Ball Balancing

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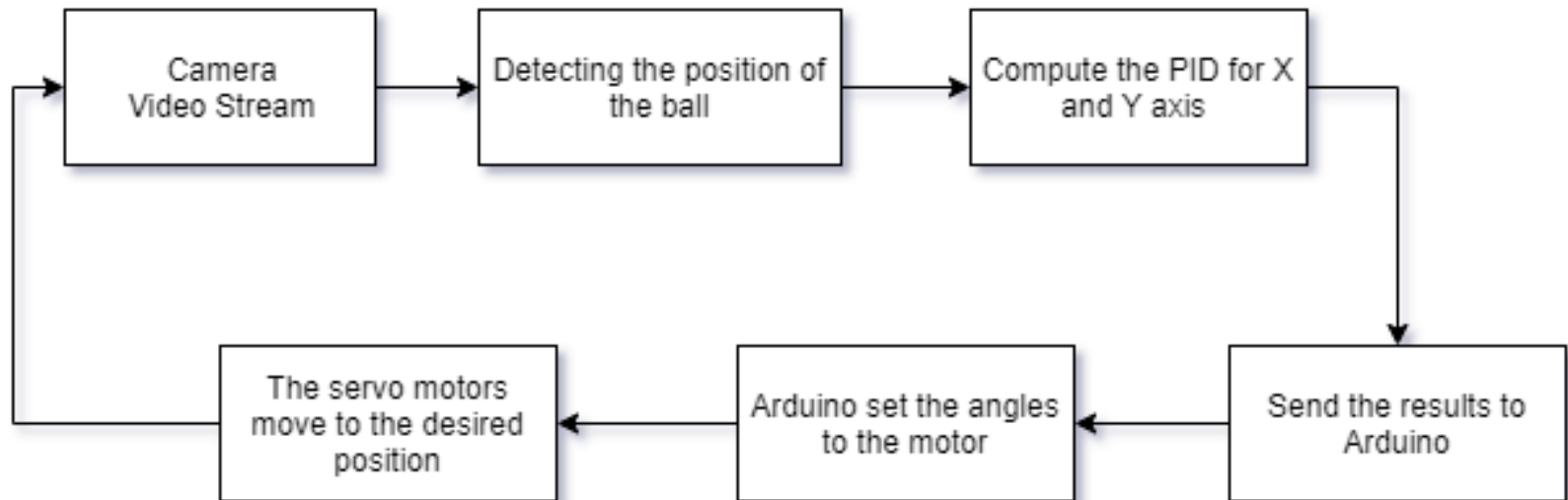# Outline

❖ Introduction
❖ Architectural View
❖ Hardware Tools
❖ Mechanical Design
❖ Software
❖ Demo

Introduction

❖ The most challenging systems in the control field.

❖ Divided into two main parts:

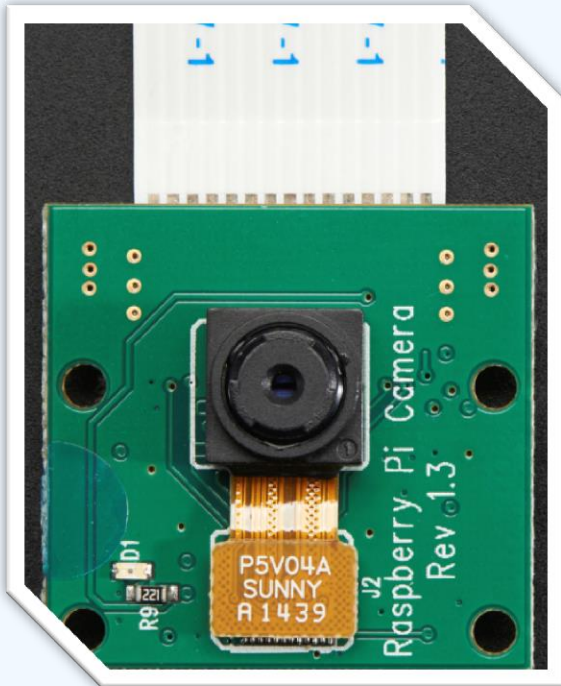 1. Software: PID algorithm and Image processing
  2. Hardware: Mechanical design.

