A Smartphone Controlled Two-wheeled Self Balancing Vehicle

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***Abstract*— Day to day new innovation is added to the different technologies, similar way in the field of self-balancing vehicle, This paper represents an approach to a driver assistant system for a two wheeled self-balancing vehicle. This approach is aimed for readily available mobile devices, which have become a part of our daily lives such as mobiles or tablets. In this work we have connected a self-balancing hover-board to a mobile (or any android device) via Bluetooth. It is eco-friendly, convenient and easy to use. In this system we have used gyro sensor for balancing and Arduino uno board which consist of microcontroller for programming, and are all powered by a 12-volt battery. The main purpose of connecting the vehicle to smartphone is to leverage mobility like anyone can control it on their fingertips it is specially made for people who are not able to move or carry weight due to any reason e.g. old age ,pregnancy, patients with back problem, etc. and it can also be used in small workshops and industries. this vehicle can solve many problems of mankind on their fingertips and in a very cost-effective way. The weight carrying capacity can be varied from 20 kg to 100kg.**

***Index Terms*— Arduino (microcontroller), Bluetooth, motor driver, gyro sensor.**

I. INTRODUCTION

Since the first small experimental prototypes raised this locomotion alternative during the 90's decade [1], [2], two-wheeled, self-balancing vehicles began attracting interest. This interest has resulted in several prototypes of experimental and commercial level, due to this latest development, the interest to develop similar mountable self-balancing vehicles has been growing rapidly. Tu Yunwu, from University of Science and Technology of China, has developed a two-wheeled self-balancing vehicle: Free Mover [3][4]. A two-wheeled self-balancing vehicle has acquired a lot of interest recently for research works as well as for commercial purposes.

This paper shows how a properly design of the control architecture and of the control loops can reduce the limitations or even cancel them improving the overall performance of the vehicle. This paper proposes an approach for a mobile operated self-balancing vehicle development that is assisted by a mobile operator. The reference model is summarized in 3 sections: design methodology, advantages and future scope. The results are summarized in conclusions.

II. LITERATURE REVIEW

The literature presents a large variety of studies, hardware and sensing configurations and control methods. Control of mobile Inverted pendulum has a long history, which flourished in the 90s with two notable examples [7], [8]. Research works may be Grouped into two categories: those that focus only on the swinging body stabilization and longitudinal motion control [9], [5] and those that also address the lateral dynamic problem [7], [10],[8]. The above cited works also present different sensors adopted to measure the swing body kinematics (i.e., the tilt angle and rate), which may comprise gyroscopes and accelerometers as in [5] or a tilt sensor, as in [10]. Mirko Brentari in Position and speed control of a low-cost two-wheeled, self-balancing inverted pendulum vehicle[12] represented a low-cost prototype of a two wheeled, self-balancing inverted pendulum realized at the mechatronics Laboratory. This vehicle lends itself to represent a class of control problems that arise in many educational robotic devices custom built and assembled with low-end market components. We provide a detailed description of the equipment and describe the strategies adopted to suitably address backlash of the low-cost DC motors and disturbances arising from the voltage controlled hardware.

III. SYSTEM ARCHITECTURE

The interconnection between different components is explained using the architecture of system. Architecture diagram is shown in figure 1. The arduino is connect to the gyro sensor and Bluetooth, along with motor driver is also connected to arduino to run the motors with which both side wheels are moving as per the commands given from the smartphone.

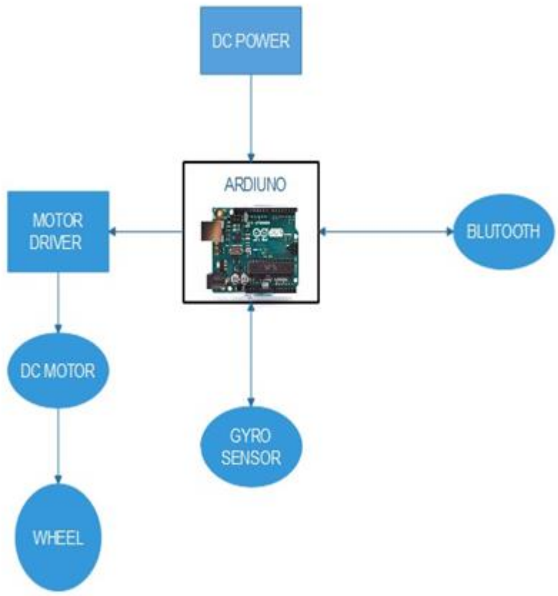

Figure.1 System Architecture

IV. DESIGN METHODOLOGY

Design of the system is divided into two parts: Hardware components and software components.

