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GAS AUTO CONTROLLER BOX USING ARDUINO

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree of Engineering Technology (Computer System) (Hons)

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UteM as a partial fullfillment of the requirement for the degree of Bachelor of Computer Engineering Technology (Computer System) with Honour. The member of the supervisory is as follow:

....

DR SUHAILA BINTI MOHD NAJID

(Supervisor)

ABSTRACT

Nitrogen (N2) gas Auto controller box is one of the important tools that is needed by all semiconductor companies. This is because usually no device being used to control the flow of gas. Therefore, N2 gas are released continously and it lead to wastage and higher cost. By using the Nitrogen gas Auto controller, it will be able to control the amount of N2 gas being released, no leakage, reduce the usage og N2 gas, reduce the cost and at the same time prevent the oxidation of metal during the 3D printing process. The objective of this project is to design a device to control the flow of N2 gas and its usage, to reduce the costs and to implement the device to semiconductor companies. In this project, arduino software and hardware is used because compared to other microcontroller this software is easy to implement and used in term of programming language and also it is easy to test on the hardware which is other microcontroller the circuit have to build by own and this is already build in and straight away can test on hardware. The expected results is when the N2 gas level researches the threshold or the critical point, the LED will blink in red and automatically the valve will be open to fill the cabinet with the gas. Once it reaches it full capacity, the sensor will detect it, LED will turn off and valve will be automatically closed. The greatest contribution of this device is there will no continous release of gas in the cabinet which use up alot of gas and end up in high cost. This device greatly reduces the wastage and costs. Its an economic way to prevent metal oxidation in semiconductor companies.

ABSTRAK

"Gas Auto Controller Box" merupakan salah satu alat penting yang diperlukan oleh semua syarikat semikonduktor. Ini kerana biasanya tiada peranti yang digunakan untuk mengawal aliran gas tersebut, gas nitrogen akan dikeluarkan secara berterusan dan ia membawa pembaziran dan kosnya lebih tinggi. Dengan menggunakan "Gas Auto Controller Box", ia mampu untuk mengawal jumlah gas nitrogen yang dikeluarkan, tiada kebocoran, mengurangkan penggunaan gas nitrogen, mengurangkan kos dan pada masa yang sama mencegah pengoksidaan logam semasa proses percetakan 3D. Objektif projek ini adalah untuk mereka bentuk alat untuk mengawal aliran gas nitrogen dan penggunaannya, mengurangkan kos dan melaksanakan peranti untuk syarikat semikonduktor. Dalam projek ini, perisian dan perkakasan arduino telah digunakan berbanding mikropengawal perisian lain, ini adalah kerana mudah untuk melaksanakan dan digunakan dalam Bahasa pengaturcaraan dan juga mudah untuk menguji perkakasan yang lain manakala, mikropengawal litar yang lain perlu membina litarnya dengan sendiri dan arduino pula litarnya sudah sedia ada dan serta-merta boleh menguji perkakasan. Hasil yang diharapkan adalah apabila nitrogen gas mencapai tahap ambang atau genting, LED akan berkelip merah dan secara automatik injap yang akan terbuka untuk mengisi kabinet dengan gas. Apabila ia mencapai tahap kapasiti penuh, pengesan akan mengesan, LED akan padam dan injapnya akan tertutup secara automatik. Sumbangan terbesar peranti ini adalah tiada keluaran gas berterusan ke dalam kabinet dan tiada pengunaan gas yang terlalu banyak atau kos yang tertinggi. Peranti ini dapat mengurangkan pembaziran dan kos.

DEDICATION

This project is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task can be accomplished if it is done one step at a time. Thank to my supervisor, lecturer and my friends.

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Firstly, I would like to express my sincere gratitude to my supervisor Dr. Suhaila for the continuous support of my studies and related research regarding this project report, for his patience, motivation, and immense knowledge. His guidance helped me in all the time of research and writing of this report. I could not have imagined having a better supervisor and mentor for my Final Year Project.

