**Visitor Dropbox**

**LUQMANUL HAKIM BIN YAHYA**



**Bachelor of Mechatronics Engineering with Honours**
**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**



**2021**

"I hereby declare that I have read through this report entitle "**Visitor Dropbox**" and found that it has comply the partial fulfilment for awarding the degree of Bachelor of Mechatronics Engineering.

Signature : .....

Supervisor's Name : Dr. Mohd Shahrieel bin Mohd Aras

Date : 6 JULY 2021

**Visitor Dropbox (VDB)**

**LUQMANUL HAKIM BIN YAHYA**

**A report submitted in partial fulfilment of the requirements for the degree of Bachelor of Mechatronics Engineering**

**Faculty of Electrical Engineering**

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**2021**

I declare that this report entitle "**Visitor Dropbox**" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : LUQMANUL HAKIM BIN YAHYA

Date : 6 JULY 2021

To my beloved mother and father

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## ABSTRACT

The world is now changing towards modernization which can now be seen in all industries. Security should be emphasized in every place to ensure security in terms of various aspects of privacy, especially in the industry. Each industry stores a variety of information that cannot be shared with strangers. Thus, to prevent that from happening by creating something that can control the movement of outsiders. Here VDB is introduced to control the movement of visitors entering any premises. By giving the visitor card they are allowed to enter the allowed place only, however, they must return the visitor card to the VDB to get out of the premises. The objective of this project is to develop the new Visitor Dropbox (VDB) system for industry applications. Another objective is to investigate the operation and performances of the new VDB system in terms of accuracy, precision, and timely response. The main challenge is to minimize the use of I / O and reduce costs because the company uses VDB by using a PLC system where it has many disadvantages in terms of energy, cost, goods, and durability. Construction of the design and simulation was done using various suitable components. TinkerCad and proteus is a type of software used for visual representation by inserting a program created into a Microcontroller. With easily available components this experiment went smoothly.

# ABSTRAK

Dunia kini berubah menuju ke permodenan yang sekarang dapat dilihat di semua industi. Keselamatan perlu dititikberatkan di setiap tempat bagi menjamin keselamatan dari segi pelbagai aspek privasi terutama di industri. Setiap industri menyimpan pelbagai maklumat yang tidak boleh dikongsi dengan orang asing. Jadi untuk mencegah perkara tersebut berlaku kita perlu mencipta sesuatu yang boleh mengawal pergerakan orang luar. Di sini VDB diperkenalkan bagi mengawal pergerakan pelawat yang masuk ke mana mana premis. Dengan memberikan kad pelawat mereka dibenarkan untuk masuk ke tempat yang dibenarkan sahaja, namun itu setelah mahu pulang mereka perlu memulangkan kembali kad pelawat ke dalam VDB untuk keluar dari premis tersebut. Objektif projek ini adalah untuk mengembangkan sistem Visitor Dropbox (VDB) baru untuk aplikasi industri. Objektif lain adalah untuk mengkaji operasi dan prestasi sistem VDB baru dari segi ketepatan dan tindak balas masa. Cabaran utama adalah untuk mininumkan penggunaan I/O dan mengurangkan kos kerana syarikat ini menggunakan VDB dengan menggunakn sistem PLC dimana ia mempunyai banyak keburukan dari segi aspek tenaga, kos, barang dan ketahanan. Pembinaan reka bentuk dan simulasi telah dilakukan dengan menggunakan pelbagai komponen yang sesuai. TinkerCad dan Proteus adalah sejenis perisian yang digunakan untuk gambaran visual dengan memasukkan sekali program yang dibuat ke dalam Microcontroller. Dengan komponen yang mudah didapati eksperimen ini berjalan dengan lancar.

