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Smart Cooling System For High Transformer

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Abstract*— Some countries, including Libya have adopted high capacity oil-cooled transformers that require constant monitoring by engineers to ensure that they operate in a way that enable to reach their full Capacity , especially in the summer because of the high temperature of the weather, which adversely affects the capacity of transformers. The transformer heat increases and the separation mechanical system could not disconnect the transformer Because of its famous failures, or if the controller engineer which observe the manual separation is not at the station during the fault on the transformer. This will cause damage to the transformer. In this paper, smart cooling circuit is designed to protect the transformers from increase in temperature, which in turn protect the transformers from the damage and combustion.

***Keywords*— transformer*;* buchholz relay; GSM SIM800; Microcontroller;**

I. INTRODUCTION

Transformers are considered to be the devices that helped people meet their energy needs , where transformer is a static device consisting of a winding , or two or more coupled windings, with or without a magnetic core , for inducing mutual coupling between circuits Transformers are exclusively used in electric power systems to transfer power between circuits through the use of electromagnetic induction [1] , Power transformers must be used at each of these points where there is a transition between voltage levels and for step-down operation, mainly used to feed distribution circuits The construction of a transformer depends upon the application. For instance, transformers intended for indoor use are primarily of the dry type but can also be liquid immersed for outdoor usage [2] , Most countries especially North African countries including Libya Depends on the oil-cooled transformers especially the 30 kV transformers For their high efficiency to reach the highest conversion rate designed for it , where Increasing the cooling rate of a transformer from increases its capacity , ,Cooling methods must not only maintain a sufficiently low average temperature but must prevent an excessive temperature rise in any portion of the transformer (i.e., it must prevent hot spots). For this reason, working parts of large transformers are usually submerged in high-grade insulating oil [3] , But transformers oil-cooled need constant monitoring , Is divided into self-monitoring which is a protective device designed to deal with the events of emergency on the transformers and be installed inside the operating room of the transformer It can be divided into special protection devices transformers into two types , first Prevention mounted on body transformer, second The protection on the transformer circuit that deals with the problems of the transformer with the electrical network Gas Relay - Oil Level Gauges - Lightning Arrestors - Protective Relay - Differential Protection - Over Current Protection – Bochholtz Relay , a Buchholz relay Commonly known as the gas accumulation relay is constructed so that it accumulates all or a fixed portion of the gas released by the protected equipment. It operates when the volume of gas reaches a certain level [4] , And human monitoring of manual handling of emergency events on transformers , Which determines the type of control is the key next to the converter either be automatic or manual , where Libyan state has adopted a control management to manual monitoring oil-cooled transformers called operating management and monitoring Its mission is to employ engineers who supervise the operation of transformers In alternating groups throughout the 24-hour to Follow-up the distribution of the required load efforts as well as the control of transformers from an emergency occurs to it as coolant Low oil level in the transformer tank, increase load signals, and converter oil pressure signal Using Buchholz which consists of 2 Relays the first to determine the level of transformer oil and the second to sense the pressure of gases inside the transformer body pressed as the oil temperature rises send the sensor A signal that the heat of the transformer has risen to A protective or monitoring device for self-separating transformer This increase in temperature is usually caused by increased load , Precisely at peak times during hotter or cooler weather , And human monitoring of manual handling of emergency events on transformers , Which determines the type of control is the key next to the converter either be automatic or manual , especially During summer season, many power transformers are exposed to intensive, direct insolation. On the other hand, in recent years, the use of increasing number of air conditioning systems during summer, caused growing trend of electrical load. As the consequence, black-outs of power transformers occurred during summer [5] Often it consumes a gas pressure sensor a mechanical because it has a mechanical movement Its consumption by causes oil loss its properties So that makes it calcifications hinder his movement and becomes compressed gas inside the

