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## **DESIGN PROTOTYPE OF SMART DETECTOR ENVIRONMENT SYSTEM ON SEMICONDUCTOR DETECTOR STORAGE (HPGE)**

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### **ABSTRACT**

The HPGe detector is a device that should be cooled when used and can be operated at room temperature. For this reason, it is necessary to monitor the temperature and humidity in the HPGe detector storage area to produce optimal performance. This research was focused on designing a Smart Detector Environment System as a means of monitoring and automatic control of temperature and humidity in the HPGe detector storage. Temperature and humidity detection in the system was carried out by the DHT22 sensor connected to Arduino Uno and the motor driver module. Arduino uno gave the command "00000011" to detect the temperature in the chamber, and "00000101" to start the detection of humidity in the chamber, then the data generated by the DHT22 sensor would be displayed and processed by LabVIEW, which was used to move the fan to regulate the temperature and humidity in the system with the condition that the lamp on the chamber was left on (manual). The results obtained were in the form of a design and automatic control of temperature and humidity monitoring and control in the HPGe detector storage whose temperature could be adjusted automatically according to the needs of the HPGe detector.

**Keyword:** *HPGE Detector; automatic control of temperature, arduino uno, Labview*

## I. INTRODUCTION

Today, technology is developing very quickly and increasingly sophisticated. The development of this technology is surely closely related to the development of electronics engineering science (Rindi, 2021).

The HPGe detector with a gamma spectrometry system is one of the systems used to determine the radioactive elements contained in an environmental snippet. One of the parameters that affect the performance of the HPGe detector is the temperature and humidity of the system and the environment in which it is stored. One of the obstacles is the increase in temperature and humidity levels in the environment where the HPGe detector is stored. So that a system is needed to maintain the temperature and humidity levels to remain optimal according to the conditions needed by the HPGe detector to keep it working properly (ORTEC, 2018).

Additionally, the optimization of temperature and humidity levels in the HPGe detector storage is a preventive step in maintaining nuclear instrumentation to prevent premature damage. This system uses Arduino Uno as an interface between analog sensor output and throws sensor readings to LabView, and LabView as a data processor in monitoring and controlling the storage temperature of HPGe detectors. Moreover, there is a Data Log facility that functions to record temperature data and humidity levels during the HPGe Detector operation, making it easier for operators to see temperature history and humidity levels. The fan on the system will be active to adjust the room so that the temperature remains optimal. The benefit of the tool made is a form of preventive effort in maintaining and maintaining the HPGe detector.

## II. LITERATURE REVIEW

### 2.1. HPGe (High Pure Germanium) Detector

HPGe (High Pure Germanium) detector is a type of semiconductor detector whose working principle is the same as that of a gas fill detector, but in this detector the gaseous material is replaced with a solid substance that is semiconductor in nature (such as Si or Ge). In a solid substance, electrons occupy a certain level (band) of energy, namely the valence band and conduction band and the area between them is called the forbidden area which includes an energy gap and a certain magnitude.

The working principle of the HPGe detector is based on the ability of electrons to ionize and excite when subjected to radiation so that electrons can move from the valence band to the conduction band which will produce electrical pulses. It is this electric pulse that is further processed and strengthened. The pulse height is proportional to the gamma photon power interacting with the detector. HPGe detector with physical form in Figure 1, of high purity germanium (with impurity concentrations  $\pm 10^{10}$  atoms/Cm or less). The best resolution of this type of detector in the range of 3 KeV  $\leq E \leq 1$  MeV.

The HPGe detector is cooled when in use and can be operated at room temperature without damaging the result. HpGe detectors can work in the temperature range of 20°C - 75°C. However, it works optimally at a temperature of 20°C. The efficiency of this detector is very high for energy of 3 KeV to 100 KeV (ORTEC, 2018).



Figure 1. HPGe Detector with Lead Shield

### 2.2. DHT22 Sensor

The sensor system used to measure temperature and humidity is the DHT-22 with a voltage source of 5 Volts and a bidirectional communication of 2-wire in Figure 2. This sensor system has 1 data path that is used for addressing and reading data commands. Data retrieval for each of the measurements is carried out by giving addressing commands by the microcontroller. Data serial legs connected with the microcontroller provide

addressing commands on the DATA DHT-22 pin "00000101" for measuring relative humidity and "00000011" for temperature measurements. The DHT-22 provides output of humidity and temperature data on the Data pins alternately according to the clock given by the microcontroller for the sensor to work. The DHT-22 sensor has an ADC (Analog to Digital Converter) in it so that the DHT-22 data output has been converted in the form of digital data and does not require an external ADC in data processing on the microcontroller (A. Hendra, 2016).