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# LIST OF ABBREVIATIONS

VDB – Visitor Dropbox

PLC – Programmable Logic Control

PWM – Pulse Width Modulation

PMSM – Permanent Magnet Synchronous Motor

SPMSM – Surface Permanent Magnet Synchronous Motor

IPSM – Interior Permanent Synchronous Magnet

IPMSM – Interior Permanent Magnet Synchronous Motor

BLDC – Brushless DC motor

LCD – Liquid Crystal Display

LED – Light-emitting Diode

# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

Visitor Drop Box (VDB) is Access control applications for industrial production facilities are essentially what they are. Safety and productivity are two of the primary goals of many industrial production plants. The latter aim is heavily reliant on providing a safe and secure environment for workers, visitors, plant managers, and other leaders. As a result, the goal of enhancing physical security in industrial production environments is to identify threats, prevent infiltration, and respond correctly and immediately if something goes wrong. Manufacturing operations are frequently subjected to hostile activities such as trespassing, theft, and counterfeiting. To produce the most secure environment practicable, integrated solutions that layer multiple different technologies and function in coordination with a complete contingency plan are required to assist enhance overall human and asset security. By using VDB in the future, there will be a way to seamlessly integrate these technologies and aid the industrial production facility in meeting their safety and productivity goals with more efficiency. VDB is frequently used to monitor all visitors in and out by providing them with a contactless ID card. To enable entry to a plant/area, these contactless ID cards are waved in front of a door reader. They interact directly with the access control server utilising wireless radio frequency ID (RFID) technology. Proximity Cards are an effective solution to restrict access to only those who are allowed to enter the premises or to allow only specific individuals in specified areas while allowing others to enter. Furthermore, the cards cannot be maintained for the visitors permanently; if they get into the hands of an outsider, they

might be disastrous. When it comes to the VDB, it will prevent any visitors from leaving the facility until they return the card by putting it into the VDB and indicate valid card by it.

## 1.2 Motivation

In today's competitive business, high-quality, dependable products at a fair price are required. To address this problem, a number of industries are experimenting with new product designs, integrated manufacturing techniques, and automated equipment. With automation, the need to manually check for various process parameters may be completely removed. Closed-loop control techniques are used in industrial processes to automatically alter process variables to preset values using automation technology. The complexity of operational processes is reduced through industrial automation. Industrial automation lowers personal safety by replacing people with automated machines that work in dangerous conditions. This VDB focuses mostly on programmable automation. The manufacturing equipment in this automation is designed to be able to alter the sequence of operations to suit different product designs. The sequence of operations is controlled by programming, which is a set of coded instructions that enable the system to read and comprehend them.

## 1.3 Problem Statements

There are many disadvantages of using PLC systems on VDB. According to past purchasers, it is heavy to handle and loud. This is due to magnetic field coupling, which occurs when control lines are in close proximity to high-current lines. Noise may be produced by relays and solenoids, especially when they are activated by hard contacts such as push buttons and selection switches. Because of the high voltage solenoid, this system is very big, requiring the inclusion of additional driving circuits. According to the industry, if anybody visits the premises, the VDB is anticipated to stay operational for 8 to 7 hours. This renders VDB inoperable, resulting in the failure of certain components. Maintenance is expensive as a consequence of minor damage. Engineers that have more essential maintenance tasks to do than VDB are wasting their time.

| Description | : Unit |
|---|---|
| Drive Mechanism | : 24VDC solenoid |
| Operating Voltage | : 24VDC |
| Power Comsumption | : 15Watts |
| Dimension | : See below |
| Weight | : 5Kg |
| Cycle operating time (valid card) | : 2.5sec per card (depend on card reader) |
| Cycle operating time (unvalid card) | : 5 sec per card |
| Electronic Controller | : Programmable Logic Controls PLC |
| Proximity Card with Pin/Clip | : Yes, but not with neck ribbon |
| LED indicator | : Green |
| Buzer | : 24VDC buzer for invalid indication |
| Duty Cycle | : 100% |

Figure 1: Technical data VDB PLC system

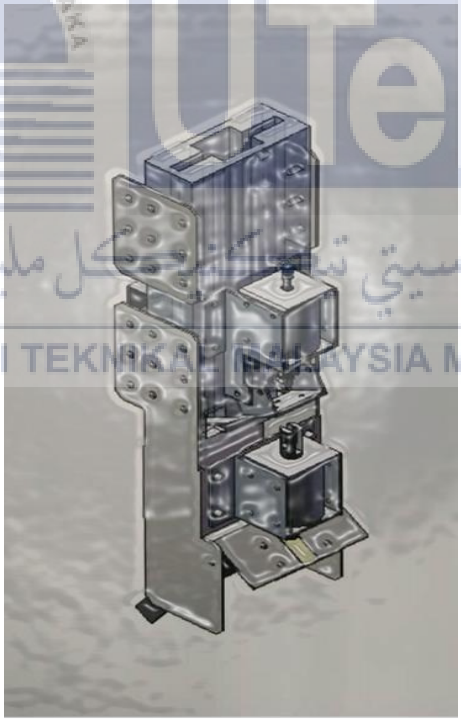



Figure 1.1: VDB with PLC system and solenoid

## 1.4 Objectives

In this project, there are two objectives going to achieve:

1) To design and develop the new Visitor Dropbox (VDB) system for industry application.