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transformer and the sensor mechanical unable to move to feel the protective device that the heat has risen And then the monitoring device will not disconnect the adapter and then will cause serious damage if the engineer cannot turns off the transformer because of his increased voice which indicates that the load has increased , If the engineer is outside the power station, severe damage to the transformer will cause damage and fire This is the most common problem experienced by the General Electric Company in Libya and can be Embodied solve this problem installing smart cooling system on the body of the transformer Where reading the temperature in an instantaneous way by a sensor installed inside the poles of the converter It sends readings to the system and compares readings with a stored reference and displays them on a LCD display within the operating station and on the comparison result the system determines its function , Either run a large-sized fan installed on the oil cooling plates or run the alarm horn to alert engineer The supervisor or the separation of the adapter, and then send a text message to a phone engineer That the emergency happens to the z elbow their last temperature reading in the text message

II. SYSTEM COMPONENTS

These problems are common in adapters especially in 30 kv transformer in Libya. The engineers and researchers focus on finding solutions to these problems that causing fires in transformers and increase periodic maintenance of the transformers periods for the purpose of continuous detection and by preventing the development of calcifications. Also, to detect a predictive oil and fined some other solutions that are special protection for heat Without tying them with oil protection so that they do not get affected by oil damage or even discharge from the body, Transformers and for this we deliberately in this report separation between control of transformer oil and temperature control Heat the transformer electrodes using a smart cooling system that it consist from 10 components.

1. Microcontroller (arduino)

It is an electronic circuit and is a small computer that can interact and control the surrounding environment better than other microcontrollers. It contains a small atmega 328 chip, which is used in controlled programming by atmel. This circuit provides ports for connecting electronic components, The Arduino circuit also contains a 16-megahertz (Crystal Oscillator) with a USB port for connection to the computer, and a separate power input. This circuit shown in Fig. 1.

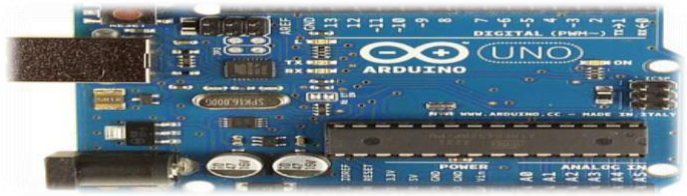

Fig.1 A microcontroller

2. liquid crystal screen

The LCD screen is a thin flat screen consumes a very small amount of energy as shown in fig. 2. The screen is used to display letters and numbers, some of which can display graphs. In this report you used to display letters and numbers which is a 2x 16 screen, which means that it is a two-line screen on which each line can write 16 characters or numbers

Fig. 2 Display

3. Sensors DS18B20

The temperature can measure in the centre Surrounding. it can be immersed in water or oil , And the nature of his work is that when we give it in its 5 volts The output exceeds 1 mV , Per Celsius degree i.e. that at 1 ° C the output will be 1 mV , Ranging from reading this sensitive from -50 to 150 ° C. This type is shown in fig. 3

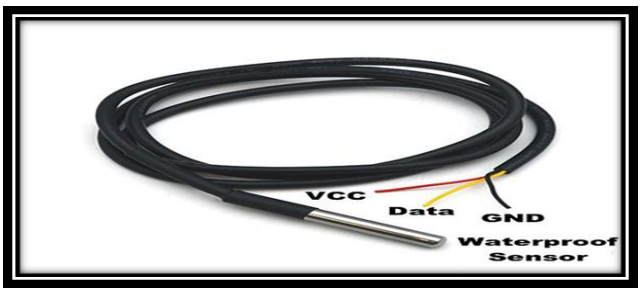

Fig. 3 DS18B20 sensor

4. Resistors

A resistors placed on the entrances and exits of controlling the minute is considered the protection of micro-controlling which (560 ohms 10 Kilwaom). Fig.4 is the resistors shape.

