MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY

SIGNAL PROCESSING, CONTROL AND HARDWARE IN ROBOTICS

Date: 28/05/2020

Dr. Nikhil Agrawal

Department of Electronics and Communication Engineering,

National Institute of Technology Raipur

OUTLINE

❑ Introduction

❑ Control systems

    ❑ On-off control

    ❑ Proportional control

    ❑ Integral control

    ❑ Derivative control

    ❑ PID control

❑ Programmable devices

❑ Arduino

❑ Arduino Interfacing

INTRODUCTION

❑ Robotics is an interdisciplinary branch of engineering and science that includes **mechanical engineering**, **electronic engineering**, **computer science**, and others.

❑ Components

   ❑ Power source

   ❑ Actuation

   ❑ Electric motors

   ❑ Vision

INTRODUCTION

Figure: Robot aided sorting hub..

INTRODUCTION

Figure: Future of robotics in human society.

CONTROL

❑ Control engineering or control systems engineering is an engineering discipline that applies **automatic control theory** to **design systems** with **desired behaviors** in control environments.

❑ Components

  ❑ Power source

  ❑ Actuation

  ❑ Electric motors

  ❑ Vision

  ❑ Programmable device

ON-OFF CONTROL

❑ **Bang–bang controller**: is a feedback controller that switches abruptly between **two states**.

❑ These controllers may be realized in terms of any element that provides hysteresis.

❑ They are often used to control a plant that accepts a binary input, for example a furnace that is either completely **on** or completely **off**.
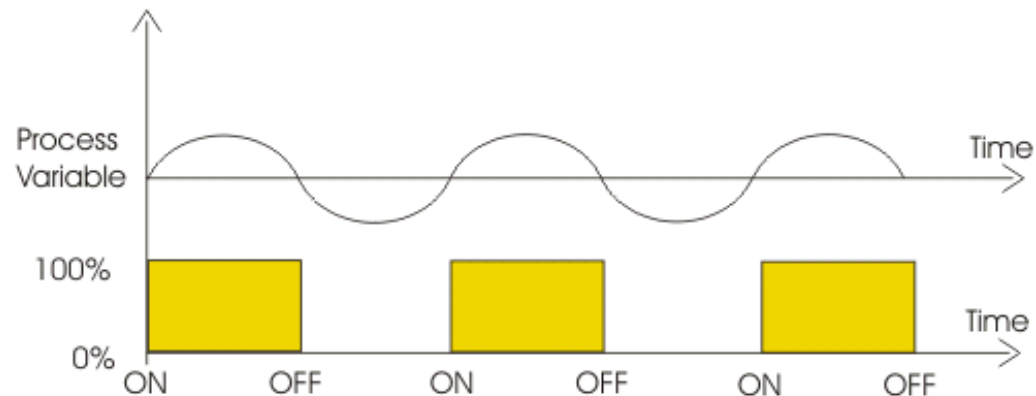

Figure: Output trends of an On-off controller.

PROPORTIONAL CONTROL

❑ **Proportional Controller**: is a linear feedback control system in which a correction is applied to the controlled variable, which is proportional to the difference between the **desired value** (set point, **SP**) and the **measured value** (process variable, **PV**).
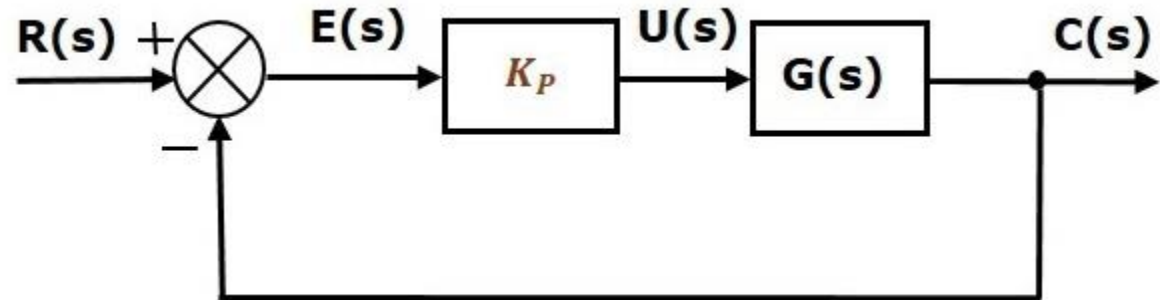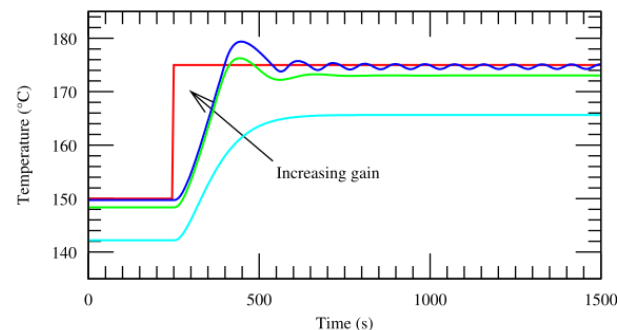

