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THE PROTOTYPE AND DESIGN OF EARLY DETECTION OF GAS LEAKAGE BASED ON MICROCONTROLLER USING PERSONAL EXTREME PROGRAMMING METHOD

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Abstract
At the beginning of the launch of LPG as an alternative fuel to replace kerosene, many cases of LPG explosions were caused by gas leaks which were not detected early on. This had created 'anxiety' in the community so that people were reluctant to use LPG due to lack of socialization, lack of public knowledge about dealing with gas leaks and no tools for early detection of gas leaks. Currently, LPG (Liquid Petroleun Gas) in the form of methane gas is widely used by the community after the government launched an energy conversion campaign. Practically today, kerosene has been abandoned by many people and replaced by LPG. The method used in this study uses the PXP (Personal Extreme Programming) method with single programming. Complete collection of information data allows developers to find views to create a software so that it can be right on target. This stage requires several steps, planning, design, coding, system testing. The goal is to produce a useful tool which can be used by the wider community. This tool can detect gas leaks precisely if the sensor is heated and the gas source is not mixed with free air. This tool can send a signal in the form of an SMS warning automatically and can sound an alarm so that people around who hear the alarm can know.

I. INTRODUCTION

Currently, LPG (Liquid Petroleun Gas) in the form of methane gas is widely used by the public after the government launched an energy conversion campaign. Practically today, kerosene has been abandoned by many people and replaced by LPG [1]. At the beginning of the launch of LPG as an alternative fuel to replace kerosene, there were many cases of LPG exploding due to gas leaks which were not known early on and this had created 'anxiety' in the community so that people were reluctant to use LPG due to lack of socialization, lack of public knowledge about dealing with gas leaks and there are no tools to detect gas leaks early. The result of research by Berlilana, Agung Prasetyo and Ika Marlisa Raharjo has produced a set of LPG leak early warning systems using the ATMega328 microcontroller as well as countermeasures which work automatically in the event of an LPG leak. This tool is targeted to find out and make it easier for users to find out the occurrence of leaks in LPG cylinders [2]. Based on the results of Zendy Kurnia Widarto's research, Hendik Eko Hadi S and Renny Rakhmawati, it is said that for the LPG concentration detection process, the TGS2610 sensor requires heating the heater sensor for approximately 3 minutes in free air. The more gas enters the faster the sensor detects leaking gas. The time required for sending SMS from the modem to the cellphone is about 3 seconds depending on the GSM operator used [3]. Mifza Ferdian Putra, Awang Harsa Kridalaksana and Zainal Arifin produced a LPG cylinder leak detector based on SMS gateway and E-Mail as information media [4]. Lavanna Indanus Ramadhan, Dahnial Syauqy and Barlian Henryranu Prasetio said that the average execution time of a system using an RTOS implementation was 1.8976 ms, while a system without RTOS was 1.7304 ms [5].

The four studies above will be developed in this research project which certainly has differences from the previous ones. Among them is that it will be targeted to reduce assembly costs. There must be additional outputs such as fans as exhaust gases which leak into a more spacious room and there is no source of fire. The buzzer as an alarm can be used. If no one is at home, the neighbors will hear and help. This research unites the coding elements in the software which requires researchers to understand the coding language, especially the C programming language, the main language used to program gas

detectors. In this study, the description of the tool made using the Arduino Uno micro controller combined with the MQ-2 gas sensor and has an output in the form of a SIM800l module for information media which will send a message after the gas sensor detects a leaking gas which exceeds the percentage of gas in the room and has a fan to exhaust gas into a more open room and a buzzer as a small version of the alarm simulation which can be replaced with a louder alarm.