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CHAPTER 1

INTRODUCTION

1.1 Background

Gas Autocontroller Box is a device used to control the filling of dry air into the cabinet so the desired relative humidity in the cabinet is under control. The dry air can be nitrogen, carbon dioxide or any inert gas. In semiconductor industries, for instance STATChipPAC Sdn. Bhd and Texas Instruments, nitrogen gas are the most frequently used dry air. Those companies use Nitrogen cabinet to store wafer chips to prevent the oxidation of the metal which will eventually damage the wafer. The function of the Nitrogen gas in the cabinet is actually for electrostatic charge neutralization that neutralize or eliminate positive and negative electrostatic charges on the wafer. Electrostatic Discharge (ESD) results from the charges on wafers and it is a serious issue in IC manufacturing processes that causes billion dolar loss. Hence, reducing or removing charges on wafers will benefit semiconductor fabrication yield. Nitrogen gas are introduced between certain critical processes such as 3D microprinting to reduce oxygen, moisture, and other airborne molecular contaminants.

Nitrogen gas is suitable for processing less reactive materials and it is also used as part of the recycle loop for more expensive gases such as argan or helium. Besides that, nitrogen gas has the advantage of being lower cost compared to other alternatives. According to MVS Engineering LTD in year 2013, April the

requirement for Nitrogen is very large (typically above 2,000 Nm3/hr). This clearly shows that it is widely used in most of the industries.

There are many advantages of using a controller box in this system. Traditionally in industries, Nitrogen cabinet is used without any controller box where it allows the nitrogen to fill the cabinet all time but with the presence of the autocontroller box, the amount of nitrogen release is reduce where it will be only released whenever necessary. This greatly reduces the cost as now the Nitrogen gas price hiked up as the demand is very high. In addition to that, a controller box has LCD display that will display the amount of Nitrogen gas in the cabinet. To make the device more valuable, I have added a switch at the door cabinet which will automatically close the nitrogen gas valve when cabinet door is open. This really helps in reducing a lot more usage of Nitrogen gas and eventually the cost itself.

1.2 Problem Statement

Recently, the semiconductor companies are facing wastage of nitrogen gas and this is because there is no device to control the flow of the gas. Besides that, the company also loses a lot of money by using Nitrogen gases without control. Nowadays, the price of nitrogen are getting higher as shown in figure 1.1.
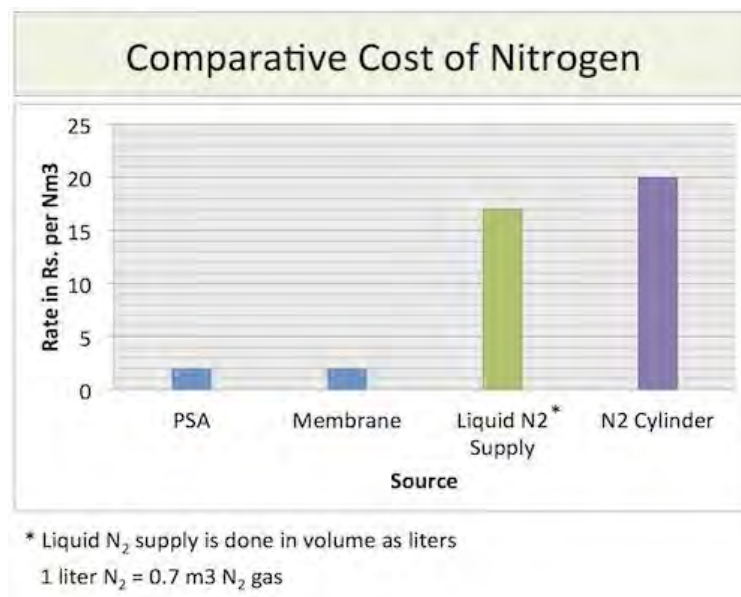

Figure 1.1: Comparative Cost of Nitrogen in April,(2013)

The companies use nitrogen gases without limits and because of this problem they are losing lot of money. Therefore, a mechanism which can control the leakage of nitrogen gas is required so it can reduce the cost of nitrogen use. However, since the nitrogen gas is very expensive, LPG gas will be used to test.