Figure: Proportional controller.

Figure: Output trend of a p-controller.

INTEGRAL CONTROL

❑ **Integral Controller**: As the name suggests in integral controllers the output (also called the actuating signal) is directly proportional to the integral of the error signal.
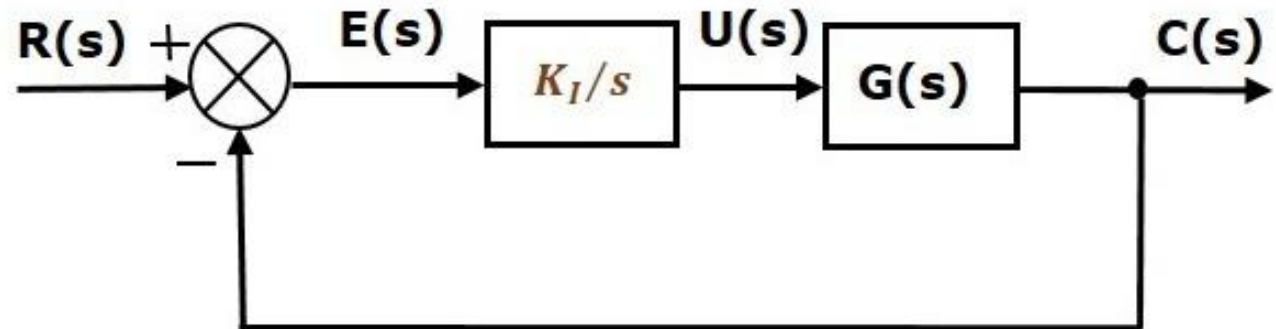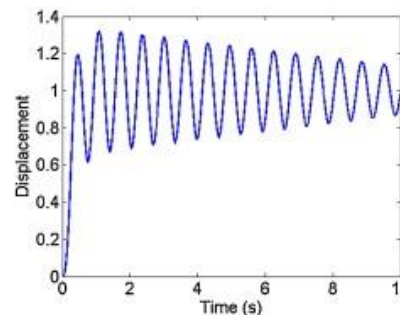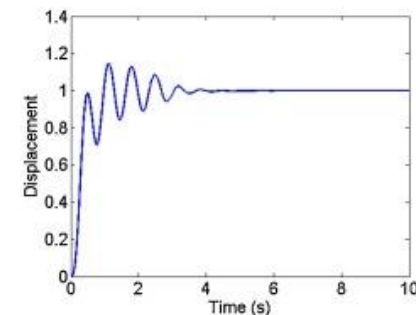

Figure: Integral controller.

(a) Integral control with $k = k_N/\lambda$

(b) Integral control with $k = k_N/(w_{h_1}(w_{s_0} + w_{s_1}))$

Figure: Output trend of a i-controller.