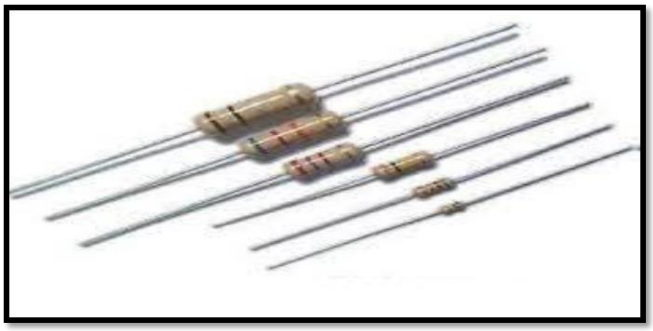

Fig5. Resistors

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5. Relays

The relay is one of the most important elements used in electronic control of various types as shown in fig. 5. It works to relay a voltage and a small current to carry a large load and the advantages of the relay lies in its ability to completely isolation between the source and load circuit

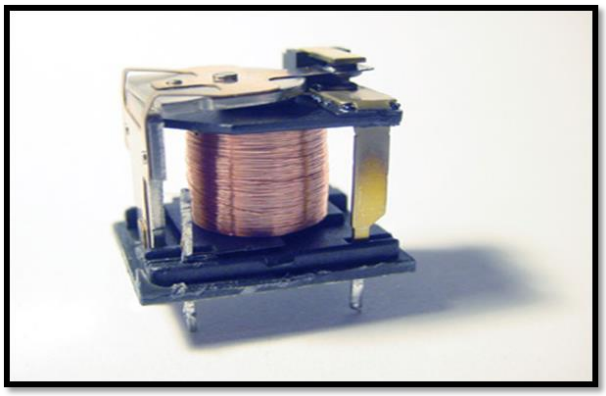

Fig. 5 Relay

6. Light diode

Fig. 6 shows some photovoltaic diodes. These are small and resemble small lamps, Turns the power supply into light, Optical diodes are available in different colours (red, green, orange, yellow, white and blue).

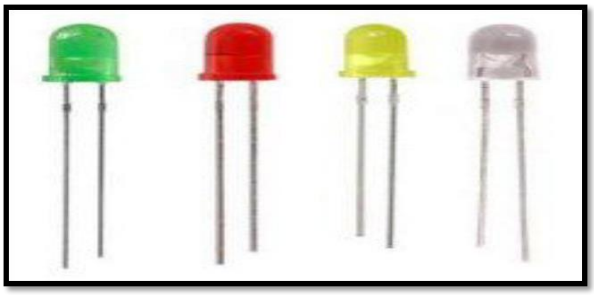

Fig. 6 Light diodes (lamp)

7. Bipolar Digital Integrated Circuit ULN2803

The way ULN2803 works when receiving a signal from the Arduino connects the ground line to the relay so that the complete nutrition. Next figure shows this type of the circuit.

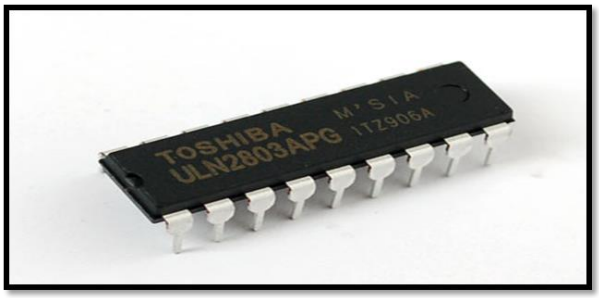

Fig. 7 ULN2803 piece full of transistors

8. Buzzer

Buzzer is an electronic component that emits a sound when a suitable voltage placed at both ends as shown in fig. 8.

Fig. 8 Siren

9. Fan

Fan an electric mater that has blades to move the air during the movement of the motor as shown in fig. 9.

Fig. 9 Fan

10. GSM SIM800

GSM SIM800 is a small device with an SMS card to send a message sent by the controller. This kind of GSM is shown in Fig. 10.

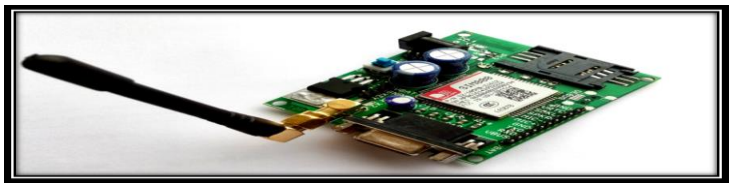

Fig. 10 GSM SIM800

III. THEORY AND DESIGN

All system components are connected to the control panel and the heat sensor is also installed Inside the transformer and be the income of the system ,and the fan is installed on the transformer oil cooling boards , Outside the operating station, the LCD display is installed , and the red and green lamps and the alarm Buzzer And all are installed inside the operating station , This system is programmed to include a reference numbers temperatures , If the heat of the transformer is increased and sent to the system by temperature sensor, It was compared with the any from the references numbers which has been divided into four stages from 0 to 100 degrees centigrade , where these stages are less than 40 degrees centigrade from the hot spots that cause the collapsed the transformer , which will been at 140 degrees centigrade. Fig. 11 shows the final assembly of a circle.