1.3 Aim and Objectives

The aim of this project is to design a device that minimizes the wastage of Nitrogen gas and reduces the cost

The objective of this project is:

1. To design a low cost controller box to control the amount of gas release in the cabinet
2. To add a switch that automatically close the valve when door cabinet is open
3. To add a gas sensor that detects the amount of Nitrogen gas in the cabinet
4. To add a display system that has all the output data even from a certain distance

1.4 Scope of the study

Figure 1.2 shows the schematic diagram of the entire system. At first, the gas will fill up the cabinet until it reaches the appropriate value. The sensor will detect the gas volume if the gas is full inside the cabinet which makes the valve automatically close. When the gas at cabinet is less than certain range the valve will automatically open and released the gas until the cabinet full.
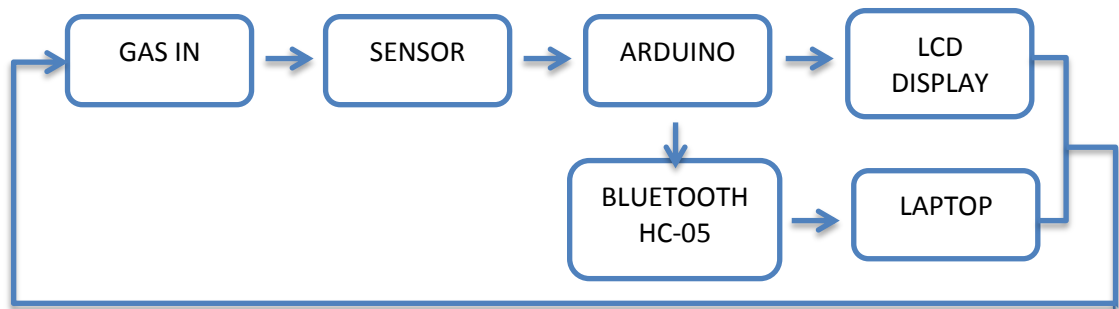
Figure 1.2: Block diagram based on Gas Auto Controller Box

The process will start by filling up the gas throught valve into cabinet. When the cabinet is full with gas, the sensor will sense the volume of gas and the data will be displayed at LCD screen and also send to the laptop through BLUETOOTH HC-05. This process will automatically control the flow of the gas whenever the cabinet less or full with gas.

1.5 Limitation of the study

Since Nitrogen gas is expensive, Liquified Petroleum Gas (LPG) will be used in this study. This is to reduce the cost of the project. Another limitation in this study is, for monitoring purpose, data from the Arduino will be send to monitor via Bluetooth HC-05. The limitation here is that bluetooth will be connected only up to a certain distance (approximately 10 meters) from the controller box.

1.6 Organization of the thesis

This dissertation shows how a realistic model can help system designers and programmers to understand the performance characteristics of the underlying gas controlling system. The organization of this thesis is as follows. Chapter 1 discusses about the introduction to this project, problem statements and the objective of this project.

In chapter 2, it is elaborates on past researches which can be refer and helpfull to upgrade and complete the project, the past researches such as automatic gas valve control system using arduino hardware, LPG gas leakage detection and control system and GSM based leakage detection system helped so much on upgrading my sistem. The last section in Chapter 2 is focusing on reviewing other related models, and show how my work is distinguished from other works.

In chapter 3, research on methodology, theory of component and process flow of gas controlling system. This chapter will explain about the technique which have used to develope and improve the design and the system with the correct and efficient way, so that the ouput will be acoording to the objective of this project.

In Chapter 4, we extend our performance studies from a point-to-point analysis to a highly congested controlling pattern, the many-to-one collective operation. I have focus on the congestion behavior of how the reliable transmission protocol performs under heavy congestive loss situation. I have conduct experimental and analytical studies on two different types of components which have used in this project.

In the last chapter which is chapter 5, i have conclude this project and also have give some reccomemdations to be improved in the future with latest and advanced technology.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter discusses the researches in the past that are related to this project. The overall result in the concept literature framework shows that the link between research projects with the theory and concepts in the figure or an appropriate model about this project.

2.1 Past Related Research.

Several researches had been done from other researcher. This study can be used as a guideline to refer and more understand the basic concept to be applied in these project work.