Hardware Components

A. Microcontroller (Arduino)

Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself (DIY) kits.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or Breadboards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler tool chains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

The Arduino project started in 2003 as a program for students at the Interaction Design Institute Ivrea in Ivrea, Italy aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

Figure.2 Arduino Uno Board

B. DC Motor and Motor driver

This DC or direct current motor works on the principal, when a current carrying conductor is placed in a magnetic field, it experiences a torque and has a tendency to move. This is known as motoring action. If the direction of current in the wire is reversed, the direction of rotation also reverses. When magnetic field and electric field interact they produce a mechanical force, and based on that the working principle of DC motor is established. The motor we have used rotates at 200rpm. A motor driver is a little current amplifier; the function of motor drivers is to take a low-current control signal and then turn it into a higher-current signal that can drive a motor.

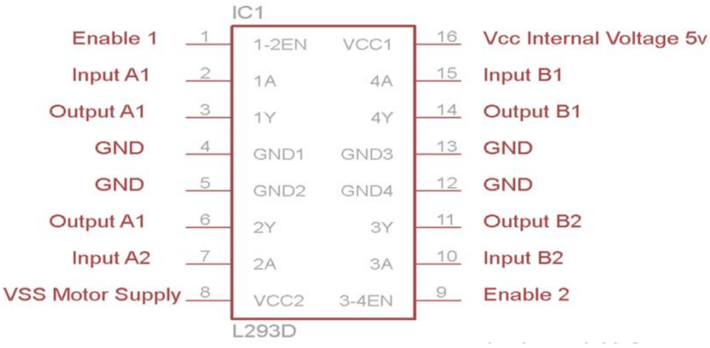

Figure.3 Motor Driver IC

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. Dual H-bridge Motor Driver integrated circuit (IC).

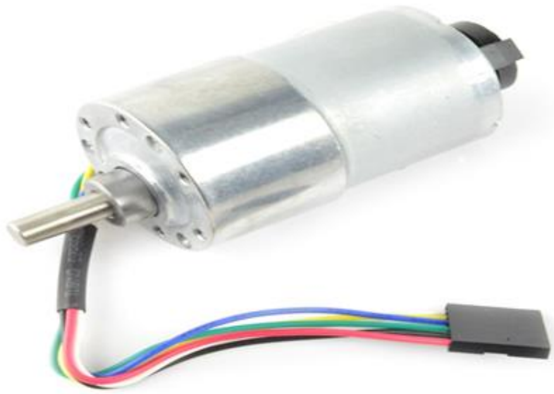

Figure.4 dc Motor

C. Gyro sensors

Gyro sensors, also known as angular rate sensors or angular velocity sensors, are devices that sense angular velocity. Angular velocity. In simple terms, angular velocity is the change in rotational angle per unit of time. Angular velocity is generally expressed in deg/s (degrees per second).

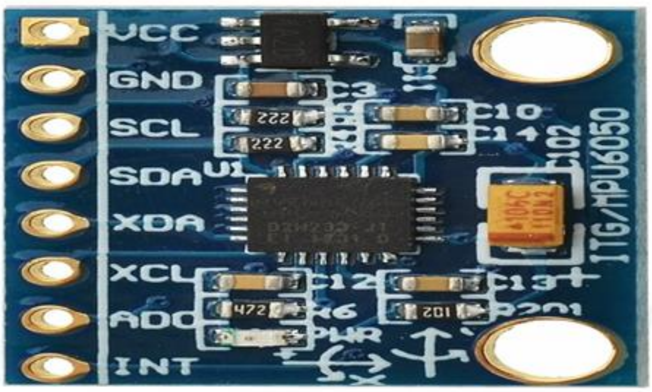

Figure.5 Gyro sensor

D. Bluetooth

A Bluetooth device works by using radio waves instead of wires or cables to connect with your cell phone, smartphone or computer. Bluetooth is a wireless short-range communication device.

Figure.6 Bluetooth

Software Requirement

A. Arduino Programing Tool

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software.