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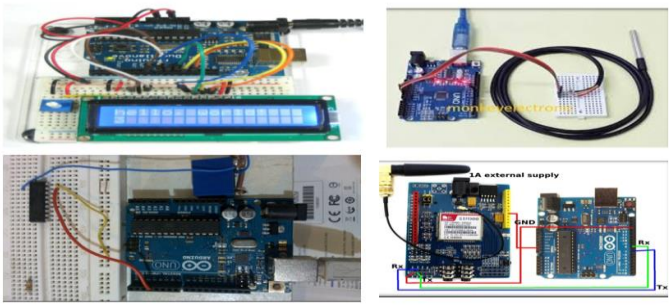

Fig. 11 Final assembly of a circle.

The task of this system is early warning and cooling , when high temperature the sensor sends the temperature to the microcontroller ,which in turn compares them with the reference stages (Normal heat mode , High temperature , Very high temperature , Full closure for transformer for service) and the temperature is displayed on the screen LCD for all stages and on the comparison results the microcontroller selects function of the system , either by sending the signal to activated the fan on level the first or second or Sends the signal to turn the lamp red or green or Sends the signal to activated the siren to inform the supervising engineer that the transformer is at a critical stage , or Sends the signal to disconnect the transformer from service It then sends a message to Phone the admin Engineer on operating station in the form of text (The heat of the transformer has risen and the transformer has been separated from the service) Via piece GSM, to teach him what happened to the transformer if the engineer outside the operating station. Fig. 12 shows the connection of the system to the transformer body. Also, Fig .13 is illustration scheme for the entrances and exits of the system.

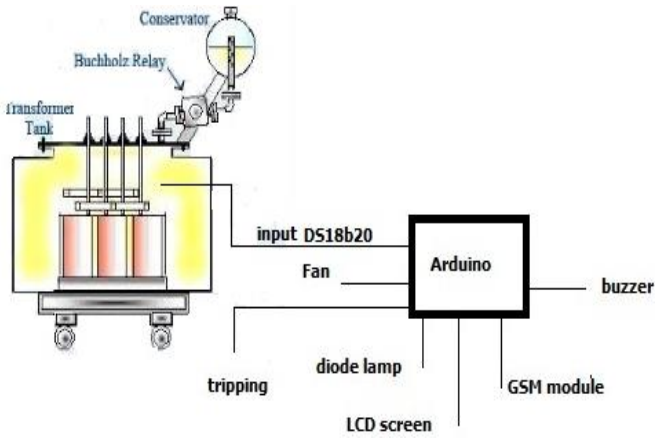

Fig .12 the connection of the system to the transformer body.

IV. SIMULATION RESULTS

Usually check the work of any electrical circuit by electronic electrical workshops for ensuring the performance of the circuit for the function designed for her to getting Matching results to connect them in fact. One of the most famous investigations in the field of control engineering is the proteus program contains an electronic library where most of the electronic pieces needed by the designer. The pieces are selected and then connected to microcontroller and taking into consideration the accuracy of the connection to the concerned parties whose tasks are determined during programming, and this software allows users to write and compile the programs and the programs compiled in mikro Basic can be directly uploaded into the microcontroller chip used in Proteus design suite. So, the microcontroller based circuit analysis is easy and simple in Proteus [6]. The smart cooling system will be checked using the Proteus program, where the program will be opened and all the pieces mentioned above will be selected. The most prominent of them is the Arduino and all the pieces will be connected with each other as shown in fig. 14.