2.1.1 Automatic Gas Valve Control System using Arduino Hardware

Based on T.K. Sethuramalingam and M. Karthighairasan (2012), they invented an automatic gas valve control system using arduino hardware. More specifically, Arduino is an open hardware platform that provides a rapid prototype development. In this study, Arduino Uno was used, which was a microcontroller board that depends on ATmega328. It has 6 analog inputs, 16 MHz crystal oscillator, 14 digital input/output pins (out of which 6 can be exploited as PWM outputs), a USB connection, a power jack, an ICSP header and finally a reset button. It includes

all the necessary things which are essential to support the microcontroller and can be atached to a computer just with an USB cable or power it with an AC-to-DC adapter or battery to get started. The hardware comprises of a simple open hardware device for the Arduino board with an Atmel processor and on-board I/O support whereby the software comprises of a standard programming language and also the boot loader that runs on the board.

A servomotor was fixed to a gas valve. Four control positions were carried out by the module, two major positions were exploited to close or open the valve (Open at 90° and close to 0°). This library allows an Arduino board to manage RC (hobby) servo motors. Servos have incorporated gears and a shaft that can be accurately controlled. Standard servos permit the shaft to be positioned at different angles, typically between 0 and 180 degrees. Uninterrupted rotation servos permit the rotation of the shaft to be set to different speeds.

The Servo library supports up to 12 motors on most Arduino boards and 48 on the Arduino Mega. On boards excluding the Mega, make use of the library disables analog Write() (PWM) functionality on pins 9 and 10, whether or not there is a Servo on those pins as shown in figure 2.1. On the Mega, up to 12 servos can be exploited without interfering with PWMfunctionality; exploitation of 12 to 23 motors will immobilize PWM on pins 11 and 12.
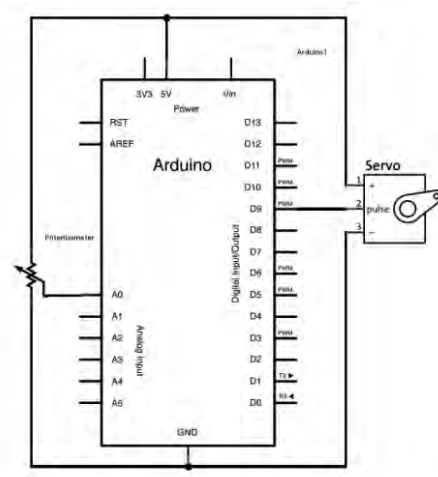

Figure 2.1: Servo motor interfacing using arduino

Servo motors consists of three wires: power, ground and signal. In figure 2.2, the power wire is red in colour and connected to the 5V pin on the Arduino board. The ground wire is characteristically black or brown and connected to a ground pin on the Arduino board. The signal pin is normally yellow or orange and connected to pin 9 on the Arduino board. The potentiometer is wired in order that its two outer pins are connected to power (+5V) and ground, and its center pin is connected to analog input 0 on the Arduino.
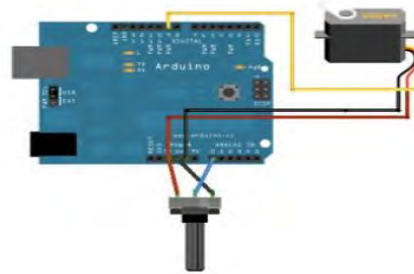

Figure 2.2: Servo Motor Connection Diagram

2.1.2 LPG Gas Leakage Detection & Control System

Based on Hitendra Rawat, Ashish Kushwah, Khyati Asthana and Akanksha Shivhare (2014), the objective of this project is to detect any leakage of LPG/CNG based cars, small scale factories or in home appliances. It will detect the leakage and will close the knob of the system to stop the supply of the gas. Steppermotor that were attached to the knob will close the supply by rotating it. For assistance, LCD of 16x2 was also placed. Besides that, an alarm was placed to stop and to alert the user as soon as the leakage was detected.

