PERSPICACIOUS OCTAPOD

A PROJECT PHASE-I REPORT

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CERTIFICATE

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This is to certify that

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Class: BE(E&TC) have partially completed Project titled, '**Perspicacious Octapod**' as a part of semester I of Final Year of Bachelor of Engineering in **Electronics and Telecommunication(2017-2018)** of Savitribai Phule Pune University.

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Date :

Abstract

Many inventions came up in the history of science and technology. Among them, the invention of robots is drastically emerging. Speed and economic advantages in daily life has increased the use of robots. A robot is an electro-mechanical system which can do autonomous or pre-programmed tasks. When wheels have dominated the robot world and seem extremely popular, innovators are struggling to find a decent replacement for wheels which would work in any kind of an environment. Adding legs to robots would be a solution for robots which runs on unprepared terrain. Now arises the problem of stability.

To overcome this, we propose a self-adaptive smart spider robot that functions without human interfacing. The legged robot inspired by spider is developed with the control mechanism and machine learning algorithms which results in the execution of various walking behaviour by adapting itself. The effectiveness of the robot is measured according to the performance on rough terrain through six legs. Control of robot is provided via communication port on computer. Functional algorithms are built for flexible motion against different conditions such as rough terrain, pit. Due to machine learning there will be no bounds for the robot in the near future it will learn to adapt as well as grow mentally as time goes by.

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Chapter 1

Introduction

1.1 Research Approach

Enormous numbers of publications and papers in years back noted an important point that approximately 50 percent of the earths land surface is inaccessible to wheeled vehicles. Though, most animals can cross rough terrain in an efficient and fairly rapid fashion. Thus, it is desirable to create legged machine bots that will imitate the excellent mobility of animals.

1.2 Use of References

Important developments have been occurred in the history of science and technology. Among them, the concept and applications of robots with each passing year are a larger place. Speed and economic advantages in daily life and industrial applications have increased the use of robots day by day. The robot is an electromechanical system which is capable of autonomous or preprogrammed tasks. Robots independently can also operate under the control of a computer program such as can be directly operated by operator. Six-legged robots can be used as search and rescue robots, space robots and discover robots. In these fields, hexapod robots present opportunities as having small size and practical mobility. When viewed from this perspective, six-legged walking robot can be easily scroll by produced algorithms in all types of terrain is an advantage.

The acceptable number of legs and the ability to move provide more controlled balance to the robot when compared to the majority of multi-legged robots.

For citing the paper use [1], [2]

Chapter 2

Literature Survey

The young and dynamically growing field of cooperative robotics has become a diverse research area that often seems to go in several different directions at once. Areas of interest range from high-level human-interactive robots to biologically inspired autonomous gnat-like agents [4]. In the past fifteen years many different research areas have emerged, each generating significant amounts of progress. However, the field is so new that no topic area within cooperative robotics can be considered mature. This chapter introduces the key areas of research within the field of robotics which are Biological Inspirations, Behavior-Based Robotics, Mapping and Exploration.

2.1 Emergence

Cognitive robotics is concerned with endowing a robot with intelligent behaviour by providing it with a processing architecture that will allow it to learn and reason about how to behave in response to complex goals in a complex world. Cognitive robotics may be considered the engineering branch of embodied cognitive science and embodied embedded cognition.

Cognitive robotics views animal cognition as a starting point for the development of robotic information processing, as opposed to more traditional Artificial Intelligence techniques. Target robotic cognitive capabilities include perception processing, attention allocation, anticipation, planning, complex motor coordination, reasoning about other agents and perhaps even about their own mental states. Robotic cognition embodies the behavior of intelligent agents in the physical world (or a virtual world, in the case of simulated cognitive robotics). Ultimately the robot must be able to act in the real world.

2.2 Biological Inspirations

There are numerous examples of biological societies that achieve collective tasks. Many researchers in the field of cooperative robotics have attempted to mimic in robots the behaviours observed in these societies. Replicating the behaviours of various biological societies has led to an entire field of research known as behaviour-based robotics.

Kube and Zhang [9] define a list of five biologically inspired mechanisms for invoking group behaviour: non-interference, following, responding to environmental cues, group realization, and auto-stimulation. Many insects use the environmental cue of sunlight to begin foraging tasks at dawn. In a like manner, the environmental cue of a fire could invoke a group of robots to begin fire fighting tasks. Many insects use a group realization mechanism as a trigger to perform different tasks depending on their proximity to the rest of the group.