DERIVATIVE CONTROL

❑ **Integral Controller**: derivative controller the output (also called the actuating signal) is directly proportional to the derivative of the error signal.
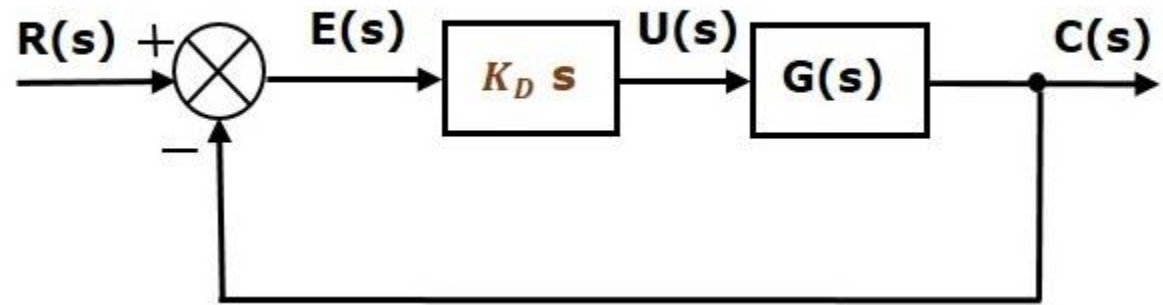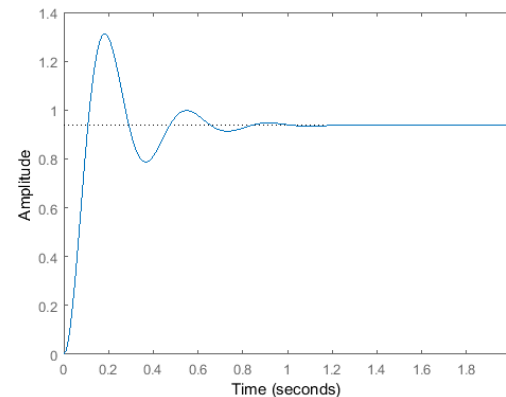

Figure: Derivative controller.

Figure: Output trend of a d-controller.

PROPORTIONAL INTEGRAL DERIVATIVE CONTROL

Signal Processing, Control and Hardware in Robotics

❑ **PID Controller**: As the name suggests it is a combination of proportional and a derivative controller the output is equals to the summation of proportional and derivative of the error signal.
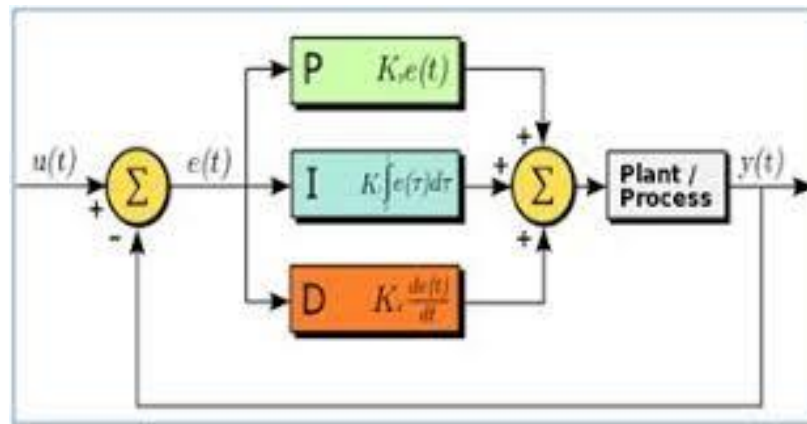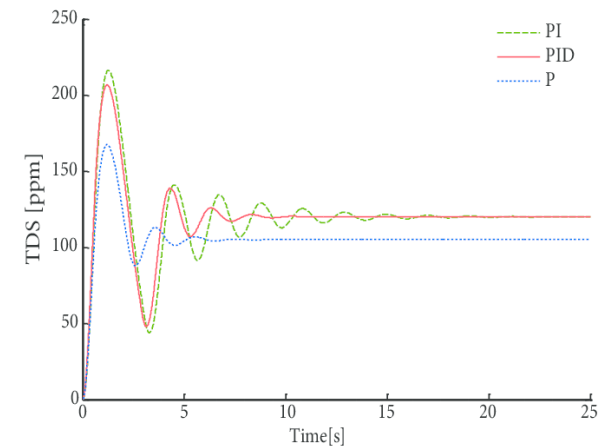

Figure: PID controller.

Figure: Output trend of a d-controller.

PROGRAMMABLE DEVICES

Signal Processing, Control and Hardware in Robotics

❑ In robotics, we need some programmable device on which our programs for control is executed.

❑ These are some programmable platforms:

- 8051 Microcontrollers

- PIC Microcontrollers

- AVR Microcontroller

- Arduino platform

- Raspberry Pi platform

❑ In current scenario Arduino due to its open forum is mostly used in wide applications.

ARDUINO PLATFORM

❑ **Arduino platform:** an open-source hardware and software company, project and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices.

❑ Famous **Arduino boards:**

- ARDUINO UNO

- ARDUINO DUEMILANOVE

- ARDUINO BT

- ARDUINO MEGA

- ARDUINO NANO 3.0

- ARDUINO STAMP

ARDUINO UNO

❑ **Arduino Uno** is a microcontroller board based on the ATmega328P.