II. LITERATURE REVIEW

2.1. SMS Gateway

Short Message Service (SMS) is the ability to send and receive text messages to and from mobile phones. The text can consist of letters, numbers or an alphanumeric combination. SMS Gateway is a technology to send, receive and even process SMS via computers and computerized systems (software) [6]. The working mechanism of sending SMS is divided into 3 parts. Those are:

1. Intra-operator SMS, sending SMS in one operator
2. Inter-operator SMS, sending SMS between different operators
3. International SMS, which is the sender of SMS from one country operator to another country

2.2. Arduino uno

Arduino uno is the brain or core of this gas detector, a board which has embedded an ATmega328 microcontroller base which has 14 digital input and output pins, 6 analog input pins, 16 MHz crystal oscillator, USB connector, power jack, ICSP header, and reset button [7]. Hari Santoso (2015:2), Arduino is an open-source singleboard microcontroller, derived from the Wiring platform and designed to facilitate the use of electronics in various fields. The hardware has an Atmel AVR processor and the software has its own programming language based on the C programming language. Arduino is a versatile microcontroller kit and is very easy to use. To make it, you need a chip programmer (to embed the Arduino bootloader on the chip) [8].

2.3. Microcontroller

Sumardi (2013:1) stated that the microcontroller is a microprocessor which is devoted to instrumentation and control. This is a digital electronic device which has I/O and control with programs which can be written and erased in a special way. Microcontroller is a computer on a chip which is used to control electronic equipment, which emphasizes efficiency and cost effectiveness. Literally it is called "MICROCONTROLLER" where an electronic system which previously required a lot of support such as IC, TTL and CMOS can be reduced/ minimized and finally centralized and controlled by this microcontroller [9].

Syahwil (2013: 57) said that the first microcontroller was introduced by Texas Instruments with the TMS 1000 series in 1974 which was the first 4-bit microcontroller. This microcontroller began to be made since 1971, which is a microcomputer on a chip complete with RAM and ROM. Then in 1976, Intel issued a microcontroller which later became popular with the name 8748 which is an 8-bit microcontroller, which is a microcontroller from the MCS 48 family. Currently, the most widely circulated microcontroller in the market is an 8-bit microcontroller variant of the MCS51 family issued by Atmel with the AT89Sxx series and the AVR microcontroller which is a RISC microcontroller with the ATMEGA16535 series. Although there are many variants of the AVR microcontroller, each of them has different features [10].

2.4. ATMEGA-328

The ATMEGA-328 consists of 28 pins and 6 analog inputs shown in the pin diagram. Analog inputs can be represented as PC0 to PC5. These analog input pins have a continuous time signal which acts as an analog input for the system. Furthermore, it also consists of 12 digital inputs[9]. The ATMEGA-328 chip is an 8-bit microcontroller chip based on Atmel's AVR-RISC. This chip has 32 KB of ISP flash memory with read-write capabilities, 1 KB of EEPROM, and 2 KB of SRAM. From its Flash memory capacity of 32 KB, this chip is named ATMEGA-328. The ATMEGA-328 chip has 23 general purpose I/O (input/output) lines, 32 registers, 3 timer/counters with comparison mode, internal and external interrupts, serial programmable USART, 2-wire serial interface, SPI serial port, 6 10-bit channel A/D converter, programmable watchdog timer with internal oscillator, and five power saving modes. The chip works on a voltage between 1.8V ~ 5.5V. Computing output can reach 1 MIPS per Mhz. The maximum operating frequency is 20 Mhz[10].

2.5. MQ-2 Sensors

This sensor is a type of gas detection sensor which can detect gases such as Methane, Buthane, LPG, and Cigarette Smoke. This requires 5v of power to continuously heat the heater, some require 2v from arduino [11], which will be very sensitive to gas if the gas concentration around the gas sensor gets higher. The mq2 gas sensor features include:

1. Very sensitive with a wide range.
2. Very sensitive to LPG, Propane, and hydrogen gas.
3. Its longevity is very cheap.
4. The circuit is very simple.

2.6. SIM800L

SIM800L is the SIM module used in this study. The SIM800L-GSM/GPRS module is the part which functions to communicate between the main monitor

and the cellphone [12]. One of the advantages of this GSM module is that it is very easy to use and operate either through a direct computer or using a microcontroller such as Arduino. Using Arduino requires an additional library to help simplify programming this GSM module (Gusmanto, 2016) [13]. These are the specifications of this Modem (features):

1. Quad-band 850/900/1800/1900MHz.
2. Connect to global GSM network using 2G SIM.
3. Voice call with external 8 speakers and electret microphone.
4. Send and receive SMS.
5. Send and receive GPRS data (TCP/IP, HTTP, etc.).
6. GPIO ports, for example for buzzers and vibrational motors.
7. AT command interface with automatic baud detection.