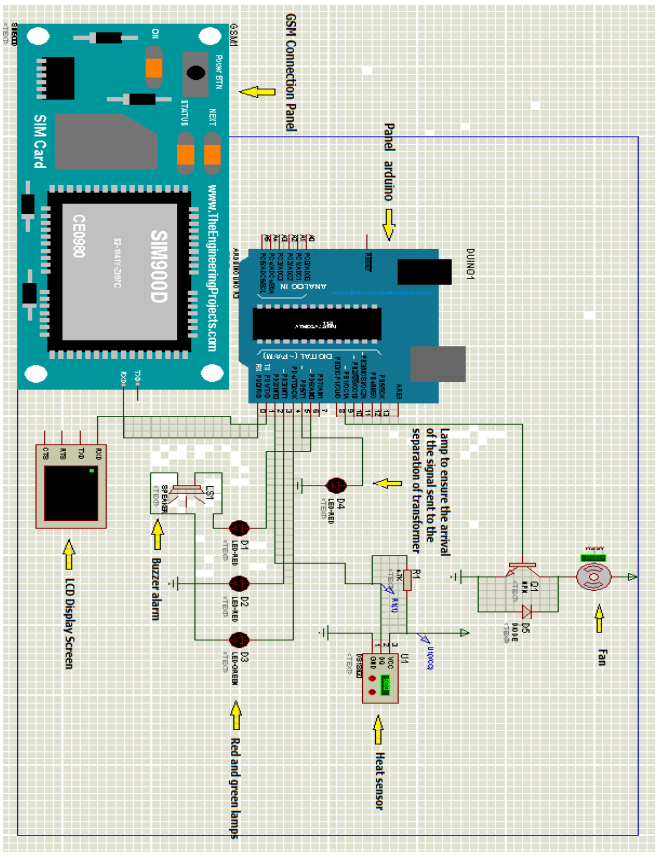

Fig.14 the circuit components Connection

Next, we bring the program stored as (Simple.cpp.hex) of the Arduino as shown in fig. 15.

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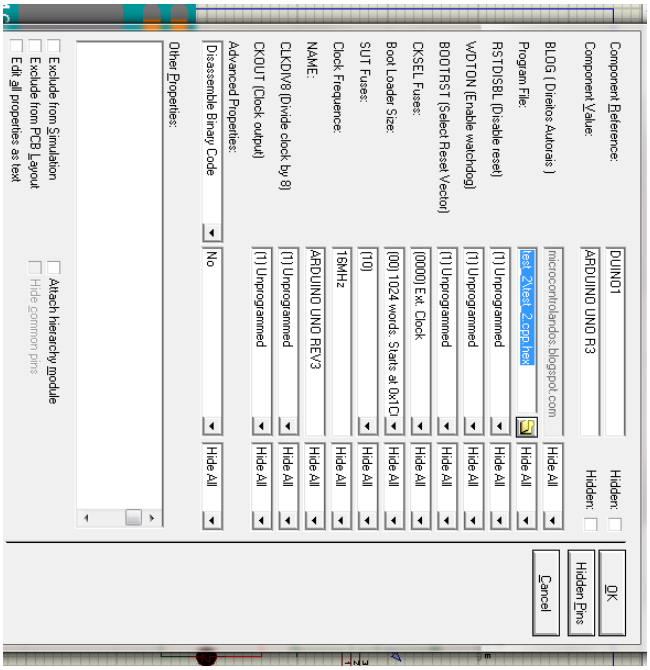

Fig. 15 program stored in the Arduino

First, we run the program. Then, we change heat sensor readings, and on the basis of comparisons, a microcontroller defining the type of outputs (Display, green light, red light, alarm clock, signal wire connected to the separation circuit of a transformer and fan) as shown in fig. 16.