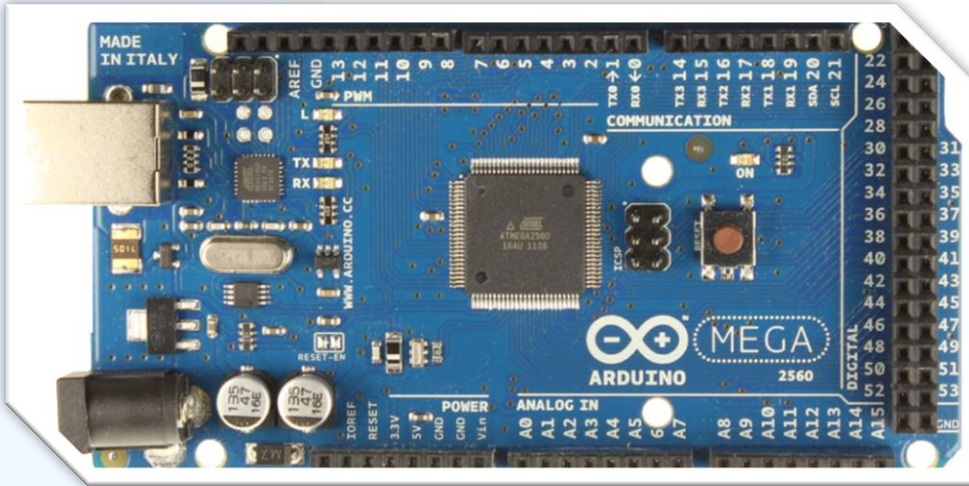# Problem is to balance the ball on the plate.

Architectural View

Camera Video Stream → Detecting the position of the ball → Compute the PID for X and Y axis → Send the results to Arduino → Arduino set the angles to the motor → The servo motors move to the desired position → (back to Camera Video Stream)

