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Design and Implementation of Omni-Wheel Robotic System Under Automatic height control and adaptation

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ABSTRACT

In this paper we present the problem of controlling automatic height and stride length of an Omni-wheel robotic system. Navigation of robots under different terrain conditions such as flat too inclined, ramp, sloppy regions and slippery environment is a great challenge. In the project work, an Omni-wheel with 60- Degree of inclination is planned and examined on ramp, inclined and sneaky surfaces. Annex the acclerometer and gyrometer sensors are accustomed. To keep track of platform parallel to the ground level regardless of the robot in the inclined position is our objective. Omni wheels are specially chosen to make the navigation easier on any circumstances. In order to equalize the ground conflict and for effective beckon on shifty surface, we use simple approach in which top surface of a robot will always be parallel to ground and the robot will be parallel to the slope.

Key Words
Pulse Width Modulation (PWM) , Degree of Freedom (DOF) Omni Directional Vehicle (ODV), Rotation Per Minute (RPM)

1. INTRODUCTION

The project discusses the problem of controlling the automatic height and stride length of an Omni-wheel robotic system. Navigation of robots under different terrain conditions is a great challenge**.** In the planned project work to transport stuff, pliably and smoothly in a firmly environment, an Omni-directional mobile robot is designed and tested on the ramp, amenable and stealthy surfaces. In order to balance the ground friction and for efficient motion on slippery surface, we use plain technique in which top surface of a robot will always be parallel to ground and the robot will be parallel to the slope.

In this project system, a PWM signal is bestowed as an input to the digital pins of ATmega-328P. Based on the on-time and off-time of PWM Signal needed degree for motion of omni-wheel is measured for each degree of freedom. Consequently the servo motors pivot and there is a catena in the Omni-wheel. Our propound method uses C language for programming the Omni-wheel stirring.

Earliest and foremost infer is that spin based robots or vehicles are incredibly easy to design and construct whereas leg based robots demand perplex mechanics and computation to maintain equilibrium, aspect, efficiency and velocity. Building a wheeled robot is cheaper than its legged counterpart Wheel based vehicles or robots travel faster than leg based robots and more energy efficient. Legged robots require the system to beget an expropriate Gait to move, wheels precisely need to roll. Gait is pattern of particular way of walking in animals and humans used for locomotion in a multiplicity of surfaces.

2. IMPLEMENTATION

Robots have become commonplace in our world during the last few decades and have served as a reliable solution to many of our problems. How they interact with people day-to-day is constantly changing as further advancements in technology are made. From industry to household work, military operations to precision surgery, it is obvious that robots are an integral part of today's society. While robots have been used to replace workers in industry, they have also been used as a way to move people away from dangerous environments while still allowing those people to do their jobs. This thesis will explore the development and control of an Omni-directional platform, which is a mobile platform that has the ability to drive in all directions without restriction. This platform will be used for autonomous applications as well as for testing of mobile-manipulator applications. In addition, the software that operates this platform will also be examined so that the robot can be easily adapted to many different applications.

In the project work legs are replaced by Omni-wheel, a Omni-wheel robot is designed and tested on the disposition and slippery surfaces. Destine to even the ground discordance and for efficient stir on furtive area, we select a technique in which top surface of a robot will always be parallel to ground and the robot will be parallel to the slope.

In this system, a PWM signal is used as an input to the digital pins of ATmega-328P.Predicated on , on-time and off-time of PWM Signal the wanted degree for the motion of the omni-wheel is obtained for each degree of freedom. Correspondingly DC Motors rotates and there is a nexus in omni-wheel. Here we use C language for programming the omni-wheel movement. The below Figure1 shows the block diagram of Base Robot motion.

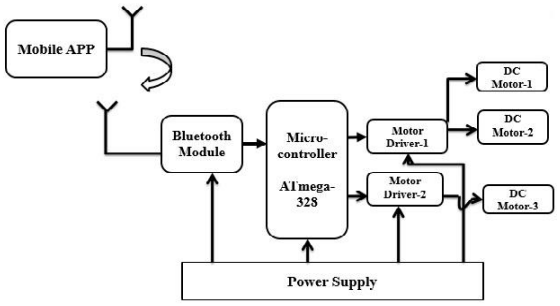

Fig.1Base Robot Motion

2.1 BLUETOOTH MODULE HC-05

HC-05 module is simple to use Bluetooth SPP (Serial Port Protocol) module, designed for clear wireless serial connection format. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Blue core 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm.