2.3 Behaviour Based

Behaviour is a biologically inspired term defined as a regularity in the interaction of a robot with its environment [33]. Behaviours need not be complex; as Kube and Zhang[9] observe, many behaviours can be realized in combinational circuits. Examples of 15 simple behaviours include wandering and obstacle avoidance. In a typical robot system,behaviours are embedded in the control architecture and are intended as building blocks for achieving higher-level goals. In multi-robot systems, the simple and complex behaviours of each robot are combined to form a group behaviour that is both new and desirable To make this point clear, consider two robots that have the task of pushing a box from point A to point B. One robot is a pusher and the other is a steerer. Notice that this is a heterogeneous, intentional cooperation approach. On a single robot level, the pusher will have a contact behaviour that will keep it in contact with the box and a drive behaviour that will keep it in forward motion. Taken individually, these behaviours accomplish nothing, but when combined the robot will push a box. Likewise, the steerer will have a homing behaviour to get to point B and some behaviour to keep the box between itself and point B. On the multi-robot level, the pushing and steering behaviours of each robot are useless when acting alone; but when combined, the task is accomplished.

2.4 Mapping and Exploration

Exploration can be a time-consuming part of many cooperative tasks and, quite often, time is of great importance (i.e. search-and-rescue). Therefore, it is important in multi-legged robot approaches to ensure that additional robots enhance the time for exploration over a single robot approach. One may assume that the addition of robots inevitably speeds up an exploration task. However, without coordination all robots might follow the same path and require the same amount of time as a single robot. Even worse, interference between robots may cause the exploration to take more time than with a single robot. Therefore, a key problem in multi-robot exploration is to cause the robots to simultaneously explore different areas of the environment.

The next level of complexity in multi-robot exploration involves the development of some form of a shared map that tells not only where robots are, but where they have been. Most of the work in multi-robot exploration deals with map-building of two dimensional environments and use either range sensors (such as sonar and laser) or camera vision. Another popular area of research that coincides with mapping and exploration is localization. Localization deals with the ability of a robot to determine its location based on information such as nearby landmarks and maps. Figure 4.6 shows a boat [3].

Chapter 3

Proposed Methodology

3.1 Problem Statement

Design an eight legged machine which is self-adaptive i.e capable of gaining stability and clearing mazes on its own.

3.2 Block Diagram

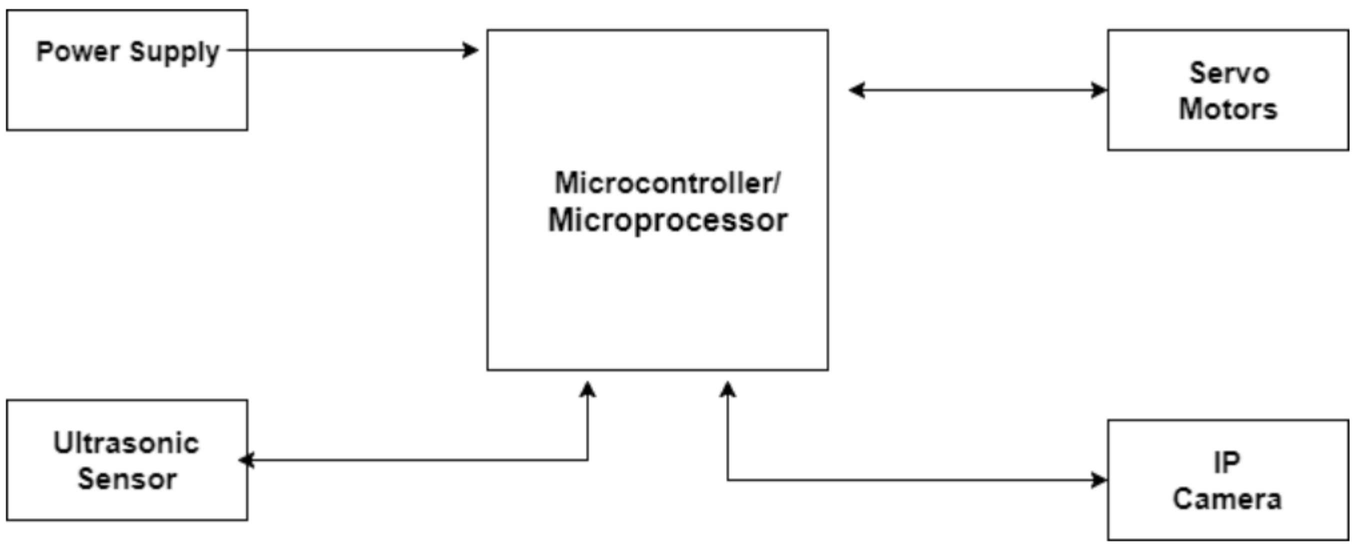

Figure 3.1: Block Diagram.

