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Dual-axis Platform Stabilization using PID controller

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PROBLEM STATEMENT

To design and implement a platform stabilization system using PID controllers to maintain the level orientation of a platform despite disturbances to the base orientation. Only angular orientation is to be controlled. Correction of lateral movement is not within the scope of this system.

The solution that we plan to implement relies primarily on two control loops that work to keep the platform stable on each axis.

APPROACH AND METHODOLOGY

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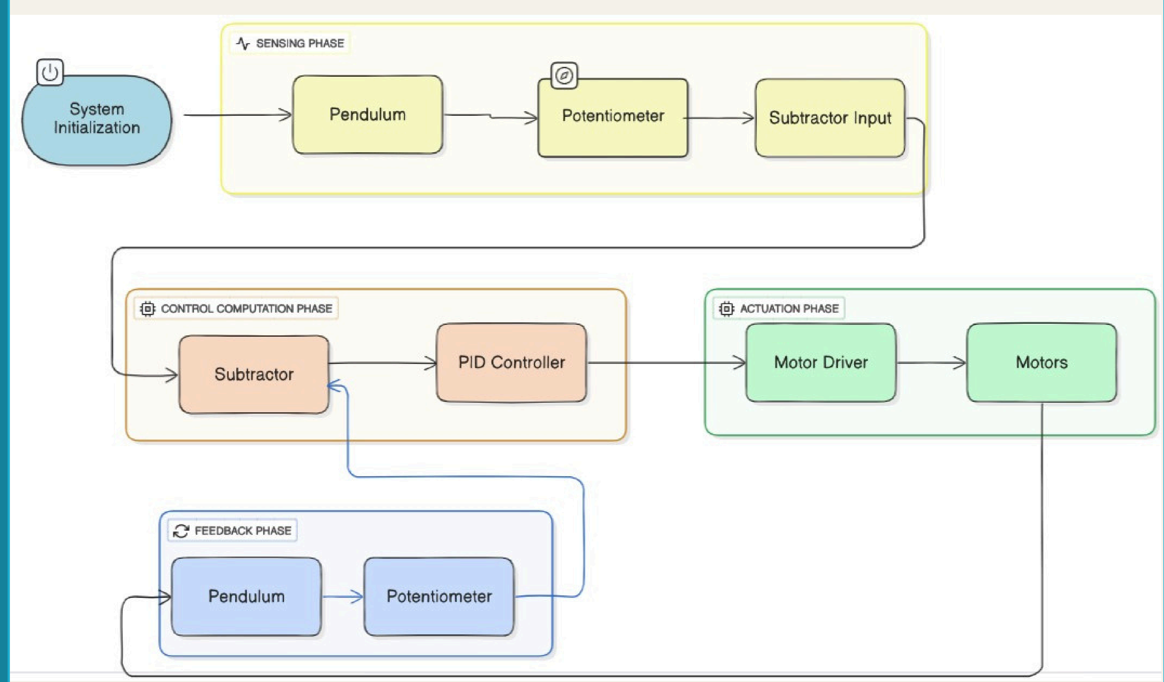
The angle with respect to gravity is sensed by a pendulum that is attached to the shaft of a potentiometer, whose body is fixed to the platform. Thus, as the platform shifts and the pendulum stays attracted towards the Earth, the shaft of the pot is rotated and induced change in resistance is sensed, the inference being that the platform has shifted.