2.2 ARDUINO

Arduino is an open-source prototyping rostrum based on simple-to-use hardware and software. Arduino caters are capable to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - triggering a motor, blunting on an LED. Arduino is the brain of many projects, from daily objects to intricate scientific instruments. A worldwide neighbourhood of makers - students, hobbyists, artists, programmers, and professionals - has collected this open-source podium, their alms added up to an incredulous amount of affordable knowledge that can be of great aid to tyro. Arduino was congenital at the Ivrea Interaction Design Institute as an royal tool for rapid prototyping, targeted at students without a backdrop in electronics and programming. The Arduino victual started transforming to embrace to new requirements and challenges, distinguishing its proffer from simple 8-bit boards to yields for IOT applications, wearable, 3D printing, and embedded environments. All Arduino boards are entirely open-source, enabling users to construct them independently and ultimately conform them to their particular needs.

2.3 Microcontroller ATMega 328p

The ATmega48P/88P/168P/328P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega48P/88P/168P/328P achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed.

2.4 MOTOR DRIVER:

A motor driver is a current amplifier, the performance of motor drivers is to grasp a low-current control signal and then turn it into a higher-current signal that can run a motor.Fig2 is the L298 Motor Controller.

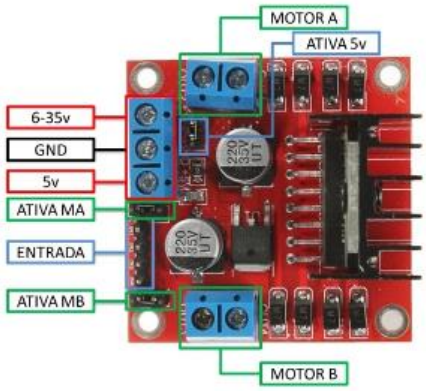

Fig 2 L298 Motor Controller

2.5 DC MOTOR

Robot is an electromechanical sleight which reacts in environment in one or some other way. Decisions and actions taken by its autonomous to do a particular work. Robot is a mechanical device that is man made whose motion is schemed, planned, triggered, modeled ,sensed and controlled. Its behavioral motion is implemented by programming.If a device contains movable mechanism, influenced by planning, actuation, controlling and sensing components is defined as Robot. Electrical energy is converted into physical energy by using this actuators and motors that is responsible for the robot to move.

2.6 LITHIUM ION BATTERY

A lithium-ion battery or Li-ion battery is a type of rechargeable battery in which lithium ions move from the negative electrode to the positive electrode during discharge and back when charging.

The below Figure shows the block diagram of Auto Adjusting Plate

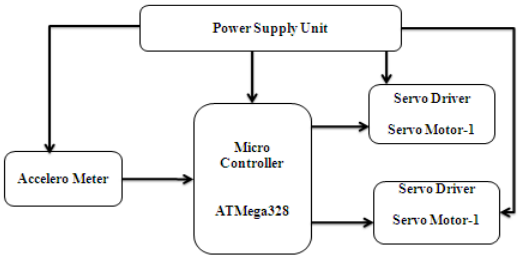

Fig.3 Auto Adjusting Plate

2.7 SERVO MOTOR

A servomotor is used for accurate control of angular or linear position . It contains qualified motor linked to sensor for position feedback. For custom design specially designed motor is servo motor . The motor provides massive torque of 35 kg-cm when designed to work on 8.4V supply voltage. A well-designed and dedicating data logging sheet for Arduino and to customize and assemble it is easy. Shifter circuitry of with 3.3v level that prevents damage of SD card.

With this 6V- 24V compatible 20A DC motor drive we can add raw power and simple connectivity to our robot ideally for the use 20A of current for starting up and normal operation of the robot. It is also fit with 6V to 24V motors. To connect directly to the IOT's of the MCU we use simple TTK/CMOS based interface. The breaking feature in this is it can guarantee circuit protection which affects operation of MCU and immediate halt in shaft of the motors in many high power application. Arduino to power DC, Servo motors are shielded by motor drive for simple to medium complex projects.

