wires / single lead wire: These wires are used to connect the components of the robot to the microcontroller board.
- Batteries – 12V: These batteries are used to power the DC motor and the L298N motor driver module.
- Buck convertor: This module is used to regulate the voltage from the batteries to ensure that the components receive a consistent power supply.
- 12V DC motor: This motor is used to drive the wheels of the robot.
- Tracked Wheel for DC Motors: These wheels are designed to provide traction and stability for the robot on various surfaces.
- Switches and Lights: These components can be used to provide feedback and control for the robot.
- L298N Motor Driver Module: This module is used to control the speed and direction of the DC motor. It can also protect the motor from overheating and overloading.

WORK PROGRESS STEP BY STEP

- Drafting in white sheet
- Modelling a product in CATIA V5
- Cutting of sheet metal
- Drilling holes on trimmed sheet metal
- Bending the sheet metal as per required dimensions
- Assembly each body parts
- Making of bot frame
- Design Electronic circuit
- Testing of electronic circuit devices
- Electronic circuit connections

III. SOFTWARE

The program for the remote-controlled two-wheeled self-balancing robot was written in the Arduino IDE environment using the C or C++ language Its purpose is to keep the robot balanced. control it and display parameters. In addition, it should be resistant to external factors, such as deliberate knocking out of balance, uneven ground, and driving at different degrees of inclination.

Code for motion of the wheeled bot:

```
void setup(){

  pinMode(11,OUTPUT);
  pinMode(10,OUTPUT);
  pinMode(9,OUTPUT);
  pinMode(8,OUTPUT);
  pinMode(7,OUTPUT);
  pinMode(6,OUTPUT);
  pinMode(5,OUTPUT);
  Serial.begin(9600);
  int var1=0;
  int var2=0;
}

void loop() {
  if(Serial.available())
  {
    char data=Serial.read();
```

```
  if (data=='f')
  {
    digitalWrite(12,HIGH);
    digitalWrite(11,LOW);
    digitalWrite(10,HIGH);
    digitalWrite(9,LOW);
  }
  else if(data=='b')
  {
    digitalWrite(12,LOW);
    digitalWrite(11,HIGH);
    digitalWrite(10,LOW);
    digitalWrite(9,HIGH);
  }
  else if(data=='r')
  {
    digitalWrite(12,LOW);
    digitalWrite(11,HIGH);
    digitalWrite(10,HIGH);
    digitalWrite(9,HIGH);
  }
  else if(data=='l')
  {
    digitalWrite(12,HIGH);
    digitalWrite(11,LOW);
    digitalWrite(10,LOW);
    digitalWrite(9,HIGH);
  }
  else if(data=='s')
  {
    digitalWrite(12,LOW);
    digitalWrite(11,LOW);
    digitalWrite(10,LOW);
    digitalWrite(9,LOW);
    digitalWrite(8,LOW);
    digitalWrite(7,LOW);
    digitalWrite(6,LOW);
  }
   else if(data=='i')
  {
    digitalWrite(8,HIGH);
    digitalWrite(7,LOW);
    delay(10000);
    digitalWrite(8,LOW);
    digitalWrite(7,LOW);
  }
   else if(data=='h')
  {
    digitalWrite(8,LOW);
    digitalWrite(7,HIGH);
    delay(10000);
    digitalWrite(8,LOW);
    digitalWrite(7,LOW);
  }


 }

}
```

Code for the hand motions:

```
#include <SoftwareSerial.h> // TX RX software library for bluetooth

#include <Servo.h> // servo library
Servo myservo1, myservo2, myservo3, myservo4,myservo5, myservo6; // servo name

int bluetoothTx = 10; // bluetooth tx to 10 pin
int bluetoothRx = 11; // bluetooth rx to 11 pin

SoftwareSerial bluetooth(bluetoothTx, bluetoothRx);

//int pos1 = 0;
//int pos2 = 0;

void setup()
{
  myservo1.attach(3); // attach servo signal wire to pin 9
  myservo2.attach(4);
  myservo3.attach(5);
  myservo4.att
  sach(6);
  myservo5.attach(7);
  myservo6.attach(8);
  //Setup usb serial connection to computer
  Serial.begin(9600);

  //Setup Bluetooth serial connection to android
  bluetooth.begin(9600);

  myservo1.write(0);
  myservo2.write(0);
  myservo3.write(0);
  myservo4.write(0);
  myservo5.write(0);
  myservo6.write(0);
}

void loop()
{
  /*if(bluetooth.available())
  {
    char data1= bluetooth.read();
    Serial.println(data1);

    if (data=='n')
    {
      for (pos1 = 0; pos <= 45; pos += 1) {
      myservo1.write(pos1);
      myservo3.write(pos1);
      myservo6.write(pos1);
      delay(15);
      }
      for (pos2 = 180; pos >= 135; pos -= 1) {
      myservo4.write(pos2);

      delay(15);
      }
    }
  }
```

```
 */
 //Read from bluetooth and write to usb serial
 if(bluetooth.available()>= 2 )
 {
   unsigned int servopos = bluetooth.read();
   unsigned int servopos1 = bluetooth.read();
   unsigned int realservo = (servopos1 *256) + servopos;
   Serial.println(realservo);

   if (realservo >= 1000 && realservo <1180) {
     int servo1 = realservo;
     servo1 = map(servo1, 1000, 1180, 0, 180);
     myservo1.write(servo1);
     Serial.println("Servo 1 ON");
     delay(10);
   }
   if (realservo >= 2000 && realservo <2180) {
     int servo2 = realservo;
     servo2 = map(servo2, 2000, 2180, 0, 180);
     myservo2.write(servo2);
     Serial.println("Servo 2 ON");
     delay(10);
   }
   if (realservo >= 3000 && realservo <3180) {
     int servo3 = realservo;
     servo3 = map(servo3, 3000, 3180, 0, 180);
     myservo3.write(servo3);
     Serial.println("Servo 3 ON");
     delay(10);
   }
   if (realservo >= 4000 && realservo <4180) {
     int servo4 = realservo;
     servo4 = map(servo4, 4000, 4180, 0, 180);
     myservo4.write(servo4);
     Serial.println("Servo 4 ON");
     delay(10);
   }
    if (realservo >= 5000 && realservo <5180) {
     int servo5 = realservo;
     servo5 = map(servo5, 5000, 5180, 0, 180);
     myservo5.write(servo5);
     Serial.println("Servo 5 ON");
     delay(10);
   }
    if (realservo >= 6000 && realservo <6180) {
     int servo6 = realservo;
     servo6 = map(servo6, 6000, 6180, 0, 180);
     myservo6.write(servo6);
     Serial.println("Servo 6 ON");
     delay(10);
   }
  }
}
```