Gas sensors were employed in a wide range of applications in the fields of safety, health and instrumentation. Common examples are domestic/commercial alarms for explosive or toxic gases, or in automotive application as gas leakage detectors for LPG powered cars and exhausts detectors inside any fuel powered truck/car. Today's sensors, while featuring a high sensitivity to a wide gases variety, are very compact in size and have significantly reduced their power consumption to better adapt to portable solutions.

In this study, the internal elements of a sensor (heater and gas sensitive resistors) were constantly kept under control to avoid failures leading to a wrong alarm indication. Furthermore, if the application needs to achieve a good measurement accuracy, factors like environment temperature, sensor life was taken into account as well. All those features and controls in the project requires a certain amount of external circuitry (including components like comparators, temperature sensor, spare logic etc. This project aims to show how a microcontroller can be employed to replace a lot of external components while adding extra functionalities at a cost comparable as a simple integrated comparator. In the prototype, the hardware and microprocessor firmware have been optimized to implement a smart LPG gas alarm (LPG stands for Liquefied Petroleum Gas) for cars running on LPG/CNG so that it can raise alarm before any fatal incident happens.

Hardware Implementation.

The block diagram of the hardware implementation of the entire system is as shown in the Figure 2.3. In this circuit, MQ-6 sensor was used for gas leakage detection. MQ-6 sensor composed by micro AL2O3 ceramic tube, Tin Dioxide (SnO2) sensitive layer, measuring electrode and heater are fixed into a crust made by plastic and stainless steel net. The heater provides necessary work conditions for work of sensitive components. The enveloped MQ-6 has 6 pin, 4 of them are used to fetch signals, and the other 2 are used for providing heating current. MQ-6 sensor works on basics of combustion process, and output is given in variable voltage form, so when LPG gas is leak, voltage at the output pin of MQ-6 is increased. IC2 (Op-amp LM324) as a comparator was also used to compare the LPG leakage with respect to normal condition. Output of comparator was fed to IC1 microcontroller (ATMEL 89S8253) and corresponding coding LCD display gas leakage and give another
instruction to stepper motor via ULN2803 to turn 90 degree to turn off the regulator of gas tank. Temperature sensor DS18B20 was continuously communicated with Microcontroller and display temperature at LCD. When temperature is more than 50 degree, then fire alarm was activated and displayed fire on LCD.
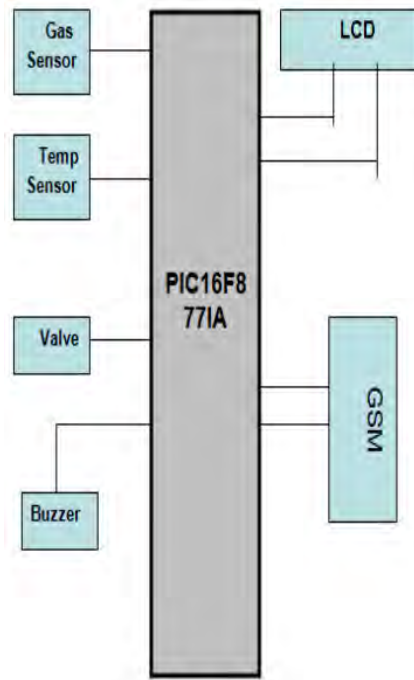
Figure 2.3: Block diagram of Gas Leakage System

2.1.3 GSM BASED GAS LEAKAGE DETECTION SYSTEM

LPG consists of mixture of propane and butane which are highly flammable chemical. It is odorless gas due to which Ethanethoil is added as powerful odorant, so that leakage can be easily detected. There are other international standards like EN589, amyl mercaptane and tetrahydrothiophene which are most commonly used as odorants. When there is any gas leakage detected, the gas concentration exceeds normal level and the alarm will be activated immediately. Gas leakage detection is not only important but stopping leakage is equally essential. This system was a cost effective and highly accurate system, which not only detect gas leakage but also alert (Beep) and turn off main power and gas supplies, and send an SMS. GSM module was used to alert the user by sending an SMS. In order to provide high accuracy gas sensor MQ-6 has been used.

The functionality of system is divided into three main steps. The fig 2.4 shows the block diagram of gas leakage security system.