III. RESEARCH METHOD

3.1. Data collection

The data collection stage needs to be carried out to obtain information from the research object in order to determine the system design which is in accordance with the research objectives. This study used several methods of data collection including the following:

1. Experiment
   The researcher made observations by trying to experiment with the tools which the researcher would make.
2. Questionnaire
   Questionnaire was a list of written questions addressed to respondents. Respondents' answers to all questions in the questionnaire were then recorded.
3. Libraries
   Literature study was a study of books, literatures, notes and reports which had to do with the problem to be solved.

3.2. Method Used

The method used in this research is the PXP (Personal Extreme Programming) method with single programming.

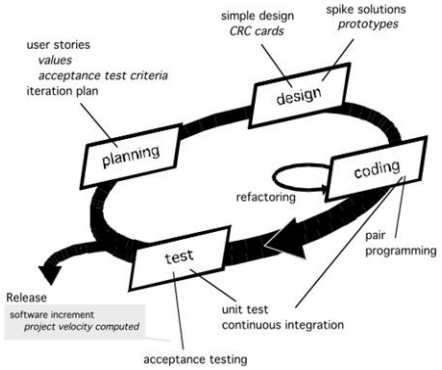

Figure 1. Stages of the XP Method

1. Planning

A successful planning phase depended on the foundation of the XP process. The planning phase in XP differed from the traditional development model, which often combined requirements gathering and application design [14]. Information data collection was carried out in a complete manner which allowed developers to find views to create a software so that it can be right on target. This stage required several steps, including:

a) Analyze the problems which will be faced in the future to make it easier to solve the problems at hand.
b) Conduct observations by distributing 20 questionnaires in the Pringsewu area.

2. Design

The researcher determined a tool design which was simple and easy to use by heeding the principle of "Keep Is Simple". This method had to contain a refactoring process which was a construction and design technique.

Refactoring is an attempt to change the structure of the program code which aims to be understood and modified more easily. Because we are in a hurry to meet deadlines, we often make program code which is difficult to understand [15].

At this stage, the design was carried out as follows:

a. Create block diagrams.
b. Create flowcharts.
c. Design on arduino using breadboard.

3. Coding

After the successful design phase using the breadboard, the researcher went straight to the coding phase which was writing, testing, repairing, and maintaining code that would build a computer program [16]. Researcher translated the logical requirements of pseudocode or flowcharts into a programming language, both letters, numbers, and symbols that made up the program.

In this stage, coding was carried out, including:

a. Mapping with Proteus Design Suite to facilitate the formation of a code in arduino.
b. Coding uses a C-based programming language with Arduino IDE software.

4. System Testing

After the coding was complete, the researcher then made a prototype form to make it easier for us to change what was lacking in this project. For the Testing stage, the researcher proposed a questionnaire and usability method in order to determine public interest with this gas leak detector.

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IV. DISCUSSION

4.1. System Design

In the process of developing a system to make a gas leak detector, a tool design is needed using:

a. Flowchart

This flowchart illustrates how this gas leak detector works, starting from the ADC (Analog to Digital Converter) conversion to how this tool reacts when it detects a gas leak.

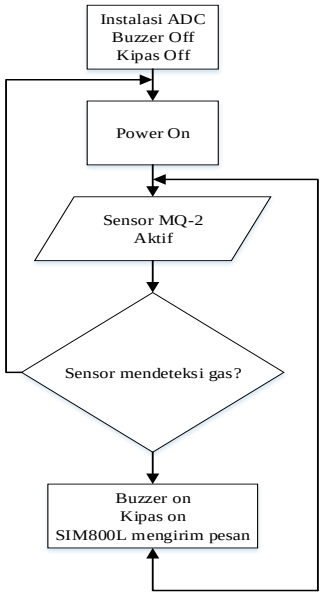

Figure 2. Flowchart of how the gas leak detector works

b. Arduino Uno Block Diagram

The Arduino Uno block diagram is a brief depiction of how the brain shape of this gas leak detector is made.