2.8 ADXL 345

The ADXL345 is a low-power, 3-axis MEMS accelerometer modules with both I2C and SPI interfaces. The Adafruit Breakout boards for these modules feature on-board 3.3v voltage regulation and level shifting which makes them simple to interface with 5v microcontrollers such as the Arduino.
The ADXL345 features 4 sensitivity ranges from +/- 2G to +/- 16G. And it supports output data rates ranging from 10Hz to 3200Hz.

2.9 ACCLEROMOTOR

An accelerometer is an electromechanical device will measure acceleration forces. These forces may be standstill and continuous.

3. HARDWARE IMPLEMENTATION

Robots have become commonplace in our world during the last few decades and have served as a reliable solution to many of our problems. How they interact with people day-to-day is constantly changing as further advancements in technology are made. From industry to household work, military operations to precision surgery, it is obvious that robots are an integral part of today's society. While robots have been used to replace workers in industry, they have also been used as a way to move people away from dangerous environments while still allowing those people to do their jobs. This thesis will explore the development and control of an Omni-directional platform, which is a mobile platform that has the ability to drive in all directions without restriction. This platform will be used for autonomous applications as well as for testing of mobile-manipulator applications. In addition, the software that operates this platform will also be

examined so that the robot can be easily adapted to many different applications.

In this project work legs are replaced by Omni-wheel, an Omni-wheel robot is designed and tested on the fain and rugged field. To even the ground friction and for fruitful motion on slippery surface, we use a technique in which the top surface of a robot will always be parallel to ground and the robot will be parallel to the slope.

3.2 BASE OMNI WHEEL

The basis of an Omni-directional vehicle (ODV) is that it has the ability to travel in any direction while maintaining a certain orientation. In order to do this, a series of contacts must be made with the travel surface that allows more than one travel direction at a time. The most common solution to this is to use Omni-directional wheels or Omni-wheels. Omni-wheels have the special ability to travel in more than one direction at a time. In contrast, a car tire is only capable of rolling in the direction. That the tire is aimed, ODVs are considered holonomic vehicles. Although there are many different types of Omni-wheels, their operating premise is generally the same. The point of contact for the wheel has the ability to roll in two different directions simultaneously. If the Omni-wheel is being driven, i.e., connected to a motor, the driven axis of rotation would be the primary axis, while the other axis would be allowed to roll freely. The free-rolling direction of the wheel is not parallel to that of the driven direction. To achieve 3-DOF motion in a plane, a minimum of three wheels must be mounted in a configuration that allows the 3-DOF to be controlled by the driven wheels. This means that the vehicle is not only capable of traveling forward and backward, but also horizontally, diagonally, rotating on the spot or a combination of translating and rotating.

Omni-Wheel Shift

Operation of Omni-Wheel robots concern chore like, Even control, Path planning, Obstacle avoidance, etc. The above missions are executed for diverse terrain conditions such as wide, disposition and inclined surfaces. For performing the above operations many sensors (Camera , Inertial moment sensor, etc.), servo motors and other components (speakers, display units, etc.) have to processed synchronously. Power needed for above noted activities is very high as it concern in many process at a given time.

3.3 MOVEMENT CONTROL OF OMNI-WHEEL ROBOT

This Omni-wheel robot is controlled using the wireless Mobile Application. This Mobile Application control is given to the Arduino board by connecting it through the Bluetooth Module. . By using Bluetooth Module HC-05 connection is established between Arduino board and Mobile Application. According to the key pressed in the Mobile application, the Arduino gives signal to the motor driver, according to which the DC Motor rotates and there will a progression in the movement of the robot.

3.3.1 Robot Moving in Forward Direction

The below Fig:.6 shows Omni-wheel robot moving in the forward direction. In order to move the Omni-wheel robot, the command has to be given through the mobile Application. By using the Bluetooth Module HC-05 connection established between Arduino victual and Mobile Application. Once the forward arrow key is pressed in the Mobile Application the robot starts moving in forward direction.