2) To investigate the performance of the new VDB system in terms of accuracy, precision and time respond.

## 1.5 Scope

The scope of this project is limited to design new Visitor DropBox using programming skill and electrical knowledge. The mechanical part has been designed by using Solidworks software. The microcontroller for this project also limited by using Arduino. TinkerCad and Proteus software used to analyse VDB operations by simulating electrical circuit parts and programming. Arduino IDE is used to develop the program for the VDB. LCD is used for visitor's guide display. Every process that takes place, the LCD that connected to the VDB will display instructions for the visitor.

The performance is mainly focused on the hardware controller. The microcontroller board tests the hardware and integrates it with Proteus real-time simulation. The repetition technique is used to obtain the precise value from the VDB in order to obtain real-time data. The VDB data is monitored and analysed to give a result. The VDB's performance will be evaluated based on its accuracy, precision, and time responsiveness.



## 1.6 Summary

As the conclusion of this chapter, it explains the importance of VDB in industries. VDB is limited to use visitors because it is designed and developed to store a card temporarily. This project aims to design and develop the new Visitor Dropbox (VDB) system for industrial applications and test it to observe its performance. This project also needs to interface with Proteus real-time simulation in order to get accurate real-time data from the controller.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

In this chapter, the literature review is discussed from journals or conference papers that are related to this project title in order to achieve the objectives of this project. There are many papers that have been studied in order to develop VDB. The important hardware and software methodology is extracted from these papers. In hardware development, the system and materials are studied, compared, and selected. The suitable system and materials are discussed to develop VDB and interface between them. Therefore, it is very important to study the basic working operation of each type of system before the system is selected for VDB development. In software development, the controller is communicated with the real-time simulation and analysed to get the real-time output graph.



## 2.2 Industrial automation

Because the products are so varied and there are so many configuration options, the industry need a high level of robotic automation [1]. In the past year, the dynamics of the industrial line have altered, requiring the reuse and reconfiguration of many production lines [2]. Manually doing this and adapting robotic arms to the new process requires a significant amount of time and effort.

The goal is to integrate as much automation into the production line as possible while utilising the smallest computer system available and getting the best possible results. The only fundamental system is the control computer device, which is often integrated on a single chip design [3].

## 2.3 Solenoid Valves PID implementation

A solenoid is an electrical device that functions of principles of an electromagnet (a magnetic field is generated when an electric current is passed via a wire or a coil); they were formerly used as low-cost, high-reliability switching components. A solenoid is an electromechanical device used in many industrial applications, including fluid power hydraulic systems, cylinder control, process control systems, and manufacturing departments. The fundamental architecture of the solenoid is seen in Figure 1. [4],[5]

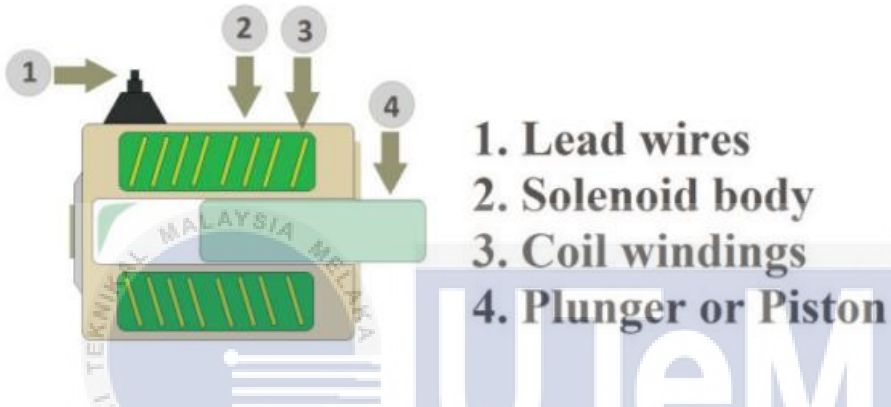


Figure 2: Architecture of a push type solenoid

The solenoid body is made up of a tightly wrapped coil that is generally composed of copper or a conducting alloy and is insulated with an insulating layer such as mica. The plunger is the free-moving component of the solenoid, which is constructed of ferromagnetic material. When electricity is supplied through the coil, a magnetic field is created, the direction of which may be identified using the right hand clasp rule. This magnetic field exerts a force on the ferromagnetic plunger, either pushing it in or pulling it out.