3.3 Elucidation

Write here [4]

Table 3.1: Cost of fruits in India

Fruit details		Cost calculations		
Fruit	Type	No. of units	cost/unit	cost (Rs.)
Mango	Malgoa	18	50	
	Alfonso	2	300	1,500
Jackfruit	Kolli Hills	10	50	500
Banana	Green	10	20	200
			Total cost (Rs.)	2,200

Chapter 4

Project Implementation

4.1 Hardware Description

4.1.1 Arduino Mega

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC to-DC adapter or battery to get started. The ATmega2560 has 256 KB of flash memory for storing code (of which 8 KB is used for the bootloader), 8 KB of SRAM and 4 KB of EEPROM (which can be read and written with the EEPROM library).


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4.1.2 Intel Edison

4.1.3 Servo Motor

What is a Servo Motor?

A servo motor is an electrical device which can push or rotate an object with great precision. If you want to rotate and object at some specific angles or distance, then you use servo motor. It is just made up of simple motor which run through servo mechanism. If motor is used is DC powered then it is called DC servo motor, and if it is AC powered motor then it is called AC servo motor. We can get a very high torque servo motor in a small and light weight packages. Doe to these features they are being used in many applications like toy car, RC helicopters and planes, Robotics, Machine etc. Servo motors are rated in kg/cm (kilogram per centimeter) most hobby servo motors are rated at 3kg/cm or 6kg/cm or 12kg/cm. This kg/cm tells you how much weight your servo motor can lift at a particular distance. For example: A 6kg/cm Servo motor should be able to lift 6kg if the load is suspended 1cm away from the motors shaft, the greater the distance the lesser the weight carrying capacity. The position of a servo motor is decided by electrical pulse and its circuitry is placed beside the motor.

Servo Mechanism

It consists of three parts: 1. Controlled device 2. Output sensor 3. Feedback system It is a closed loop system where it uses positive feedback system to control motion and final position of the shaft. Here the device is controlled by a feedback signal generated by comparing output signal and reference input signal.

Here reference input signal is compared to reference output signal and the third signal is produces by feedback system. And this third signal acts as input signal to control device. This signal is present as long as feedback signal is generated or there is difference between reference input signal and reference output signal. So, the main task of servomechanism is to maintain output of a system at desired value at presence of noises.

Controlling Servo Motor

Servo motor is controlled by PWM (Pulse with Modulation) which is provided by the control wires. There is a minimum pulse, a maximum pulse and a repetition rate. Servo motor can turn 90 degree from either direction form its neutral position. The servo motor expects to see a pulse every 20 milliseconds (ms) and the length of the pulse will determine how far the motor turns. For example, a 1.5ms pulse will make the motor turn to the 90 position, such as if pulse is shorter than 1.5ms shaft moves to 0 and if it is longer than 1.5ms than it will turn the servo to 180.

Servo motor works on PWM (Pulse width modulation) principle, means its angle of rotation is controlled by the duration of applied pulse to its Control PIN. Basically servo motor is made up of DC motor which is controlled by a variable resistor (potentiometer) and some gears. High speed force of DC motor is converted into torque by Gears. We know that WORK= FORCE X DISTANCE, in DC motor Force is less and distance (speed) is high and in Servo, force is High and distance is less. Potentiometer is connected to the output shaft of the Servo, to calculate the angle and stop the DC motor on required angle.

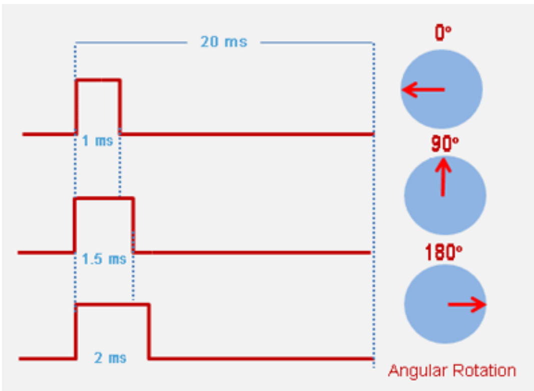

Figure 4.3: Servo mechanism.

Servo motor can be rotated from 0 to 180 degree, but it can go up to 210 degree, depending on the manufacturing. This degree of rotation can be controlled by applying the Electrical Pulse of proper width, to its Control pin. Servo checks the pulse in every 20 milliseconds. Pulse of 1 ms (1 millisecond) width can rotate servo to 0 degree, 1.5ms can rotate to 90 degree (neutral position) and 2 ms pulse can rotate it to 180 degree.