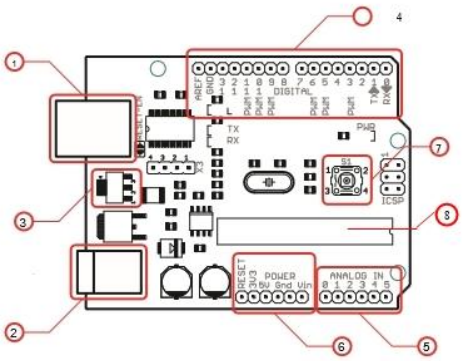

Figure 3. Arduino Uno Block Diagram
Source: abierto.cc

1. The USB connector is used to connect the Arduino board to the computer.
2. The power connector is used when you don't want to connect Arduino with a USB cable.
3. Automatic power switch in the form of a plastic jumper
4. There are 13 digital pins
5. Analog pins
6. The power pin is to the left of the analog pin so it can provide either 3.3V or 5V voltage.
7. Reset switch
8. The processor functions as a controller of the entire system.

c. MQ-2 Sensor Block Diagram

The block diagram of the MQ-2 gas sensor below is a block diagram of the MQ-2 gas sensor without a minimum module to run the sensor.

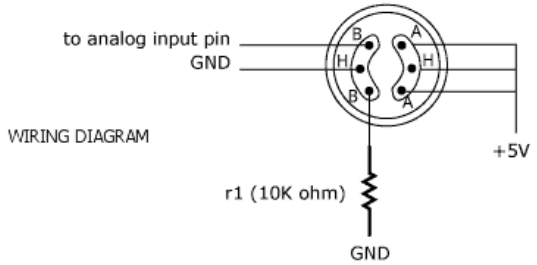

Figure 4. MQ-2 Sensor Block Diagram

This is Pin H. Of the two H pins, one is connected to supply and the other to ground.

- Pin A This pin is tied to the supply voltage.
- Pin B One pin acts as an output while the other will be pulled to ground.

4.2. Interface Design

a. Arduino IDE

The initial display of Arduino IDE is used as a code input and code checker which is inputted into the Arduino board which is the mainboard running the gas leak detection system.

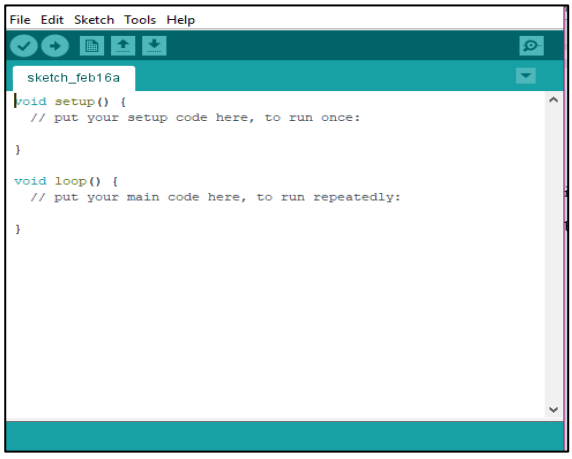

Figure 5. Arduino IDE Application Interface

a. Schematic Gas Leak Detection Equipment

The initial design of the wiring that will be implemented to the gas leak detector.

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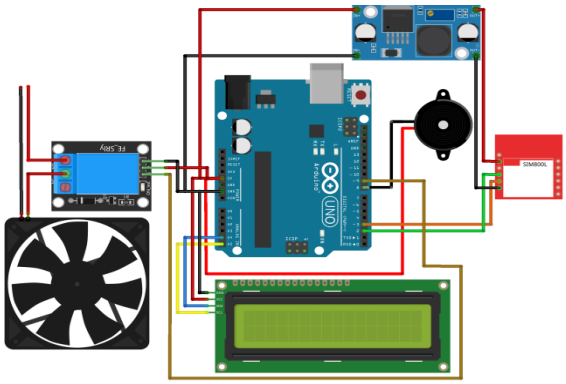

Figure 6. Gas Leak Detection Detector

b. Box Design Tool Module

Front tread design is a form that will be the design of a gas leak detection device later.