❑ It has 14 digital input/output pins (of which 6 can be used as PWM outputs),

❑ 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0),

❑ a USB connection, a power jack, an ICSP header and a reset button.
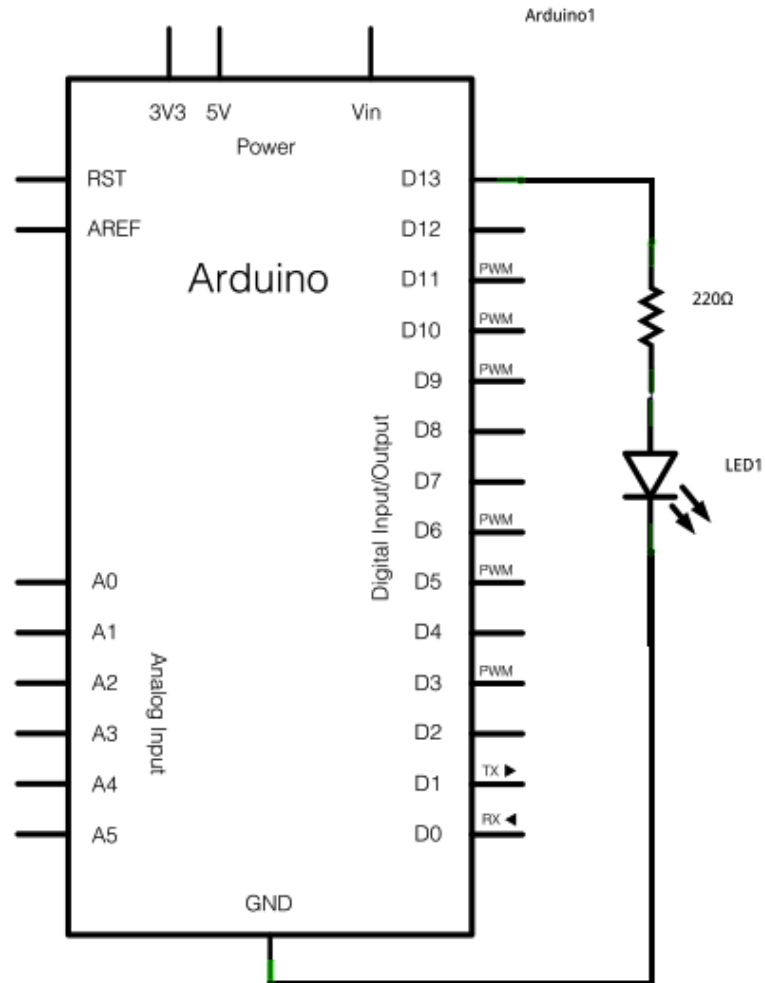
ARDUINO UNO SIMULATOR