All servo motors work directly with your +5V supply rails but we have to be careful on the amount of current the motor would consume, if you are planning to use more than two servo motors a proper servo shield should be designed.


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4.1.4 Ultrasonic Sensor

What is an Ultrasonic Sensor?

An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object.

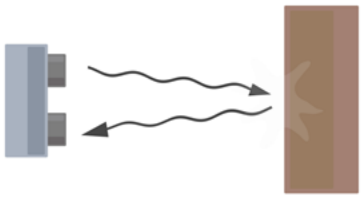

Figure 4.5: Diagram of the basic ultrasonic sensor operation.

Since it is known that sound travels through air at about 344 m/s (1129 ft/s), you can take the time for the sound wave to return and multiply it by 344 meters (or 1129 feet) to find the total round-trip distance of the sound wave. Round-trip means that the sound wave travelled 2 times the distance to the object before it was detected by the sensor; it includes the 'trip' from the sonar sensor to the object AND the 'trip' from the object to the Ultrasonic sensor (after the sound wave bounced off the object). To find the distance to the object, simply divide the round-trip distance in half.

$$distance = \frac{speed\ of\ sound\ \times time\ taken}{2}$$

Figure 4.6: Formula for distance calculation.

It is important to understand that some objects might not be detected by ultrasonic sensors. This is because some objects are shaped or positioned in such a way that the sound wave bounces off the object, but are deflected away from the Ultrasonic sensor. It is also possible for the object to be too small to reflect enough of the sound wave back to the sensor to be detected. Other objects can absorb the sound wave all together (cloth, carpeting, etc), which means that there is no way for the sensor to detect them accurately. These are important factors to consider when designing and programming a robot using an ultrasonic sensor.

HC-SR04

HC-SR04 is an ultrasonic ranging module that provides 2 cm to 400 cm non-contact measurement function. The ranging accuracy can reach to 3mm and effectual angle is ¡ 15. It can be powered from a 5V power supply.