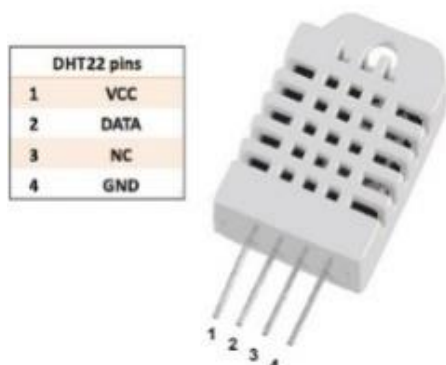


Figure 2. DHT22 Sensor (A. Hendra, 2016)

It has an excellent level of stability as well as a very accurate calibration feature. The calibration coefficient is stored in the OTP of the memory program, so when the internal sensor detects something, this module includes the coefficient in its calculation. Power 5V , Good for 0-100% humidity reading with 2-5% accuracy, Good for -40 to 80°C with temperature reading accuracy  $\pm 0.5^{\circ}\text{C}$  (A. Hendra, 2016).

### 2.3. Arduino Uno

Arduino Uno is a microcontroller board in which there is a microcontroller, the use of the type of microcontroller is different depending on the specifications. In Arduino Uno, a microcontroller based on ATmega 328 is used. Arduino is a microcontroller that can provide a fixed voltage of 5V, with input / output pins that can be programmed as soon as possible so that it can support the work of the microcontroller, this microcontroller is connected to a computer with a USB cable, so it can be used to provide input voltage to run the DHT22 sensor. Figure 3, is the physical form of Arduino Uno.

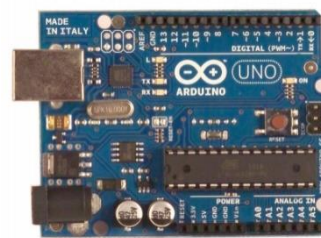


Figure 3. Arduino Uno (Rendi, 2010)

### 2.4. LabView (Laboratory Virtual Instrumentation Engineering Workbench)

LabView (Laboratory Virtual Instrumentation Engineering Workbench) is a programming software of National Instruments with a programming language based on graphs and block diagrams. Programming in LabView is a virtual instrument with a way of working and appearance similar to a physical instrument.

LabView software consists of three main components, namely the Front Panel, namely the window section with a gray background containing controls and indicators, the front panel is used to build a VI and run programs as well as debug programs, then the Diagram Block of vi part of the window on a white background contains the source code created and serves as instructions for the front panel and the last Control and Functions Pallete is used to build. (Universitas Komputer Indonesia, 2005).

### 2.3. Driver Motor Module

ICL298 is an H-bridge type IC that is able to control inductive loads such as relays, solenoids, DC motors and stepper motors which can be seen in the figure.

The L298 IC consists of logical transistors (TTL) with a nand gate that functions to make it easier to determine the direction of rotation of a dc motor or stepper motor. The control pin serves as a control of the rotation and speed of the motor connected to the microcontroller, in this case what is used is arduino uno. The advantage of the L298N motor driver module is in terms of precision in controlling the motor so that the motor is easier to control. The power supply pins are 12Vinput DC, ground, and 5V I/O. (Dedi Irawan, 2016).

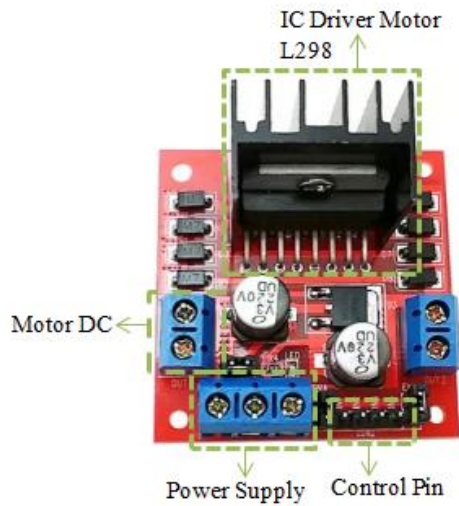


Figure 4. Pin out of the l298 motor driver

### III. METHODOLOGY

#### 3.1. Software Design Labview

The research carried out included applied research, with experimental research methods (Kothari, 2009). The stages of research carried out were literature study, software design, hardware design, system testing, and analysis (Rindi, 2020). The state machine diagram of the created system can be seen in Figure 5.