❑ **UnoArduSim:** Open source simulator package for Arduino Uno.
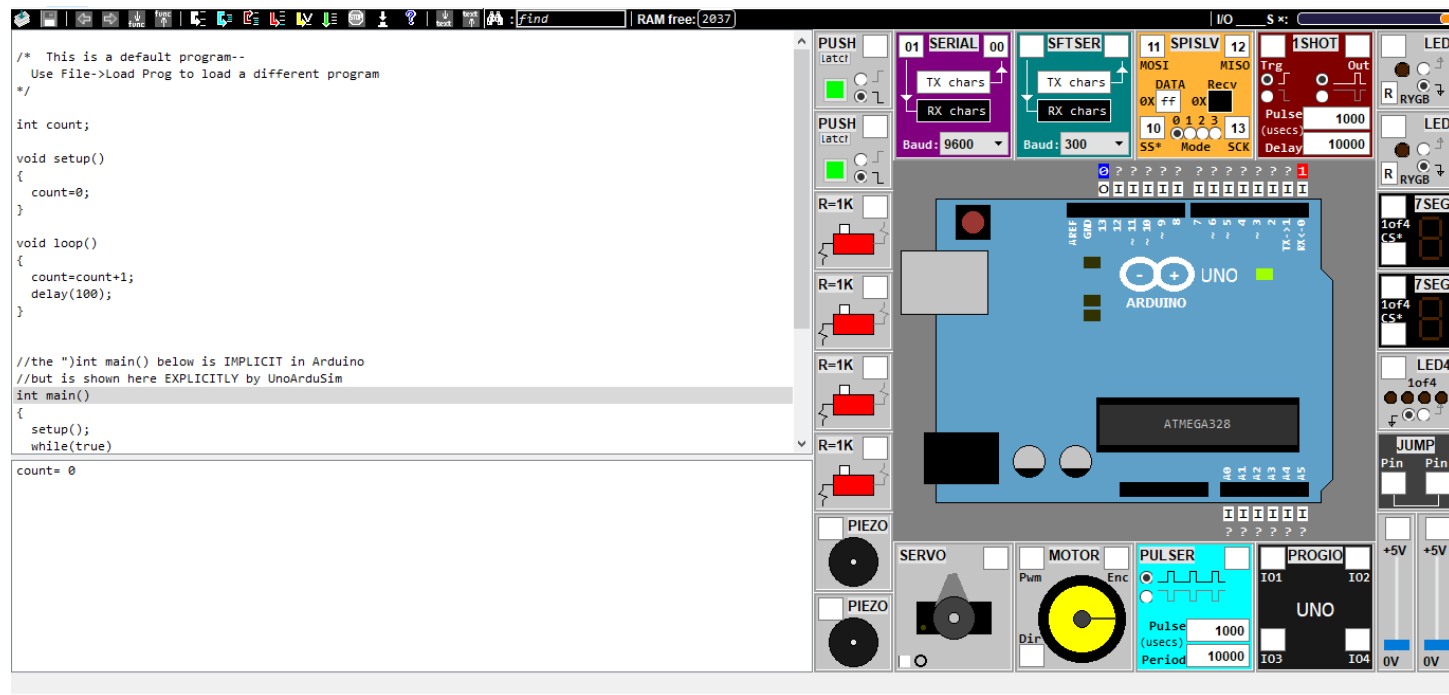
❑ **Arduino Uno:**
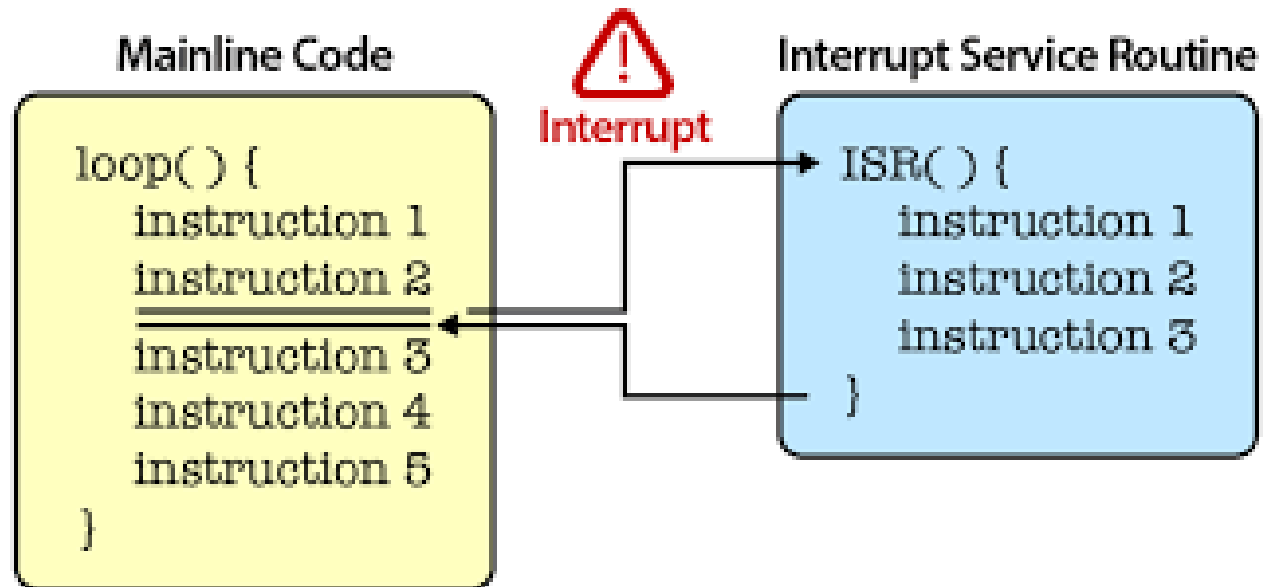
Signal Processing, Control and Hardware in Robotics

❑ **Interrupts:**

Thank You