e-Yantra Summer Internship Programme 2015

IIT Bombay

Development of PC controlled two wheel balance bot

Interns:

B Suresh
Email:sureshbutterfly@gmail.com
Mob: 9972413186

Devendra Kumar Jangir
Email:devendraj592@gmail.com
Mob: 9454190392

Ramiz Hussain
Email:ramizhussain123@gmail.com
Mob: 8495980234

Mentors:

Piyush Manavar

Saurav Shandaliya

Under the guidance of
Prof.Kavi Arya

25 June 2015
to
8 July 2015

Abstract

Balance bot is a two wheeled robot which can balance itself without any extra support. The balance bot can be considered as an advancement of the classic inverted pendulum problem.

In order to balance the bot, the magnitude and direction in which the bot is tilting is measured using accelerometer and gyroscope. The signals obtained are then used to move the wheels in the direction in which the bot is falling.Complementary filter is used to obtain better results from the accelerometer and gyroscope. Proportional Integral Derivative (PID) is used to control the motor speed. The wireless communication is done using zigbee to move the bot in forward and backward direction. Comparison of output and input is done using scilab and a GUI is also made.

Objective

- Selection of components, sensors and actuators
- Design and fabrication of bot
- Designing of circuit,power management and interfacing
- Algorithm and code implementation for balancing
- Algorithm and code implementation for locomotion via PC communication
- Analysis and documentation

Extent of Completion

The bot was balanced and made PC controlled. The forward and backward motion control was achieved. The right and left motion control were not accomplished as it required more time for tuning.

The tasks alloted were well designed and enough time was given for the respective tasks. the first, second and the third tasks were completed on time but the tuning for task four got delayed as we did not receive the batteries. Nevertheless, with some extra effort and determination we were able to complete the project on time.

Results and Discussion

- The bot is balancing and its motion can be controlled by PC.
- There were many changes in the design like reducing the weight of the bot and removing the weight shifting mechanism,changing the position of batteries, sensors etc.
- The major challenge was that of design which in turn affected the tuning process.The higher center of gravity requires high torque that demands large tuning parameters.This results in frequent polarity change that leads to large current and back-EMF which resulted in burning of brushes in motors.We solved this problem by moving the battery lower moving to a more stable Center of Gravity.
- Real-time plot of input and output of PID controller helped in tuning and to check the crossing of bounds.
- Complementary filter was very effective in making the bot more stable.

- In order to move forward and backward, the method of changing PID setpoint was used.

Bugs

- The bot is not able to balance at a single point.It sways and moves over time.It is very susceptible to unbalanced mass.
- There is jitter at the balance point.Its reason is not known at this point.
- The maximum disturbance angle is limited to 15 degrees due to the motor torque and rpm.
- There is more tendency for the bot to fall when turning due to lesser stability.
- Additional weight added to the bot makes it more unstable
- While using the Scilab realtime plot,if the bot is turned off before pressing the 'stop' button it can cause Scilab to hang.

Future Plans

1. PID tuning can be made finer to make the bot more stable
2. Right and left turns can be improved
3. Low pass filter can be added to the motor PWM to reduce the jitter
4. Gyroscope can be used to take precise turns
5. Accelerometer/optical encoders can be use to balance the bot at a given position
6. Other actuators can be added to make it a line follower

References

- Integration of accelerometer and gyroscope using complimentary filter
- PID Implementation
- Coursera course on PID Control by Dr.Magnus Egerstedt
- Velocity mapping from PID output
- Serial library for Scilab