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Arduino Based Self Balancing Robot

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ABSTRACT

In the last decade, the open source community has expanded to make it possible for people to build complex products at home. In this thesis a two-wheeled self-balancing robot has been designed.
These types of robots can be based on the physical problem of an inverted pendulum. The system in itself requires active control in order to be stable. Using open source microcontroller Arduino Nano and reliable angular and positional data the system can be made stable by implementing a controller.
A modern and efficient controller is the LQR-Linear Quadratic Regulator. Being a state space feedback controller the model has to be a good representation of reality since the output signal depends on the model.
In this thesis, the validation process was performed using a PID-regulator. The results showed thatthe model is not yet reliable. The reasons for this are discussed and recommendations for future development are listed.
Keywords: Arduino Nano, NEMA 17 Stepper Motor, A4988 Motor Driver, MPU 6050, HC-05 Bluetooth Module, 12 Volt Lipo Battery, 100 micro Farad Capacitor, 1K OHM Resistor.

I. INTRODUCTION

To make a robot which can balance itself ontwo wheels. There will be only one axle connecting the two wheels and a platform will be mounted on that. There will be another platform above it. The platform will not remain stable itself. Our job will be to balance the platform using distance sensors and to maintain it horizontal. At first, we have decided to just balance the robot on its wheels. If the platform inclines then Microcontroller (in this case it is Arduino) will send signals to motors such that motors would move forward or backward depending on the inclination direction and extent. So if the platform tilts forward then motors will run forward and vice versa to keep the platform horizontal. For this we will need to code the Arduino in order to perform job according to this.
Technique used in making the self-balancing robotis same as the principle used in balancing of Pendulum the Inverted. Balancing of the Inverted Pendulum is a classic problem in dynamics and control theory and is widely used as a benchmark for testing control algorithms. Variations on this problem include multiple links, allowing the motion ofthe cart to be commanded while maintaining the pendulum, andbalancing the cart-pendulum system on a see-saw. The inverted pendulum is relatedto rocket or missle guidance, where thecenter of gravity is locatedbehind the center of drag causingaerodynamicinstability. The understanding of a similar problem can

be shown by simple robotics in the form of a balancing cart. Balancing an upturned broomstick on theproblem is solved in the technology of the Segway PT, a self-balancing transportation device.

This report documents the design and implementation of a self-balancing robot, which is an unstable system, the basic model is that of an inverted pendulum balancing on two wheels. Thiswork details the derivation of the model of the system and lays out the framework of the robot's control system. It also shows the full implementation of a control system stabilizing the robot. The robot is built using LegoMindstorm, an educational product first released by lego in 1998. The Lego Mindstorm kit is equipped with a 32-bit ARM7 Microprocessor with a bootloader modified to run the next OSEK real-time operating system.

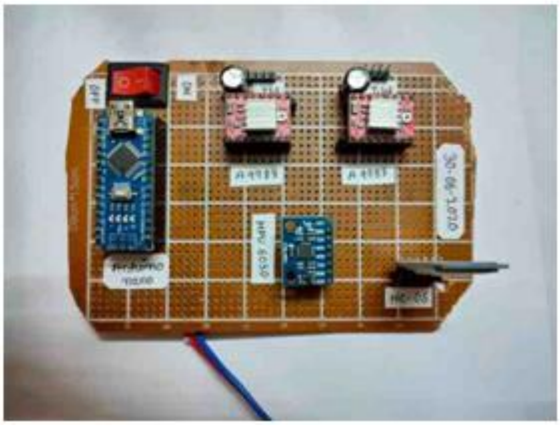
II. STRUCTURE

For a balancing robot the most important thing is the frame. The performance of the balancing robot is totally dependent on the structure of the frame. Try to make the frame small and as light as possible. A light weighted frame will help to get an optimal performance. The basic approach is to make a three layer frame, where the motors are connected at the bottom layer and the remaining circuit will be fixed in the middle layer. However, you can also customize the design according to the project requirement.

Here we are going to follow the basic approach, which is a three-layer frame. You have to put all the heavy equipment (like motors and battery) at the bottom layer. Then you need to put the circuitin the middle layer. It may affect the performance of robot. Also, check the alignment of the frame. The alignment should be perfect without any fault.

III. CIRCUIT CONNECTION

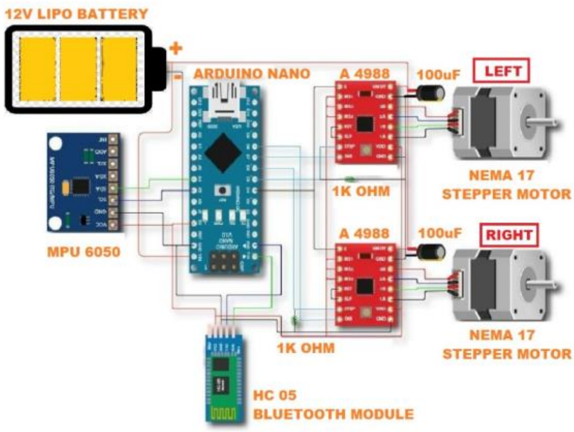
Now you have to make the circuit. You can make the circuit at your home by using Vero board or you can directly order a PCB from any PCB manufacturing company. While designing the circuit, you have to keep some important fact your mind. Try to put the gyroscope sensor MPU 6050 at the middle of the circuit. Also place the A4988 motor driver at any side of the circuit. It is recommended to use Arduino Nano in spite of using Arduino UNO. This will make the circuit simple and less bulky. Now take a look at the connection below.



These are the basic connections of the circuit. Now you can add some extra things to make your circuit more secure and fine.

1. Add a 1 Kilo Ohm resistor at the step pin of each motor driver.
2. Add a capacitor of 100 micro Farad between the VMOT and GND pin of each motor driver. This will prevent the extra heating in motor driver. And your motor driver will not damage any more. If you don't provide the capacitors, your motor driver may heat up and damage.
3. Also give a volt dc supply to the other components of the circuit (like MPU 6050, HC-05 Bluetooth Module).

For better understand of the circuit, look into the circuit diagram given below



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