By using the above Arduino code the fabricated robot can perform actions like waving hand, raising hand, moving forward and backward and rotate 360^0. This code is dumped into Arduino mega 2560 and then connected the power supply to run the robot. Then we need to connect the Bluetooth MIT app invertor interface by using HC-05 Bluetooth module and then the robot will be operated.

IV. RESULTS AND CONCLUSIONS

After the fabrication of the smart four-wheeled robot with an ultrasonic sensor, several tests were conducted to evaluate its performance. The robot was tested in a controlled environment with different obstacle configurations, and the results showed that the ultrasonic sensor accurately detected obstacles and the robot avoided collisions. After conducting tests in a controlled environment, it was found that the smart four-wheeled robot with an ultrasonic sensor performed satisfactorily in detecting obstacles and avoiding collisions. This capability makes it suitable for applications that require obstacle avoidance, such as warehouse and factory automation. In addition, the robot's hand motion control system was tested, and it was found to be effective in performing several hand motions such as waving, greeting, and raising its arm. This feature makes the robot suitable for human-robot interaction applications, such as assisting elderly or disabled people.

However, there is room for improvement to enhance the robot's performance and capabilities. Additional sensors such as infrared or lidar could be added to improve obstacle detection accuracy and range. Moreover, the gesture recognition system could be improved to recognize a wider range of hand gestures and movements, making the robot more versatile in its applications. Finally, integrating a wireless communication system for remote control could allow for greater flexibility and control of the robot. This could be especially useful in applications where the robot needs to be controlled from a distance, such as search and rescue missions.

Overall, the smart four-wheeled robot with an ultrasonic sensor and hand motion control system has demonstrated its effectiveness in various applications and has the potential for further development and improvements.

V. CONCLUSIONS

The successful fabrication of a smart four-wheeled robot with an ultrasonic sensor for obstacle detection marks a significant milestone in the development of smart robots. The robot was designed using basic electrical components and an aluminum body, demonstrating that sophisticated robotics can be built using accessible materials. The ultrasonic sensor was a crucial component of the robot, accurately detecting obstacles and allowing the robot to avoid collisions. This feature makes the robot suitable for a wide range of applications, including surveillance, rescue operations, and exploration. The hand motion control system was also an essential aspect of the robot's design, enabling the robot to perform various hand motions, such as waving and greeting, and improving its human-robot interaction capabilities. This feature could prove invaluable in applications such as assisting the elderly and disabled people. However, there is still room for further improvements to enhance the robot's performance. For instance, additional sensors such as infrared or lidar could be added to improve obstacle detection accuracy and range. Integrating a wireless communication system for remote control could also allow for greater flexibility and control of the robot.

The work has demonstrated the effectiveness of the ultrasonic sensor and hand motion control systems in building smart robots. The insights gained from this work could serve as a basis for further research and development in this field. The successful fabrication of this robot provides a significant contribution to the advancement of robotics, and the knowledge gained from this work could pave the way for the development of more sophisticated and intelligent robots in the future.

VI. FUTURE SCOPE

The future of 4-wheeled smart robots is indeed very promising, with vast potential applications across numerous industries and fields. One of the most significant areas where these robots could have a significant impact is in manufacturing and industrial automation. They could be used to perform repetitive and dangerous tasks, thereby reducing the risk of injury to human workers. This could lead to increased productivity and cost savings for manufacturers. In healthcare, these robots could be used to assist healthcare workers in a variety of ways. For instance, they could be used to transport medical supplies and equipment, disinfect surfaces, or provide remote monitoring of patients. These robots could help reduce the workload of healthcare workers and improve patient outcomes. In agriculture, smart robots could be used to perform a wide range of tasks, such as planting, harvesting, and crop monitoring. This could help farmers improve crop yields, reduce costs, and increase efficiency. Similarly, in military and defence applications, smart robots could be used for reconnaissance, surveillance, and even bomb disposal. This could help reduce the risk of injury or death for human soldiers. In education, smart robots could be used to teach programming and robotics to students at all levels. This could help develop the skills needed for the workforce of the future and inspire the next generation of innovators. Finally, smart robots could be used in research to develop new technologies and applications. Researchers could use these robots to perform experiments, collect data, and analyze results. This could lead to new discoveries and breakthroughs in various fields, including medicine, engineering, and more.

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