In this Mobile application gives control signal to the Arduino board which has ATMEGA 328 Microcontroller in it. This Arduino gives the required control signal to the Motor Driver circuit. Accordingly the DC drive rotates and robot will move forward. Here the front wheel of the robot is not moved. Clockwise and anti-clockwise direction of motor in two back wheels makes robot moves forward. As long

as the key is pressed in the Mobile Application, the Arduino passes signal and the movement will be present in the robot. When the key is stopped pressing in the Mobile Application, it stops giving signal to the Arduino board, so the movement of the robot will be stopped.

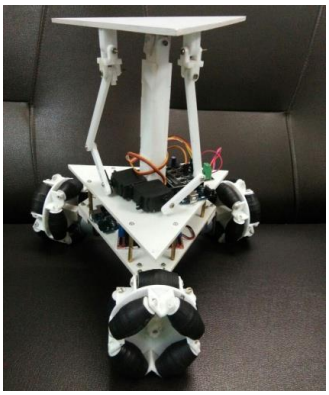

Fig: 4 Forward direction Movement

3.3.2 Robot Moving in Left Direction

The below Fig: 7 shows the Omni-wheel robot moving in the left direction. In order to move the Omni-wheel robot, the command has to be given through the mobile Application. By using Bluetooth Module HC-05 connection established between Arduino feed and Mobile Application. Once the left arrow key is pressed in the Mobile Application the robot starts rotating in the left direction.

In this the Mobile application gives control signal to the Arduino board which has ATMEGA 328 Microcontroller in it. This Arduino gives the required control signal to the Motor Driver circuit. Accordingly all the DC Motor rotates in the Anti-clock wise direction and the robot will rotate left without changing its position. Here all three wheels of robot is moved together to rotate the robot in the left direction. As long as the key is pressed in the Mobile Application, Arduino passes signal and movement will be there in robot. When key is stopped pressing in the Mobile Application, it stops giving signal to Arduino board so the movement of the robot will be stopped.

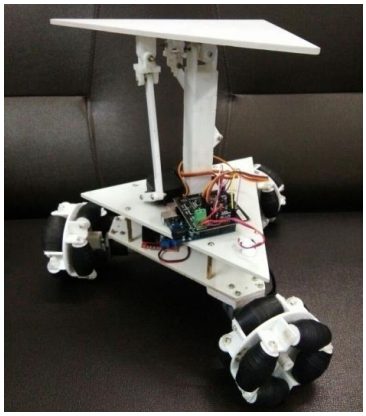

Fig: 5 Left Direction Movement

3.3.3 Robot Moving in Right Direction

The below Fig:8 shows Omni-wheel robot moving in the right direction. In order to move the Omni-wheel robot, the command has to be given through the mobile Application. By using the Bluetooth Module HC-05 the connection established between Arduino board and Mobile Application. Once the right arrow key is

pressed in the Mobile Application the robot starts rotating in the right direction.

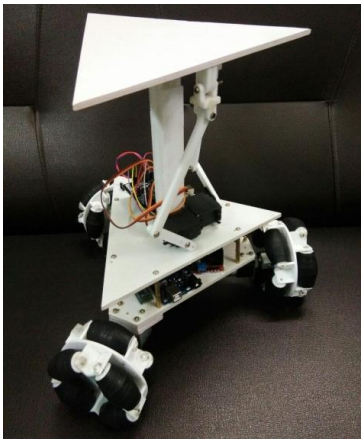

Fig: 6 Right Direction Movement

In this the Mobile application gives control signal to the Arduino board which has ATMEGA 328 Microcontroller in it. This Arduino gives the required control signal to the Motor Driver circuit. Low is converted into a high current signal by motor driver to run the DC Motor. Accordingly all the DC Motor rotates in the clock wise direction and the robot will rotate right without changing its position. Here all the three wheels of the robot is together moved to rotate the robot in the right direction. As long as the key is pressed in the Mobile Application, the Arduino passes signal and the movement will be present in the robot. When the key is stopped pressing in the Mobile Application, it stops giving signal to the Arduino board, so the movement of the robot will be stopped.