### 2.3.1 Direct acting ON/OFF type Solenoid Valve

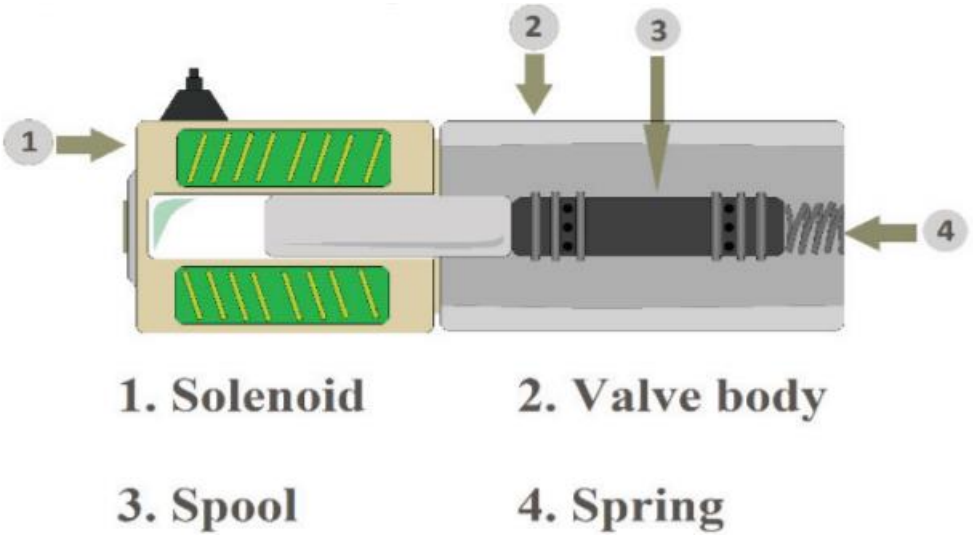


Figure 2.1: Solenoid valve

Figure 2 illustrates the basic design of a direct acting ON/OFF solenoid valve [4]. The valve body is a different detachable component that linked with the solenoid so that its plunger can enable spool movement. The spool is the component that functions as a gate to the many channels that a solenoid must open or close.

The 95% of commercially available solenoids are pull or push type solenoid valves that may be either fully open or fully closed. There are also proportional solenoid valves available, but they are rare and hence cost nearly 5 to 7 times as much as a push type solenoid valve. To turn an on/off switching solenoid valve into a proportional solenoid, the magnetic properties, switching delay, and maximum frequency of operation of a solenoid are examined, followed by the development of a closed-loop control circuit.

### 2.3.2 System Architecture

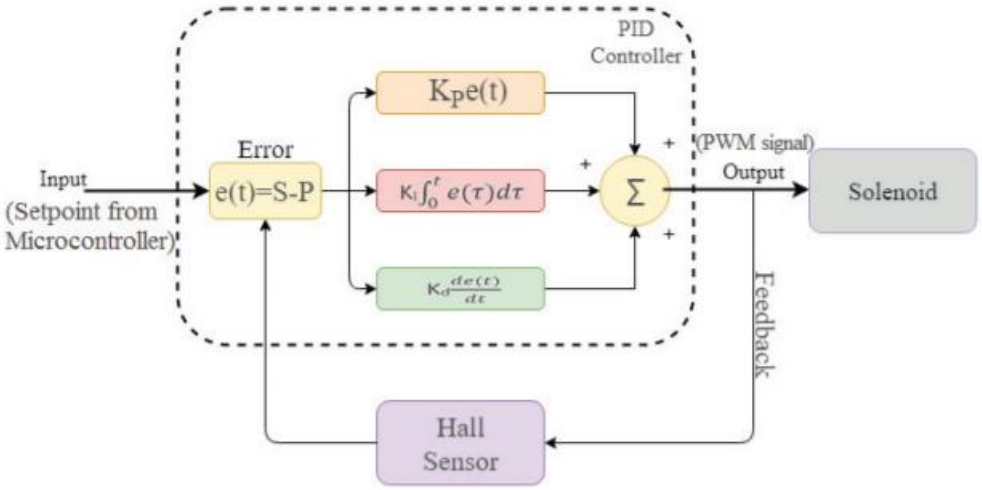


Figure 2.2: System Architecture of PID loop

Figure 2.2 shows the control loop of a changing a push type solenoid to a proportional solenoid [6],[7],[4]. The major focus is on developing an external control system that can supply inputs to the solenoid in such a way that it acquires stability at any arbitrary point between its open and closed states, rather than changing the electrical or mechanical design of the solenoid.