Hardware Tools

Raspberry Pi 3

Raspberry Pi Camera

Hardware Tools

Arduino Mega

Servo Motors

Mechanical design

40 cm × 35 cm

50 cm × 50 cm
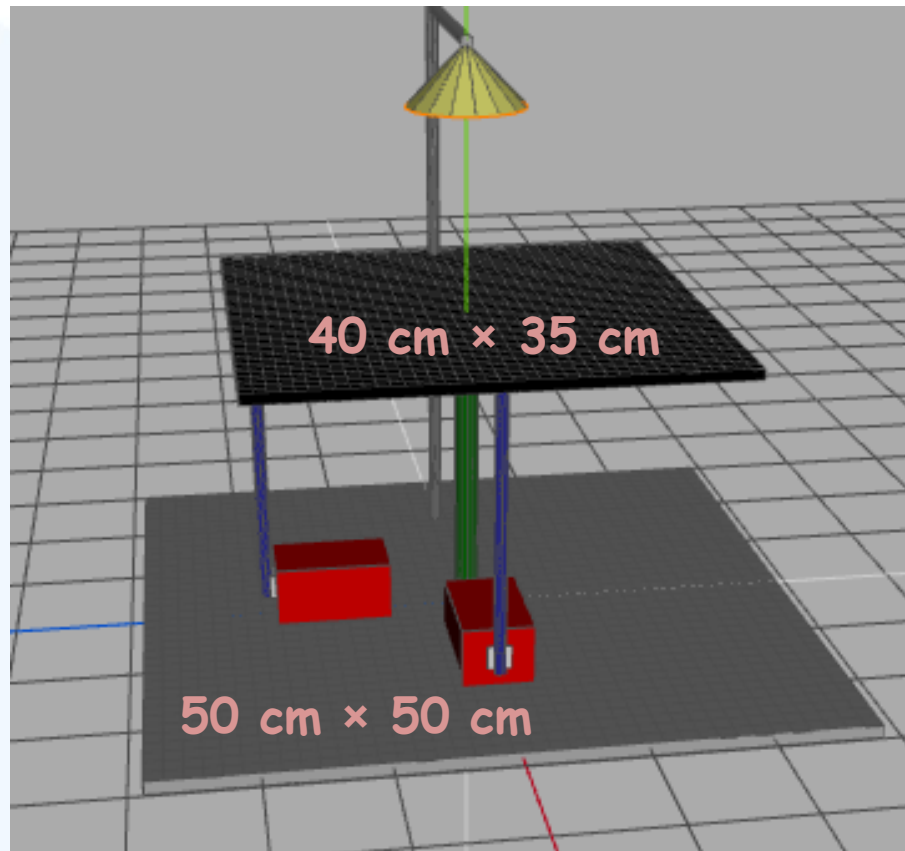
Software

1.Calculate the ball position

Video Stream → Convert the frame to HSV color → Recognize the color of the ball → Erosion and Dilation for the ball → Find Contour → Calculating the moments → (loop back to Video Stream)
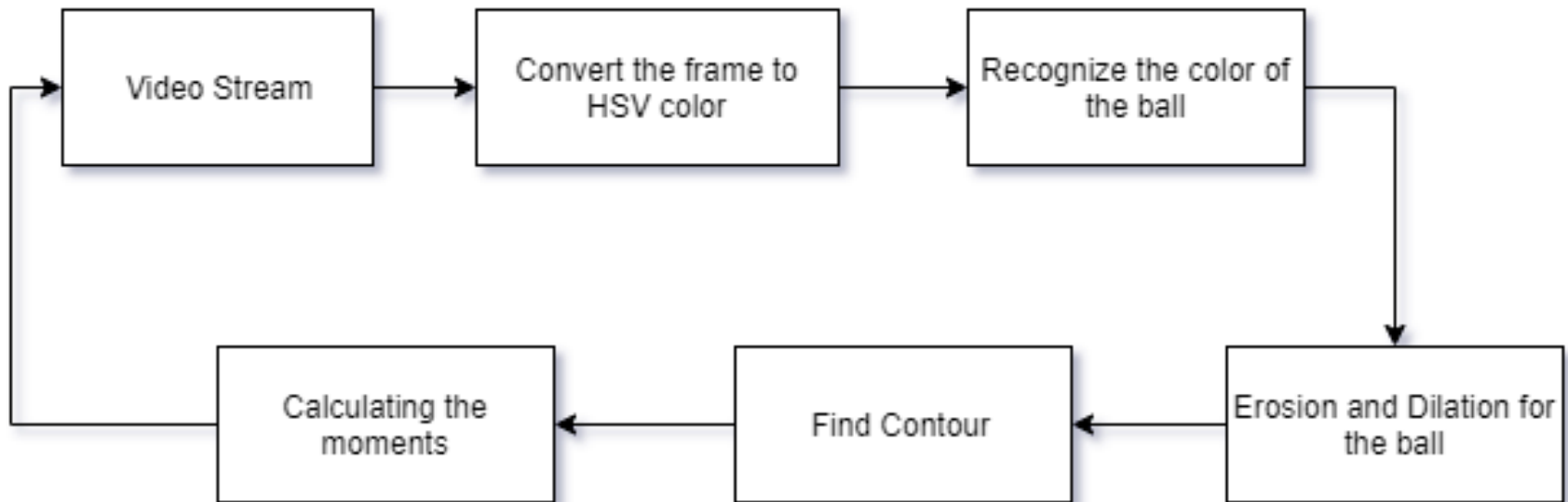
2. Compute PID