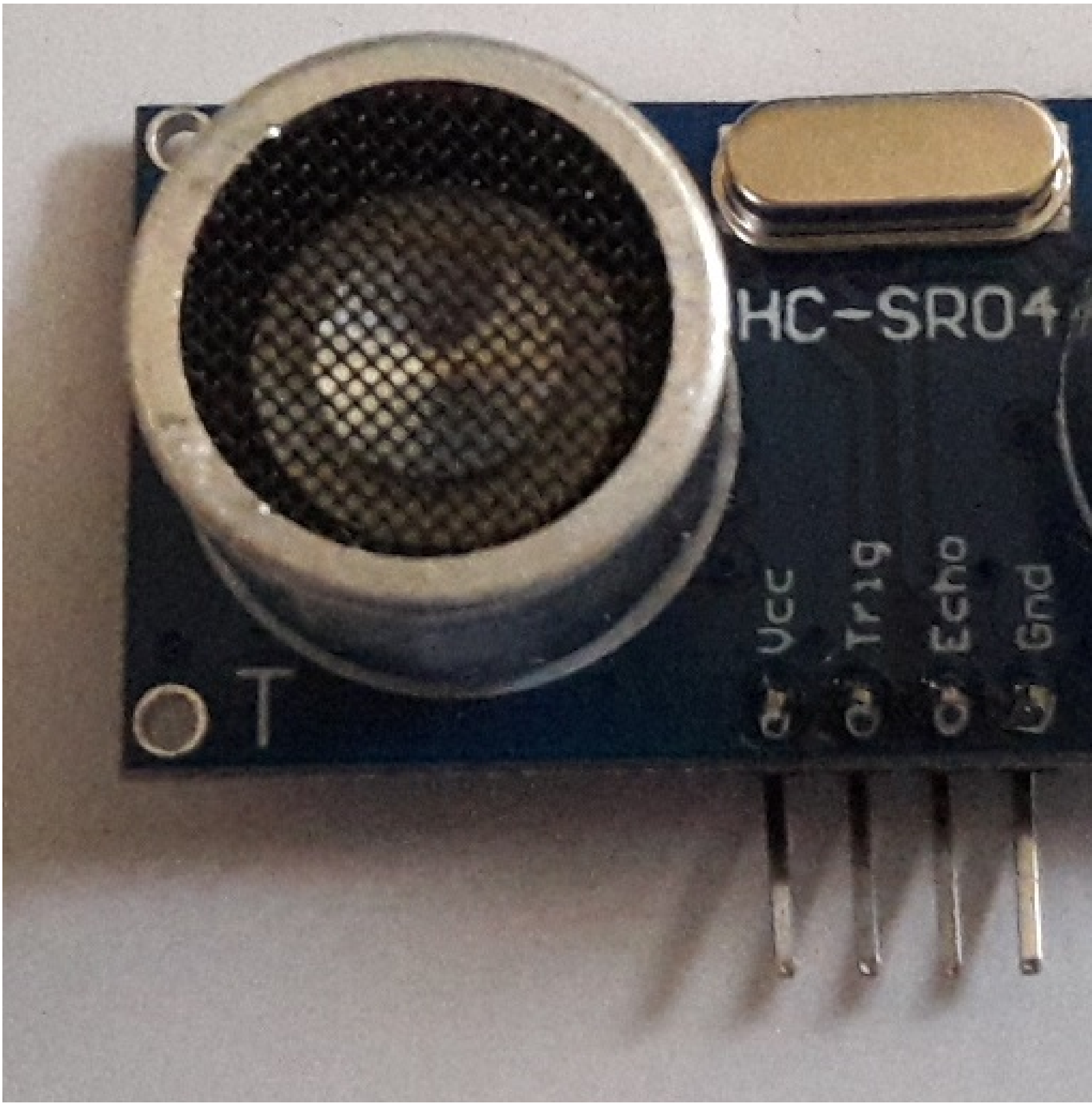

Figure 4.7: HC-SR04.

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The basic principle of work: (1) Using IO trigger for at least 10us high level signal, (2) The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back. (3) IF the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning. Test distance = (high level timevelocity of sound (340M/S) / 2.

4.1.5 IP Camera

An Internet protocol camera, or IP camera, is a type of digital video camera commonly employed for surveillance, and which, unlike analog closed circuit television (CCTV) cameras, can send and receive data via a computer network and the Internet. Although most cameras that do this are webcams, the term "IP camera" or "netcam" is usually applied only to those used for surveillance. An IP camera is typically either centralized (requiring a central network video recorder (NVR) to handle the recording, video and alarm management) or decentralized (no NVR needed, as camera can record to any local or remote storage media). The first centralized IP camera was Axis Neteye 200, released in 1996 by Axis Communications. IP cameras are available at resolutions from 0.3 (VGA resolution) to 29 megapixels.[1] As in the consumer TV business, in the early 21st century, there has been a shift towards high-definition video resolutions, e.g. 720p or 1080i and 16:9 widescreen format.
subsubsectionPotential Benefits IP cameras differ from previous generation analog cameras which transmitted video signals as a voltage, whereas IP camera images are sent using the transmission and security features of the TCP/IP protocol. Some advantages to this approach include: 1.Two-way audio via a single network cable allows users to listen to and speak to the subject of the video (e.g. gas station clerk assisting a customer on how to use the pay pumps) 2.The use of a Wi-Fi or wireless network. 3.Distributed intelligence such as video analytics can be placed in the camera itself allowing the camera to analyze images. 4.Secure data transmission through encryption and authentication methods such as WPA, WPA2, TKIP, AES. 5.Remote accessibility allowing live video to be viewed from any device with sufficient access privileges. 6.PoE Power over Ethernet to supply power through the ethernet cable and operate without a dedicated power supply.

4.2 Software Description

We will demonstrate the creation of equations with some samples. Let us start with the model of an inverted pendulum:

$$\frac{d}{dt}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & -\gamma & 0 & 0 \\ 0 & \alpha & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ -\delta \\ -\beta \end{bmatrix} \Delta\mu \tag{4.1}$$

Proportional, integral, derivative controller is most popular in industry. It has three tuning parameters: K, τ_i and τ_d. The integral mode includes the term $\int_0^t () dt$.

$$u(t) = K\left(e(t) + \frac{1}{\tau_i}\int_0^t e(t)dt + \tau_d \frac{de(t)}{dt}\right) \tag{4.2}$$

Let us go through the discrete equivalent of equation 4.2

$$\begin{aligned} u(n) - u(n-1) = K\Bigg[&e(n) - e(n-1) + \frac{T_s}{2\tau_i}\{e(n) + e(n-1)\} \\ &+ \frac{\tau_d}{T_s}\{e(n) - 2e(n-1) + e(n-2)\}\Bigg] \end{aligned} \tag{4.3}$$

Section 4.2 shows how to write equations.

Chapter 5

Chapter 5

5.1 Start sections

5.1.1 Name of subsection

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Chapter 6

Results and Future Work

6.1 Start sections

6.1.1 Name of subsection

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