The proportional integral derivative is a method used in control systems to stabilise systems that are supposed to achieve a set-point of some kind. For example, a temperature controller must achieve a specific temperature that is labeled a "set-point." The feedback is supplied by a device, such as a sensor, and the PID controller calculates the amount of error and makes an adjustment to the output to correct that error based on the difference between the set-point and the feedback value, referred to as a "Process value." By just adjusting the PID settings, this basic controller may produce quite decent results (Kp, Ki, Kd). PID controllers are classified into two types: error feedback controllers and output feedback controllers. PID parameters may be tuned in two ways: manually by beginning from 0 and progressing until the system or prototype is stable, or by modelling the entire system and eventually presenting the controller's output as an equation and theoretically computing these parameters. As previously stated [7][8], an error feedback controller was used. This controller is described by equation in continuous time (2)

$$u(t) = K_p e(t) + K_i \int_0^t e(\tau)d\tau + K_d \frac{de(t)}{dt} = Ke(t) + KT_i + KT_d$$

…

(2)

Where e() indicates the error function, u(t) the PWM output from the PID loop, K the gain, Ti the integration time, and Td the derivative time. The following factors are critical in achieving accurate solutions. Proportionate action (P): The proportional component of a PID controller contributes to the system's speed. The P-major part's function is to decrease error so that the output signal may approach the reference value faster. A very big proportional component, on the other hand, will result in a highly oscillatory system. Kp is the rate at which this activity occurs. Derivative action (D): A derivative action is indicated when an oscillating system is present due to high proportional gain. The derivative component attempts to damper the system, i.e. to minimise the oscillations, but it slows the process down. Kd is the rate at which this activity occurs. Integral action (I): If the system is stable, an error between the output and the set-point may exist. This little mistake can be eliminated by inducing the important component. Ki is the pace at which this activity occurs. This is a PID loop, which is a closed loop system. [8]



### 2.3.3 Analysis result

The tuning parameters of the PID loop are selected by using thumb rule, and the loop is operated once the PID controller is fed with the tuning parameters. Figure 2.3 [8] depicts the findings acquired by tapping the feedback values at short regular intervals, which represent the stroke lengths at these intervals. i.e. hall output $= f(s)$

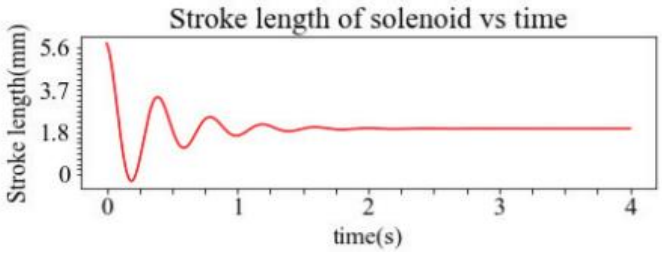


Figure 2.3: Stroke length of solenoid (mm) vs. time (s)

## 2.4 Servo motor

### 2.4.1 Industrial application

In the industrial area, servo motors are frequently use for applications that need accurate controlon speed, position and acceleration. Servo motor can be found in a variety of applications such as commercial robots, rolling machines, and printers. A number of servo motors may be used to achieve this. Because of their high power density and efficiency, permanent magnet synchronous motors (PMSMs) are the most common kind of servo motor.

Many PMSM designs are used in servo applications, but the two most popular are the surface PMSM (SPMSM) and the interior PMSM (IPSM) (IPMSM). Servo motors are engineered to generate very low ripple and cogging torque [9]. An IPMSM servo motor has a low reluctance torque as a result of these characteristics (low saliency ratio). The main advantage of an IPMSM setup over an SPMSM system is that it does not need the use of a sleeve for high-speed operation.



Standard IPMSMs may be utilised for injection based self-sensing control because to their trackable saliency. Besides, Standard SPMSMs have a low saliency which make them not suitable for sensing themself. A lot of research proposed improve the SPMSM architecture to establish a low-level saliency that able to use on self-sensing control. In [10], Faggion et al. suggest utilize the ringed-pole SPMSM design to establish saliency. Moreover, in [11] Yang et al. recommend use a narrow tooth tip to take advantage of the zigzag leakage flux, which able to moderate the saliency. However, no research has been done on the affect of these methods on motor power conversion.

In the recent year, the price of earth magnet have been raise. The consequence had because the motor maker reduce the use of magnetic material which may also lower the