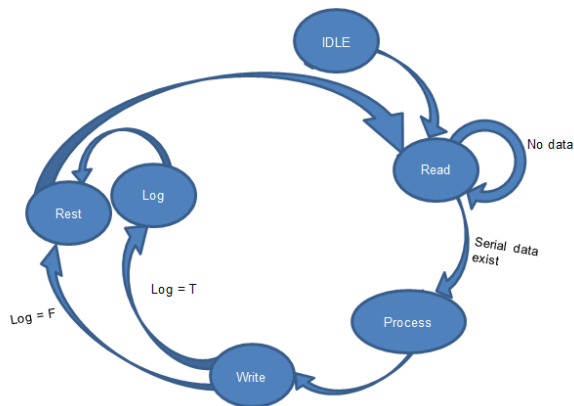
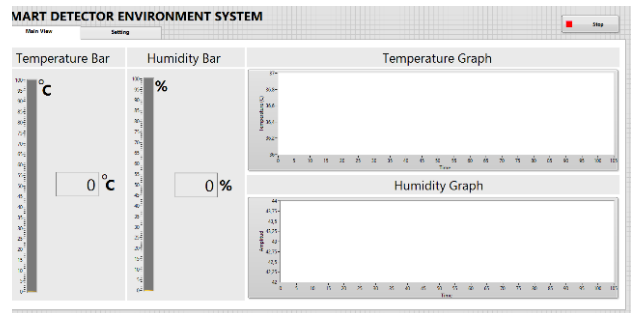
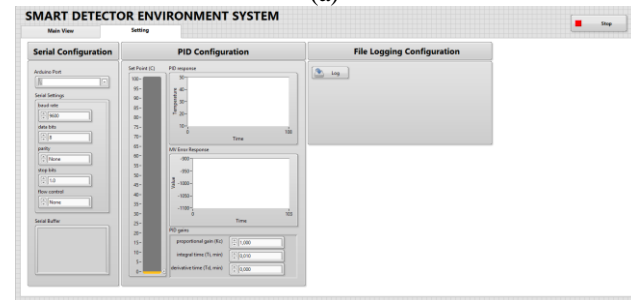


Figure 5. State machine system

When the input is read, the machine state will change to another state or state. Each condition specifies what conditions will occur when given an input. Where in figure 5 the idle condition will only change to read when the temperature and humidity data is read, then the process will occur when there is serial data. State write then does two things, namely storing logs on the computer / pc, and doing feedback, namely writing temperature and humidity data that has been processed previously from labview to Arduino. Here is Figure 6, showing the front panel on the LabView program



(a)



(b)

Figure 6. Front panel display (a) Main View, (b) Settings in the LabVIEW program

The front panel itself is divided into two parts, namely the main view, and settings. In the main view there is a temperature and humidity display in the form of bars and graphs. Thus, it is clearly visible fluctuations in temperature and humidity when controlled. Then in the settings, it is given the ability for users to change the serial configuration, PID, and data logging.

The temperature control system used for the heater incorporates PID control scheme to maintain the temperature at desired setpoint. The hardware and LabVIEW Graphical Programming is integrated via LINX toolkit. The detail process on the design of PID controller with system interfacing is described as following section (H. Muhammad Asraf, 2017)

#### 3.2. Hardware Design

The system circuit can be seen in Figure 7.

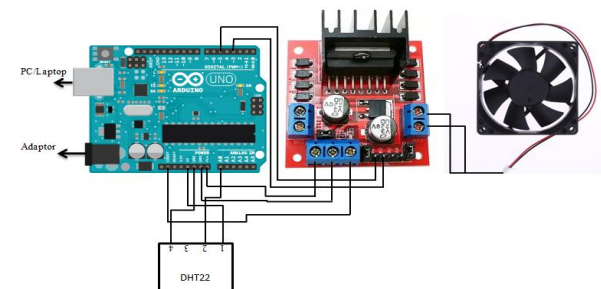


Figure 7. Series of Automatic Monitoring and Control Systems at Temperature and Humidity

The 12v dc fan will be connected by a plastic tube, which depicts a closed chamber. With a 5

Watt lamp on the lid and a dht22 sensor in the tube, as can be seen in figure 8. The input on the laptop/PC is the sensor reading and PWM of the motor. Which will then be processed by labview.