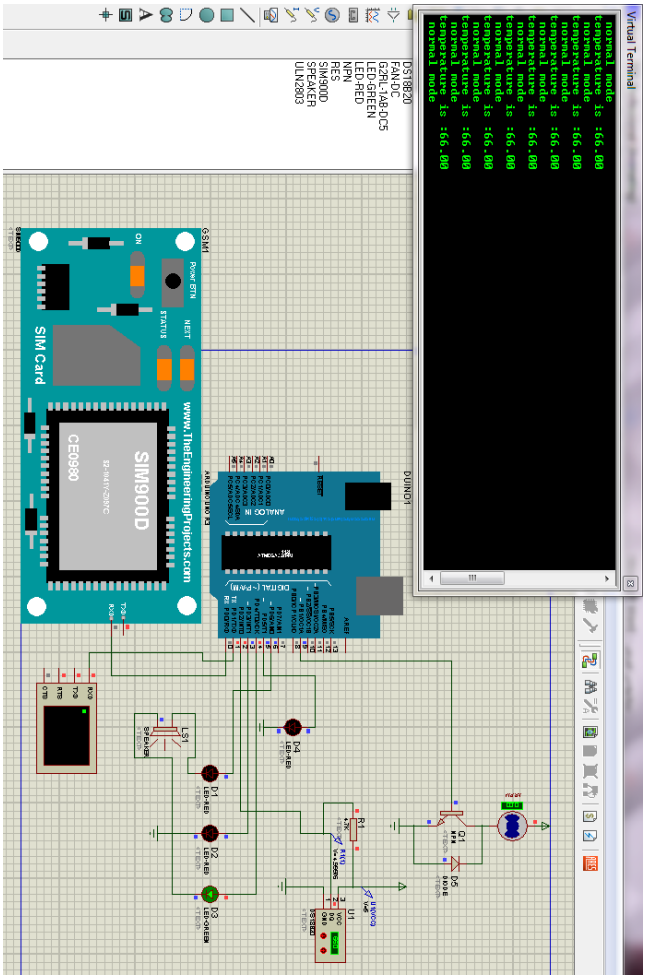

Fig. 16 the change in heat sensor readings

The input is displayed from heat sensor on the display screen over a four comparison stages:

1. Normal heat mode: In this part of the comparison, a temperature will be between (0, 70) centigrade degree. In this period, the microcontroller function is to run green lighting with momentary display on-screen of heat degrees that coming from the sensor. This situation is shown in fig. 17.

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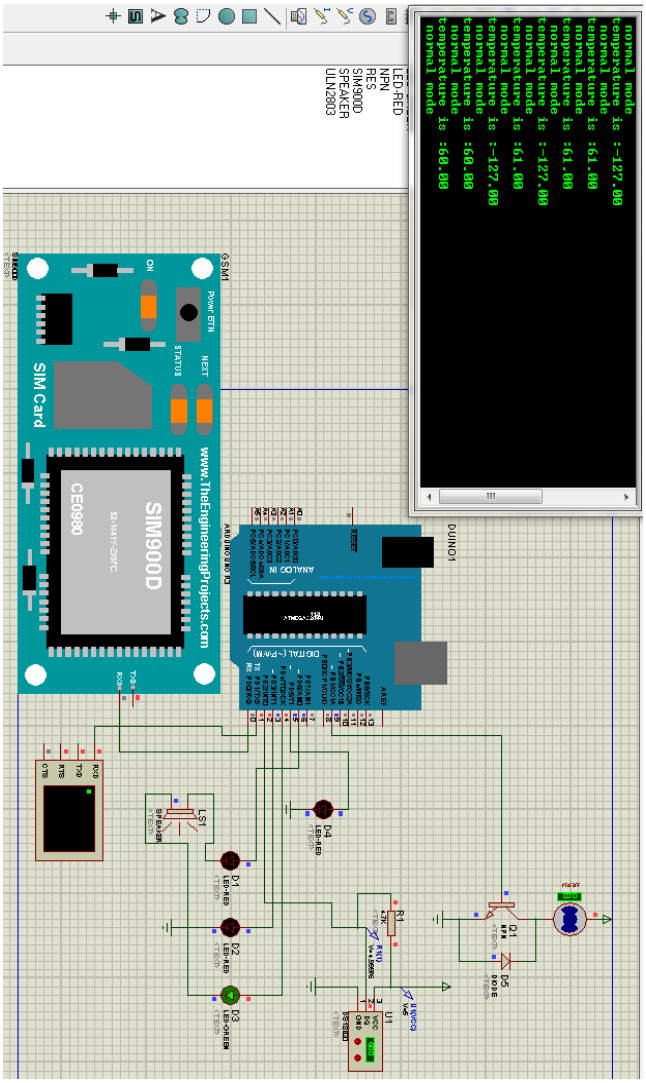