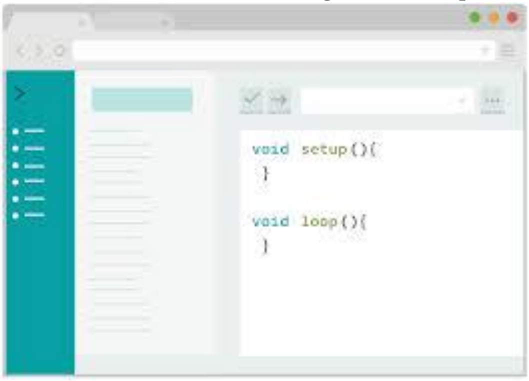

Figure.7 Arduino programming Tool

B. MIT App Inventor

A mobile app is developed with the help of MIT APP INVENTER. This app is gives command to arduino and in the compiler it was returning signals, for example; by pressing forward in the smartphone it was giving signal "F" and for backward "G".so for each signal we used "else if" and return statement .Then these commands are forwarded to motor driver and gyro via arduino.

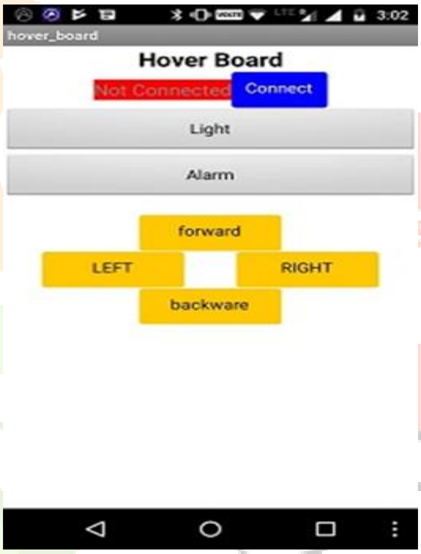

Figure.8 Android Application

V. IMPLEMENTATION

1. Initially we made connection between hardware components.
2. Program is downloaded to the arduino board using its programming tool
3. The motors are connected to motor driver and wheels, this motor driver is then connected to arduino.
4. A gyro sensor is used for the balancing of the vehicle (the gyro sensor is used only for the balancing of pitch horizontal plane). The sensor is then connected to arduino.
5. A 12 volt, 2.5A power supply is given to the motors required power supply is given to the arduino as well.
6. A Bluetooth device is also connected to arduino for the commands to be received from the smartphone. These commands are used for the balancing and movement of the vehicle.

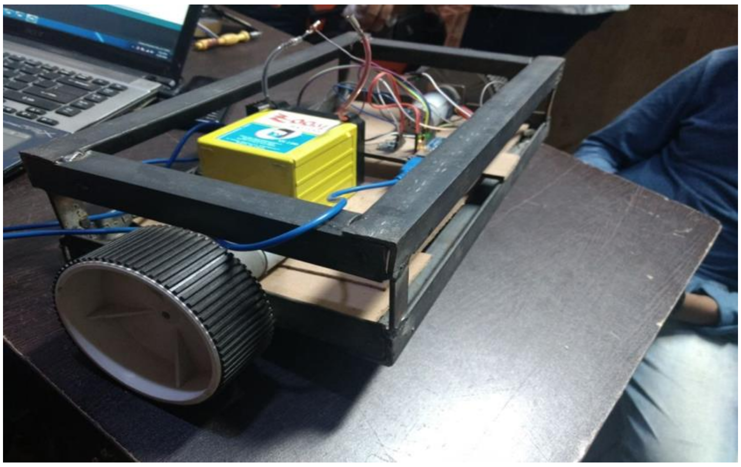

Figure.9 System

VI. CONCLUSION AND FUTURE WORK

We presented a model of a mobile operated hover board in this project. The model consists of these main components Arduino, mobile application, motor driver, gyro sensor and Bluetooth. The smartphone-based application can be used by any smartphone both for indoor as well as outdoor uses, manifesting itself as an affordable technological vehicle for any user.

The skateboards of the future will be hover boards and if they are to fly they will need to be made out of lighter materials. What materials might they be made of, Chances are they will be made of Carbon Nano Tube construction, grapheme or ultra-light weight composites. Most plastics such as polyethylene and polypropylene are way too heavy and wood simply won't work.

This means the current manufacturing processes that are used to make skateboards will have to be changed along with the materials. This transition may upset the industry and some of the riders and there will be resistance to change. The resistance will be similar to what we saw with skis or choosing to go down the slopes on snowboards.

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