#### IV. RESULT AND DISCUSSION

##### 4.1. Design System

The results of the system build design are shown by Figure 8. The model is made of a plastic tube measuring  $\pm 10\text{cm}$  and a radius of 4 cm. The component consists of an arduino uno that reads the output of the DHT22 sensor and performs serial communication with LabView, after which the communication occurs the Labview state changes to another state of the machine state. In the condition of Figure 8, the temperature and humidity data are read, the system goes to the State write condition then does two things, namely storing logs on the computer / PC, and doing feedback, such as writing temperature and humidity data that has been processed previously from the labview to arduino. Previously, the fan was always in a living condition with a rotation corresponding to the specified set point so that changes in humidity and temperature could occur. The smaller the set point value, the tighter the fan rotation. The fan will adjust to reach the set point. Deficiencies in this research, the system has not been able to reach the desired condition because it has not been tested for the function of the PID system so that the optimal value is not yet known. In addition, incandescent lamps that function to regulate the humidity of the room have not been able to work automatically.



(a)

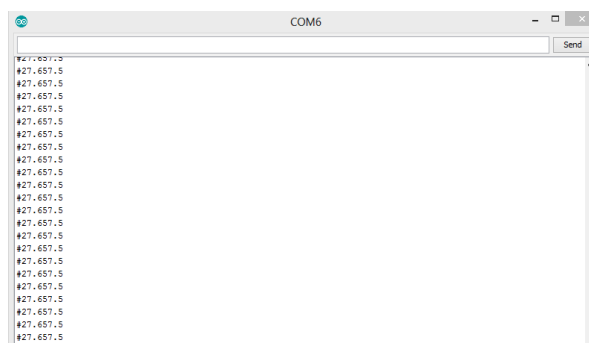


(b)

**Figure 8.** System-Wide (a) when the system is not operating (b) when the system is operating

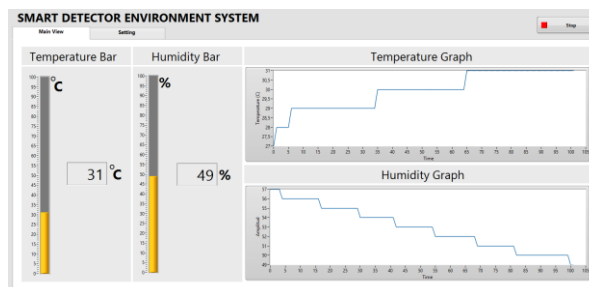
##### 4.2. System Operating Results

In this stage, testing the function of the entire system is carried out by operating the system and measuring. In figure 9, it shows the readings of the DHT22 sensor by arduino uno.



**Figure 9.** Dht22 sensor reading results by Arduino uno

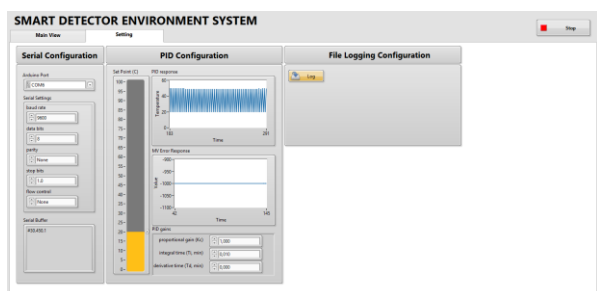
After the reading process of the DHT22 sensor by arduino, serial communication occurs with LabView and on the Panel front is displayed the result of its reading in the form of bars and graphs as shown in Figure 10.



**Figure 10.** Temperature and Humidity Readings in the Labview font panel

When the operating system set point can be changed according to the desired conditions. The settings are made in the LabView font panel of the PID Configuration settings menu which can be seen in Figure 11. In addition, in this system, the

data that is read during the operation can be stored data through the data log function in LabView.



**Figure 11.** Panel Front view for setting point set and log data

The data stored from this system can be in the form of .txt and Microsoft Excel, the results of data storage on this system are shown by Figure 12.

Date	Time	Temperature	Humidity
08/05/2018	14:15	30,000000	49,000000
08/05/2018	14:15	31,000000	49,000000
08/05/2018	14:15	30,000000	49,000000
08/05/2018	14:15	30,000000	49,000000
08/05/2018	14:15	30,000000	49,000000
08/05/2018	14:15	31,000000	49,000000

**Figure 12.** Storage of data on the system in the form of .txt

## V. CONCLUSION

### 5.1. Conclusion

A Smart Detector Environment System has been designed on semiconductor detector storage (HPGe) which functions as a monitor and regulator of environmental temperature conditions to suit the needs of HPGe detectors. The benefit of the tool made is a form of preventive effort in maintaining and maintaining the HPGe detector. The measurement of the temperature and humidity of the detector storage is carried out by the DHT22 sensor read by arduino and performs serial communication with LabView which has a PID function to regulate the rotation speed of the fan on the system and logs for data storage. The disadvantage of this system is that the incandescent lamp in the system is still operated manually and the system has not been able to reach the desired condition because the PID system function test has not been carried out so that the optimal value is not yet known.

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