Fig.17 Normal heat mode stage

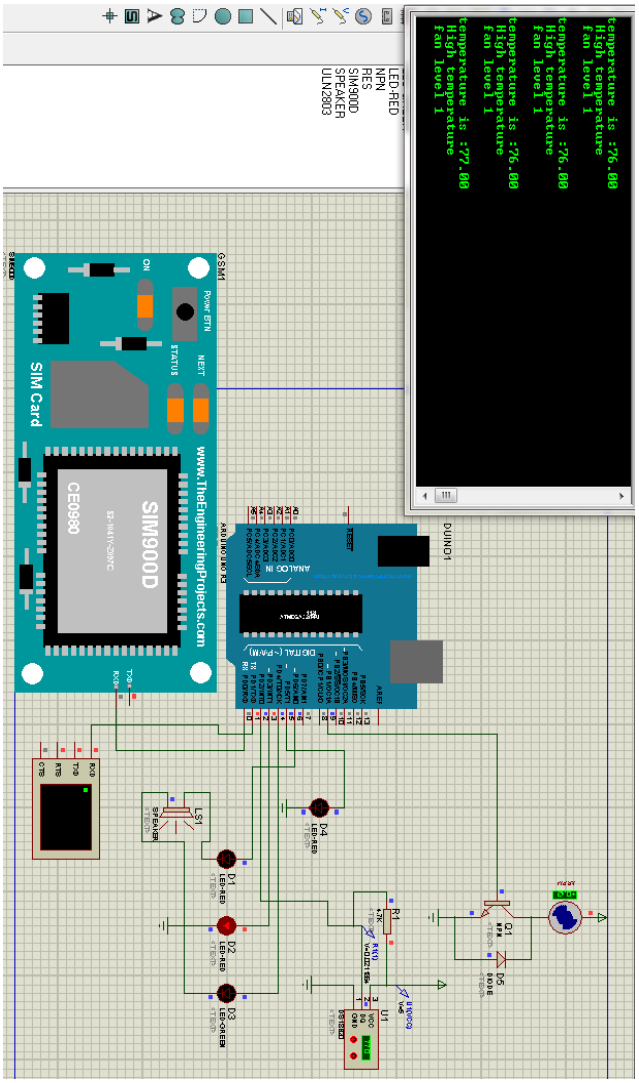

Fig. 18 High temperature stage

2. High temperature: In this part of the comparison, a temperature will be between (70, 80) degrees Celsius. In this period, the microcontroller function is to separate the green lighting and replace it with red light. As well as running the fan on the first level with an instantaneous display of temperature on the screen. Fig. 18 represents this situation.

3. Very high temperature: In this part of the comparison as shown in fig. 19, a temperature will be between (80, 90) degrees Celsius. In this period, the microcontroller function is to continue the red lighting as well as running the alarm clock. Also, the fan will be run on the second level.