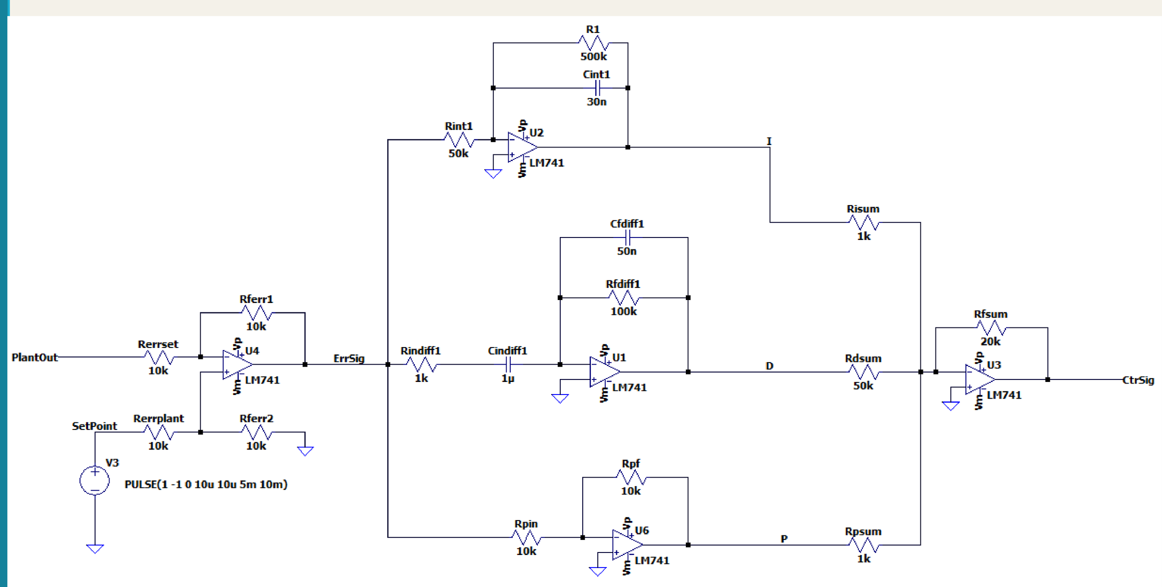
To achieve this, the resistance of the potentiometer is constantly compared and subtracted with a setpoint (which indicates a ground level orientation) to create an error signal. With this signal at hand, the PID control loop works to minimize the error. With proper PID tuning, this is expected to provide the control signal that will stabilize the platform in one axis. The same setup, with another orthogonal potentiometer, will stabilize the other axis.

The three components of the control system work to minimize the error with as little overshoot and steady-state error as possible.

Proportional – to the error signal
Integration – over time to reduce steady-state error
Differentiation – to correct according to the rate of change of error