Ziegler-Nichols method
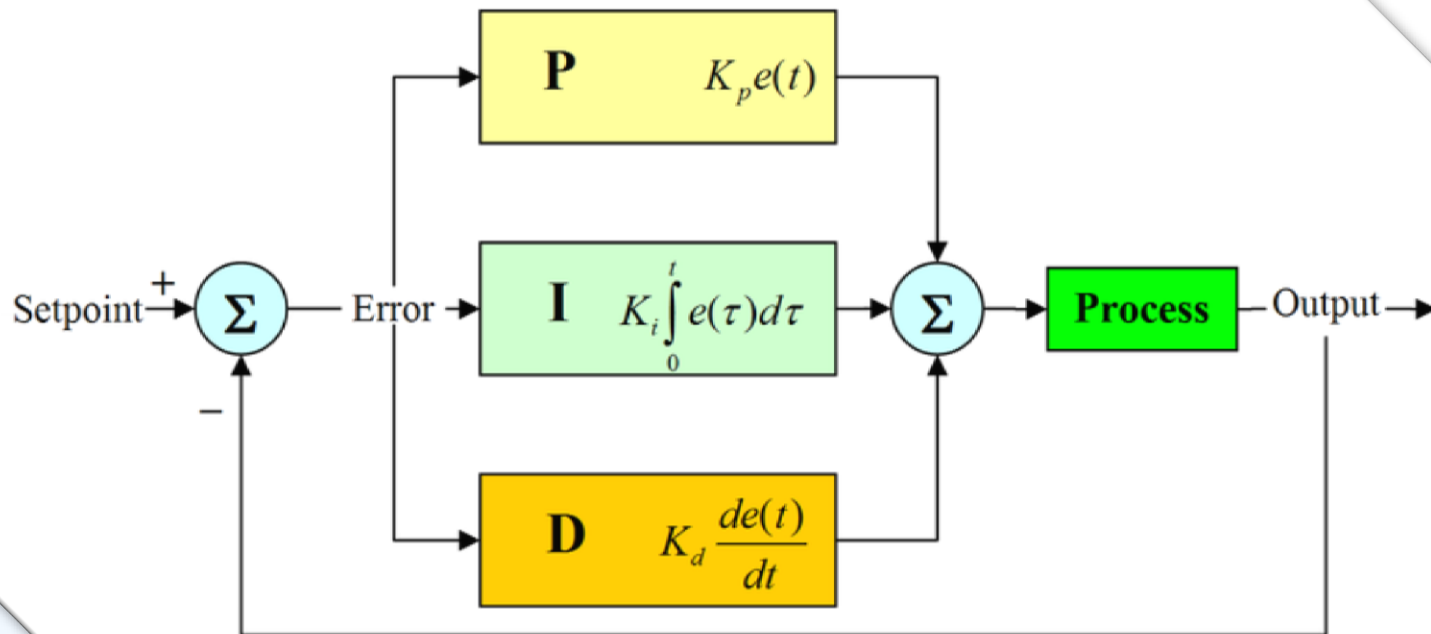
2. Compute PID Cont.

Proportional = **(**X_Center_ball – X_Center_Plate**)** × KP

Integral = **(**Previous_Integral + **(Proportional × Period**)) × KI

Derivative = **((Proportional – Previous_Proportional)** / Period**)** × KD

Result = **Proportional** + Integral + **Derivative**

Parameter Increase	Rise time	Overshoot	Settling Time	Steady-state error
Kp	↓	↑	Small Change	↓
Ki	↓	↑	↑	Great reduce
Kd	Small Change	↓	↓	Small Change

3. Send the angles to Arduino

❖ **Open Connection, Baud:** 115200, **Port**

❖ **Write angles to the serial.**

❖ **Close the connection.**

3. Arduino

❖ **Opens connection via baud number.**

❖ **Attaches servo motors via their pin number on the card.**

❖ **Writes initial angles to the servo motors.**

❖ **Receives angles.**

❖ **Writes those values to servo motors.**

Demo

THANK YOU FOR LISTENING