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DEVELOPING A CONTROLLER OF TWO-WHEELED SELF-BALANCING ROBOT BY USING ARDUINO MICROCONTROLLER

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ABSTRACT

Most of two-wheeled self-balancing robot is designed based on an inverted pendulum system, which is thedynamically system stable but not for steadily system. The objective of this project is to design the simple self-balancing robot using SOLIDWORKS software, then this robot will be controlled by using Android application via Arduino interface as a microcontroller. The idea of this project was used a sensor which called as IMU to estimate and obtain the tilt angle of the robot. To make the better performance in term of balancing and stability, a PID concept was applied to correct the error between the desired set point and the actual tilt angle position. The error was calculated to adjust the motor speed accordingly for the balancing and stability of robot. The robot system also was implemented with Android and Arduino microcontroller to move from one place to another place. As the results, the robot was able to balance the system acceptably but with some limitations due of noisy and disturbance of environment. In addition, the PID tuning using heuristic method was used to find and improve the balancing and stability of the robot system.

Keywords: self-balancing robot, two-wheeled, arduino microcontroller, PID controller, inverted pendulum

1. INTRODUCTION

Designing with a simple mechanism of robot is increasing in order to introduce how important the robot industrial in era IR 4.0. One of them is designing a two-wheeled self-balancing robot, which is an important kind of mobile robots. Balancing robots means the capability of the robot to balance on its two wheels without falling. The inverted pendulum system [1], unlike many other control systems is naturally unstable. The robot system needs to be controlled until it reachesthe stability in this unstable state. The designing of two-wheeled self-balancing robot is simply from inverted pendulum system concept which stands upright on two wheels. Unlike the other mobile robots, the two-wheeled self-balancing robot has advantages for its small scale, mobility, low cost and has been widely used for various events. While as a unique case of inverted pendulum, a two-wheel self-balancing robot has unstable, multivariable, complicated and non-linear properties.Working on two-wheeled self-balancing robots has increased in recent years due to the invention of Segway, a human carrier device. In this project, the robot was designed by using SOLIDWORKS software, and then for controller, the Android applications was implemented via Arduino microcontroller.

2. CONCEPT OF TWO-WHEELED SELF-BALANCING ROBOT

In this project, the designing of two-wheeled self-balancing robot was designed using SOLIDWORKS software. The idea of this design based on inverted pendulum concept. There are lot of research regarding inverted pendulum [2]. The simple and small size robot was designed and was fabricated as shown in Figure 1 (a) and (b).

(a) (b)

Figure 1. (a) Two-wheeled robot was designed by SOLIDWORKS (b)Prototype of two-wheeled robot

Based on the findings in the research papers, there are lot of controllers can be used to mount on two-wheeled self-balancing robot, such as Linear Quadratic Regulator (LQR), Pole-Placement Controller and Fuzzy Logic Controller (FLC) and Sliding Mode Controller (SMC) [3].Although many papers have simulation results, most of the linear and nonlinear controllers lack experimental results but in practically, there are a lot of problems with their implementation, particularly in LQR, SMC, FLC, However, the simulations can be used to demonstrate robustness to disturbances and model uncertainties. It is also unclear how the application of the controller can be carried out in practice and there is also a lack of consistency between various controller strategies. The system of inverted pendulums is of course unstable, so, a suitable technique and method for controlling the system must be investigated. The two-wheeled self-balancing robot is an application of the inverted pendulum that requires the controller to maintain its upright position. Figure 2 shows the block diagram for two-wheeled self-balancing robot. The input from the smart phone and the output is the balancing and stability of the robot itself.

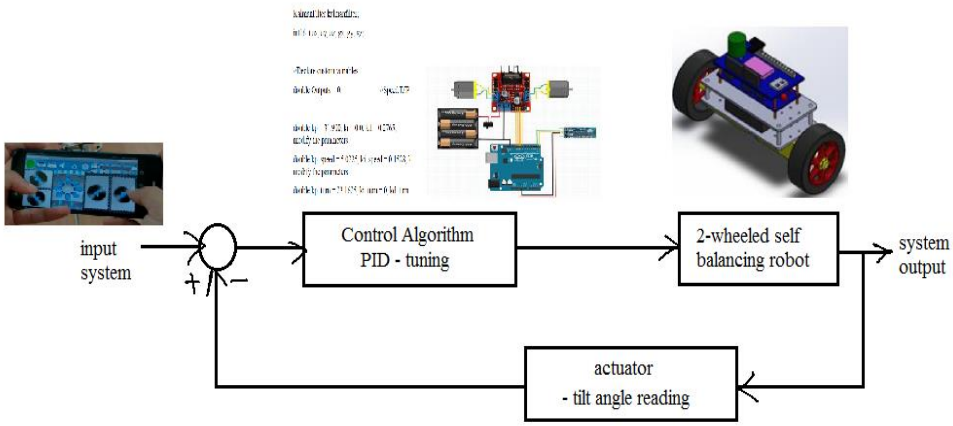

Figure 2. Block diagram of two-wheeled self-balancing robot (from input-controller-output)

As a conclusion, the aims of this objective to balance and stable the two-wheeled robot are successful. Hopefully this robot can be implemented in designing any others living products such as vacuum cleaner, toys for kids and can be used in education.

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