CIRCUIT DIAGRAM /ALGORITHM

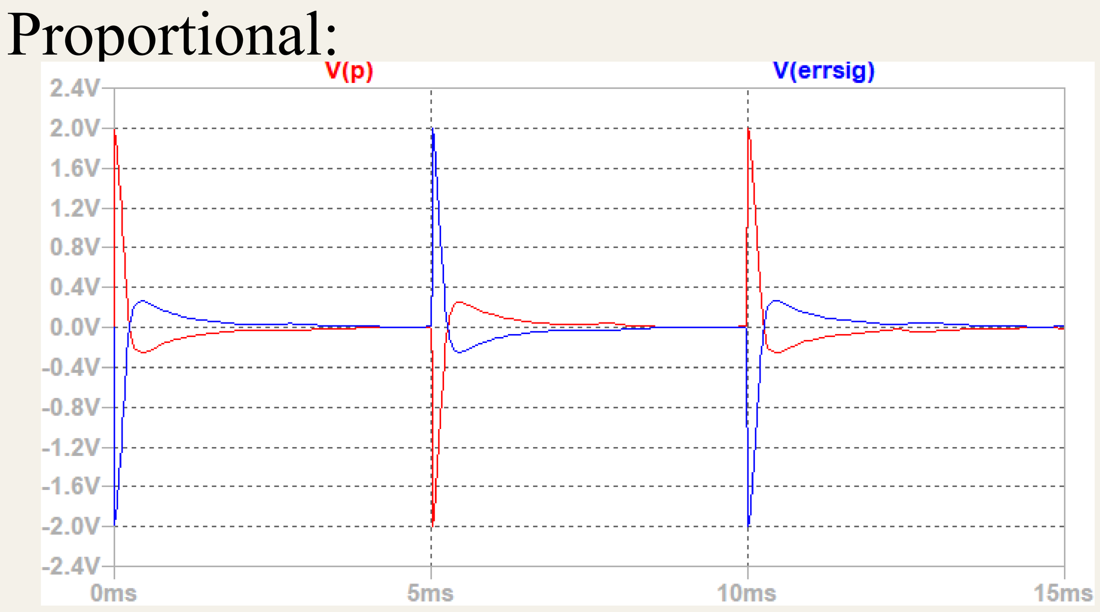




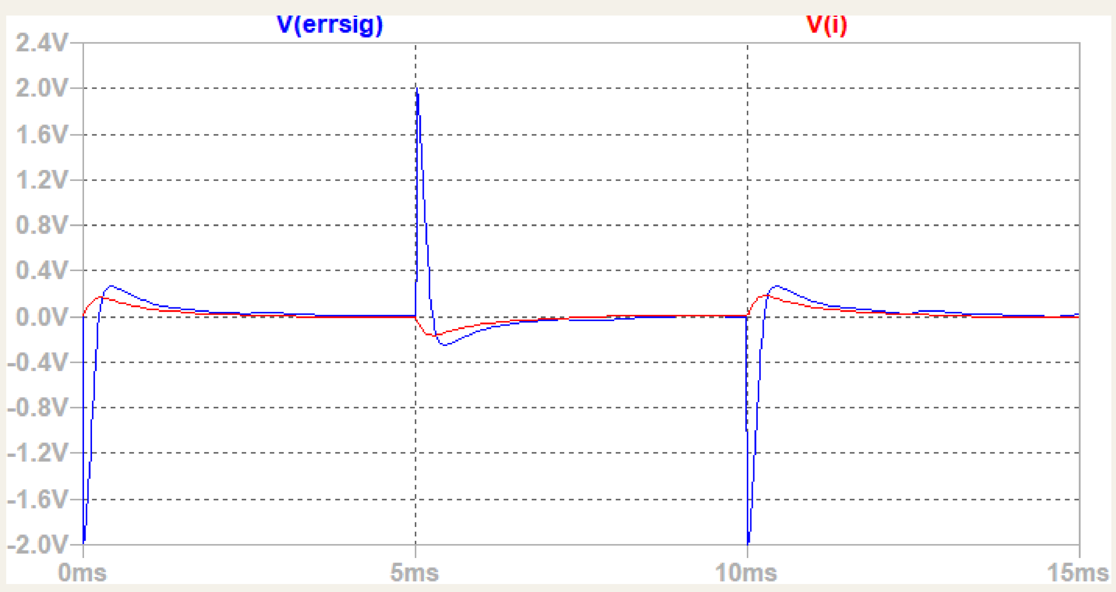
SIMULATION RESULTS

(Simulation has been performed using a placeholder plant transfer function to represent a motor with armature)

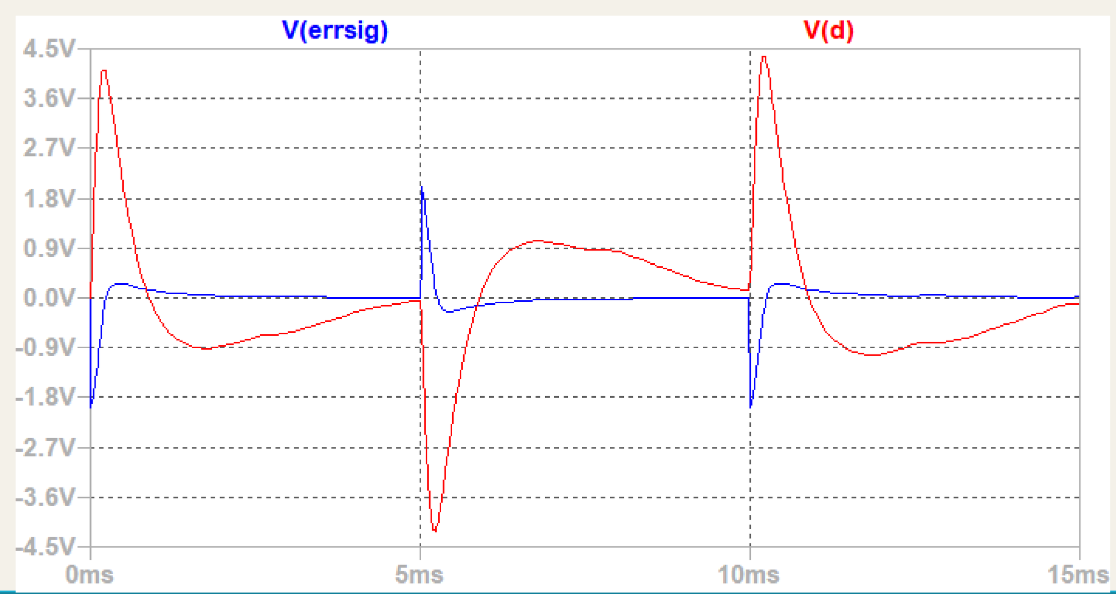
Proportional:



Integral:

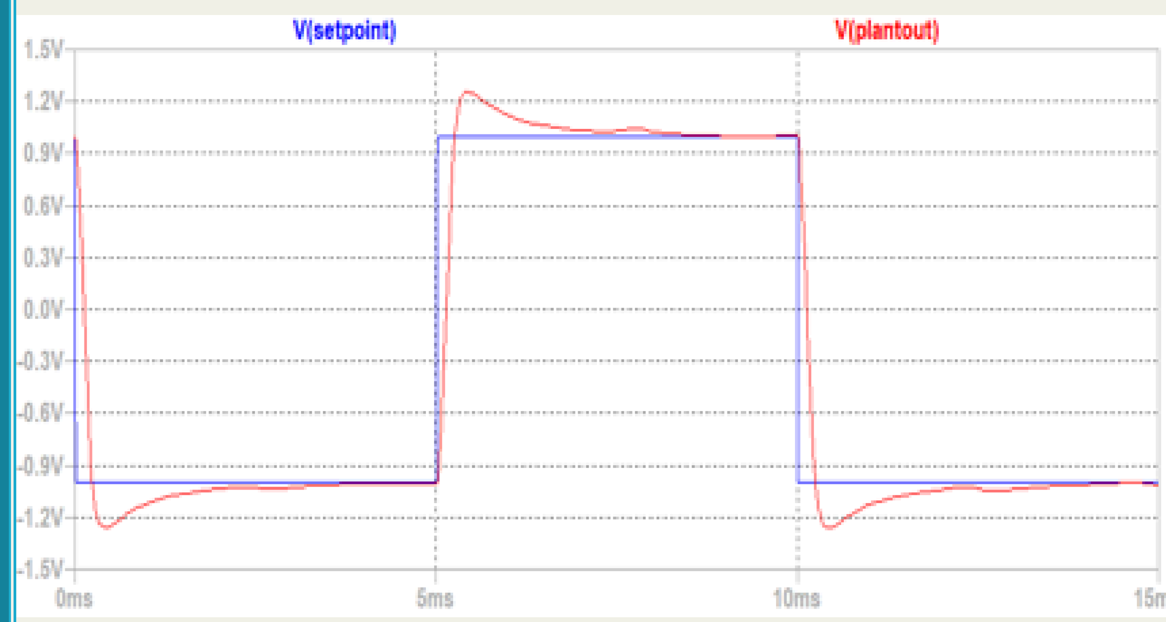


Differential:

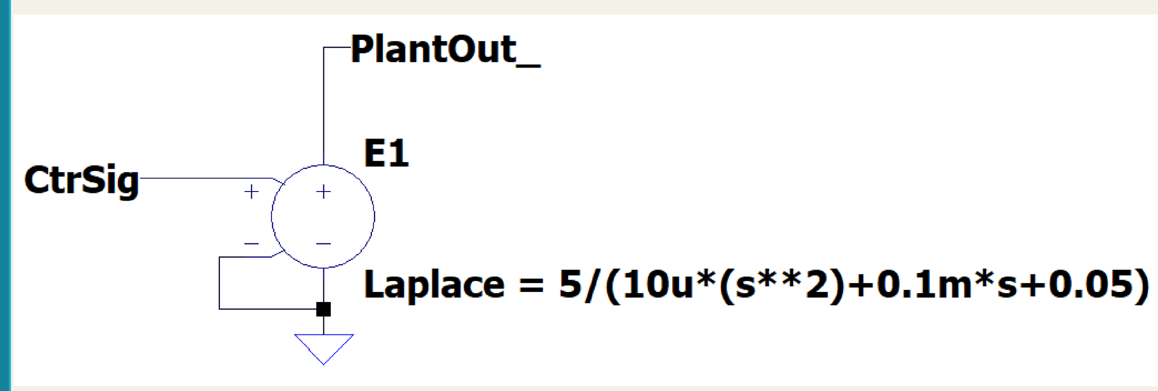


RESULTS

Step response for a third-order plant:



A motor with an armature is (roughly) a third-order plant.



From the step response, it can be seen that the designed PID controller is capable of driving a third-order system akin to a motor. Therefore, by duplicating this for each axis and using them to drive the motors, we can create a dual-axis stabilized platform.

REFERENCES

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