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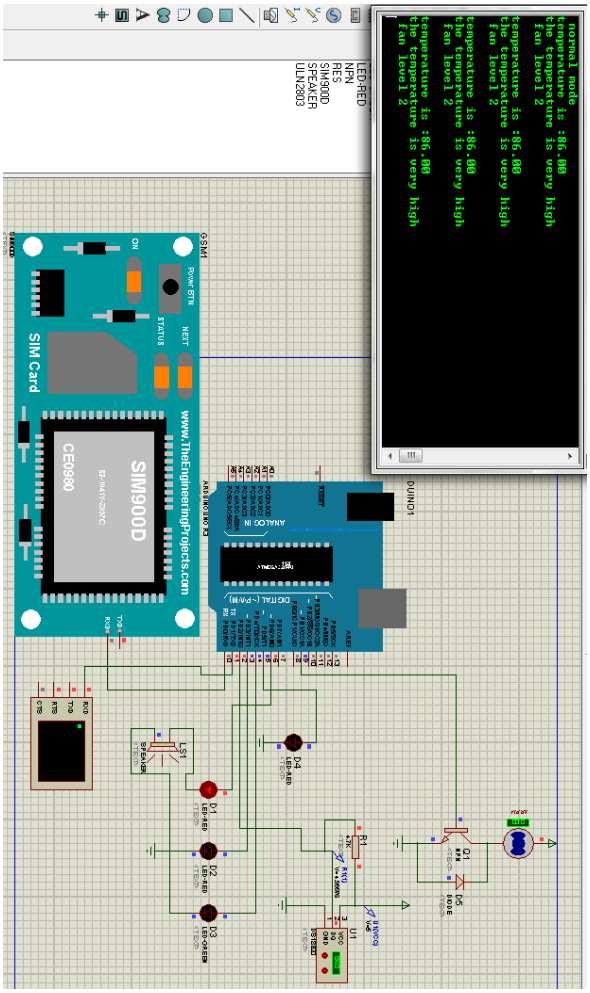

Fig. 19 Very high temperature stage

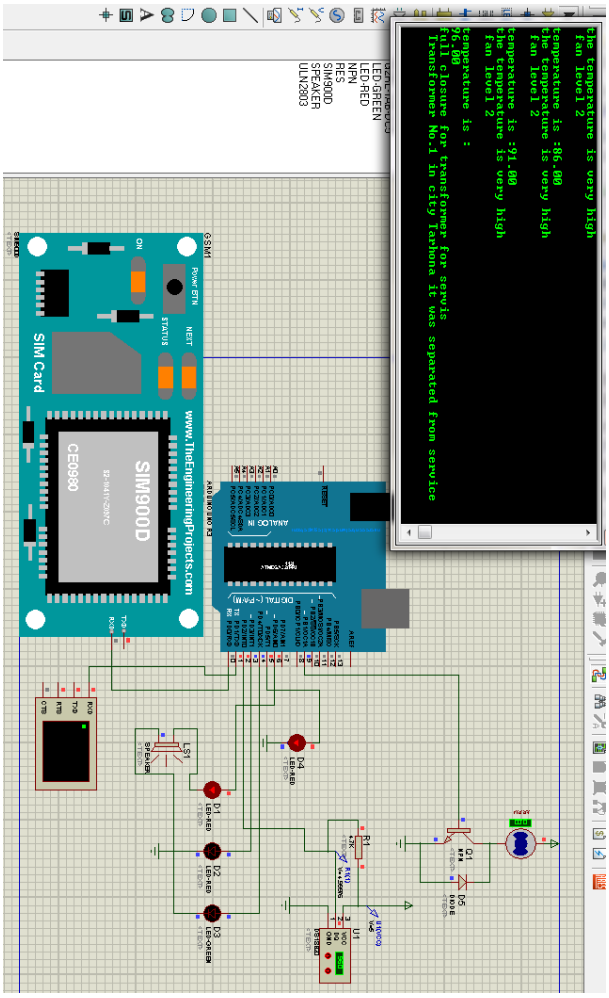

Fig. 20 Full closure of transformer

4. Full closure for transformer for service: In this part of the comparison, a temperature will be between (90, 100) degrees Celsius. In this period, the microcontroller function is continue to turn on the red light as well as the alarm clock and the fan on the second level until the temperature reaches 95 degrees Celsius. Thereupon microcontroller will send a signal pulse to the line which will be linked to the separation circuit of a transformer (Off-duty). Also, the microcontroller works on extinguish the fan and the alarm will work continuously. Finally, a message will be sent by GSM. This stage is shown in fig. 20.

V. CONCLUSIONS

Smart cooling circuit has been designed in the paper. Depending on this design, and after using this system on transformers. The transformers was kept from the unwanted rise in temperature and the risk of damage due to the large error rate in the mechanic sensor Balbakhluz. These errors caused a combustion of several transformers which commissioned the General Electricity Company in Libya huge sums of money.

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