3.3.4 Robot Moving in Backward Direction

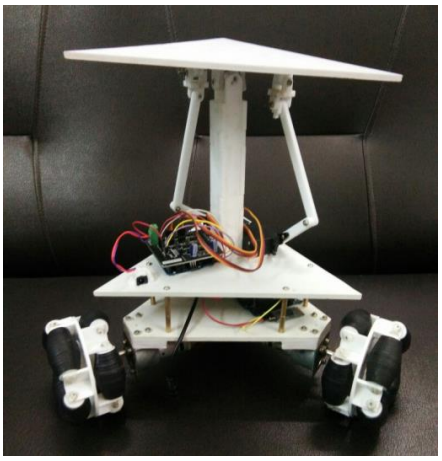

Fig: 7 Backward Movement

The above Fig:9 shows the Omni-wheel robot moving in backward direction. In order to move the Omni-wheel robot, the command has to be given through the mobile Application. By using the Bluetooth Module HC-05 connection established between Arduino cater and Mobile Application. Once the backward arrow key is pressed in the Mobile Application the robot starts moving in backward direction.

In this the Mobile application gives control signal to the Arduino board which has ATMEGA 328 Microcontroller in it. This Arduino gives the required control signal to the Motor Driver circuit. Motor Driver select low current control signal and converts into a higher current signal to drive the DC Motor. Accordingly DC Motor rotates and robot will move

backwards. Here the front wheel of the robot is not moved, in two back wheels one motor turns clockwise and other motor turns anti-clockwise , so the robot moves forward. The forward and backward movement of robot is determined by direction of the motor. As long as the key is pressed in the Mobile Application, the Arduino passes signal and the movement will be present in the robot. When key is stopped pressing in the Mobile Application, it stops giving signal to the Arduino board, so the movement of the robot will be stopped.

ARROW KEY COMMAND	DIRECTION MOVEMENT
TOP	FORWARD
BOTTOM	BACKWARD
LEFT	LEFT
RIGHT	RIGHT

Table 3.1 control mechanism of Omni-wheel Robot

3.4 Auto Adjusting Plate

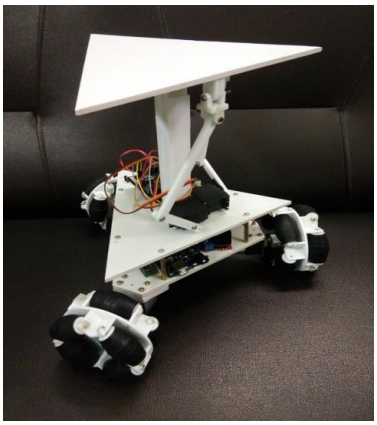

Fig 8 Rig

The process of accelerating forces is being weighed by an accelerometer. These forces may be stationary or continuous. The earnestness , linear acceleration , whirl vector, eloquent move , step counter and step detector are being monitored by various sensors. Both base motion of a Omni-Wheel and rig uses the AT Mrga328 microcontroller with the arduino Uno. Lithium Ion battery is charged externally using 12V SMPS power supply. Rigorousness regulate of angular and linear position is maintained by means of servomotor.

4 CONCLUSION AND FUTURE WORKS

4.1CONCLUSION

This hardware implementation describes the navigation of an Omni-wheel robotic system under different terrain conditions. In the previous case, Big-dog the rough terrain quadruped robot was funded by DARPA to accompany soldiers in terrain. This Robot uses four legs that use variety of sensors for the movement. The size of robot is too large and the cost of robot is also high. Here the Omni-wheel robot is designed for progressions in various directions. The servo motors are used for the control of rig. These motors are controlled by the pulse width modulated signal. Based on these angles the progression of the Omni-wheel robot takes place. To equipoise the ground friction and for effectual motion on slippery surface, we use a method in which top surface of a robot will always be parallel to ground and the robot will be parallel to the slope.

4.2 FUTURE WORKS

In the near future work, the Omni wheel robots can be designed using a hydraulic piston which gives more strength to the robot to do mechanical work in the field. The wheels of the robot can be further improved for the navigation in the rugged surfaces and in the sloppy areas. Further the platform of the Omni- wheel robot can be designed stronger to carry more loads in the terrain region. These kinds of robots are used in the military, industrial and various other applications.

Hardware Implementation YouTube Link:
https://youtu.be/1jwhr7gYMco

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