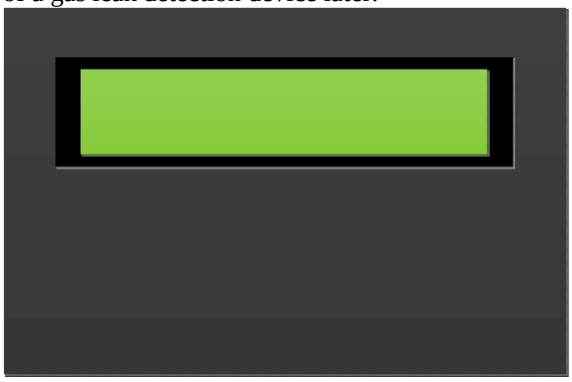

Figure 7. Front Tread

c. Design Sensor and Fan Box

Design This front tread design is a form that will be the design of a gas leak detection device later.

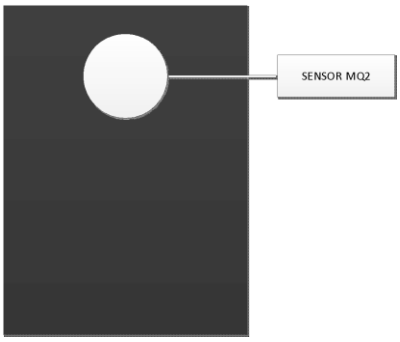

Figure 8. Side Tread Design

3.1. Implementation

Implementation which is the final result of a project that is ready to be presented to the outside community, the following is the final result of this gas leak detection device made:

Figure 9. Display Tool Part Module Box

The front of the device has an LCD that functions to display information what is being processed by the device, such as showing gas levels to sending SMS information. Then there is a buzzer hole that will sound when the tool detects a gas leak.

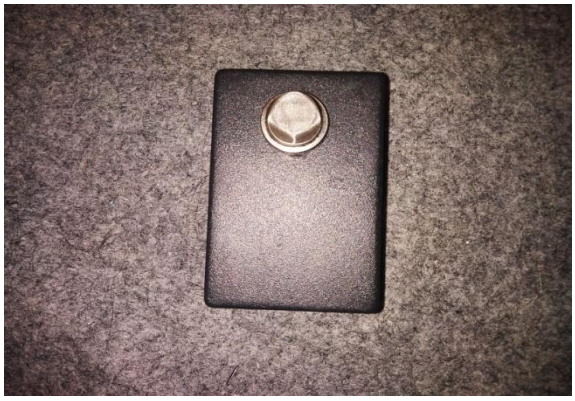

Figure 10. Display Tool Parts of the Sensor Box

This sensor box contains an MQ2 sensor that serves to detect gas levels, and a 1v 5v relay that is useful for connecting fans where the fan is functioning to dispose of gas when the sensor exceeds a predetermined limit.

Figure 11. Overall Tool Display

Above is the display tool that has been connected between the module box and the sensor box connected by cable.

Figure 13. Sms Display Sent by the Device When a Gas Leaks Detected

This is a display on the owner's mobile phone sent by the device in the form of information and warnings, but the owner can also send requests for real time gas level monitor data.

4.3. Analysis of Research Results

The results of the test using the system distributed through a questionnaire about the opinions of application users get the results of the questions asked and it can be concluded that the respondents who answered 'Strongly Agree' were 58 answers, 'Agree' were 47 answers, 'Disagree' were 12 answers, and 'Strongly Disagree' were 3 answers. Those who show a positive response from respondents in an effort to use the developed system reach an average of 80 to 90% which means that the development of the tool can be continued to a better stage by paying attention to the function and usability of using applications and SMS.

V. CONCLUSION

Based on the research conducted, it can be concluded that there is a useful tool to be used by the wider community. This tool can detect gas leaks precisely if the sensor is heated and the gas source is not mixed with free air. This tool can send a signal in the form of an SMS warning automatically and can sound an alarm so that people around who hear the alarm can know.

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