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RESEARCH ARTICLE

DESIGN AND FABRICATION OF A LABVIEW AUTOMATED COMPUTER-BASED FIRE FIGHTING SYSTEM

D.K. Ketui*, Dr. P. Karimi and Dr. A.S Merenga

Kenyatta University, School of Pure and Applied, Science, Department of Physics, Nairobi, Kenya.
P.O. Box 43844-00100

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ABSTRACT

Fire detection, control and notification at early stages are of great importance as human life and property is concerned. In this paper we report the design and fabrication of simple, cheap and reliable computer based fire fighting system for use at homes, offices, supermarkets, schools among others. The system comprised of fire detection units made of smoke and temperature sensors, computer display unit, actuators, Bluetooth and GSM networks. Systems functionality was tested by introducing smoke and raising temperature of the surrounding beyond a set threshold levels. With smoke introduced, sensors were activated within 5-10 seconds while with temperature sensors activation took 5-20 seconds. Fire scenes were displayed by the computer 5seconds after detection and respective sprinklers triggered 10seconds later. Bluetooth enabled mobile phone interfaced to the Bluetooth enabled computer via Bluetooth network was able to send a short preset text message to a target remote mobile phone connected to it through GSM network within a period of 60-70 second. With extinction of fire components, respective sprinklers were automatically switched off by the system.

INTRODUCTION

An automatic fire detection and notification system plays a major role in the early detection and response to fire [1]. Many people have been losing their lives and property due to fire accidents more so when fire is not detected at its early stages of development [2]**.** In order to address this issue, reliable and cost effective fire detection, control and notification systems are required. However installations of commercially available systems are usually costly for ordinary low income earners. Currently, fire detectors are based on components of fire produced during burning. These components include smoke, temperature, gas and flame among others [3]. Despite the high false rate of smoke detectors [4, 5], they are still the cheapest and most effective detectors for early fire [6]. Temperature sensors on the other hand are more accurate but take long time to respond to fire. Its response occurs normally after great destruction has been witnessed. Combination of both smoke and temperature sensors will thus provide a more intelligent fire alarm system [7]. With advancement of technology in 20th -21st century different components such as sensors, mobile phones, audio alarms and firefighting equipments among others can be interfaced to the computer for automatic control [8]. Programming languages that enhance real time device control are also available. These include Labview, C, C++, C#, FORTRAN, JAVA. Labview is a graphical programming that uses graphical icons which are easily identified by quick visual inspection than text based programming language [9, 10].

**Corresponding author: dketui@yahoo.com*

This feature makes it more advantageous for instrument control over other programming languages. In order to enhance notification on fire emergencies to the corresponding personnel's including fire departments and the owner of the premise, mobile phone connected to GSM network can be interfaced to the computer to send short text messages to them. In this paper, we report the design and fabrication of an automated computer based firefighting system. The system detect smoke or/and temperature beyond some set threshold levels thus switching on the respective sprinklers and sending 9 preset short text messages to target mobile phone(s).The controlling software for the system was designed using Labview which is the leading graphical tool for science engineering and development [11]. Block diagram of the whole system is shown in figure1. It is compost of two main parts namely the software and hardware.

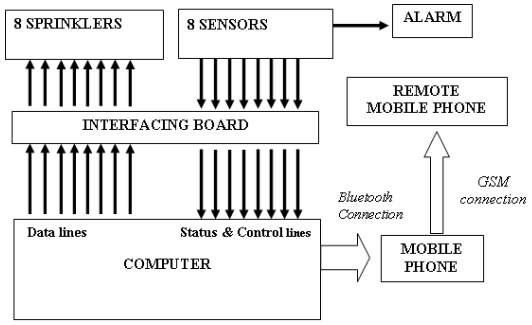

Fig. 1. Block diagram for the computer based firefighting system

Experimental procedures

Hardware

The hardware designed in this system were the sensors and interfacing board. Sensing circuit shown in figure 2 was powered by 9 volts power source while interfacing board's circuit shown in figure 3 was powered by 5 volts. Smoke sensors employed the use of a light dependent resistor (LDR) while temperature sensor used LM 35 IC. Light emitting diode (white LED) was set to shine light continuously onto the LDR. When smoke passed between LED and LDR light intensity reaching LDR reduced leading to sudden rise in voltage at the output of the sensor triggering the audio alarm and sending a high voltage to interfacing board that link the analog sensors to the computer. This board accommodated a maximum of eight inputs and 8 outputs to the computer through the parallel port (Status and control lines pins 1,14,16,17,15,10,11, and 13). Designed temperature sensors were set to trigger when temperature of the room reached 57^{o}C. Both sensors were then integrated to form a single unit sharing the same power source.

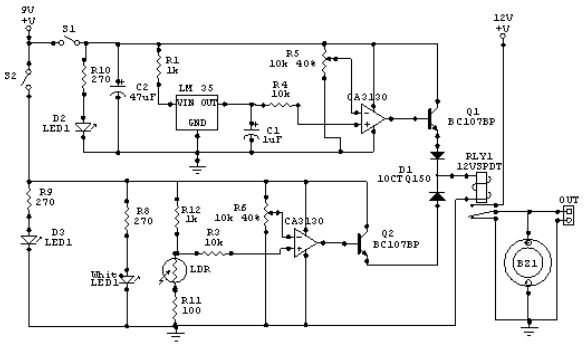

Fig. 2. Schematic diagram for the combined temperature and smoke sensors

Software

In order to facilitate communication between computer and the hardware, systems software driver was designed in Labview together with mobile phones attention (AT) commands. AT commands were used to command a Bluetooth enabled mobile phone to send preset short text messages (SMS) to target remote mobile phones through GSM network whenever fire was detected. Labview software consisted of the front panel and the block diagram shown in figure 4 and 5 respectively. Front panel contained buttons and indicators which were the interactive tools for the user [11]. On the front panel shown in figure 4, the lower most 8 green buttons like were the indicators that showed the rooms in which fire was detected. At the left upper part of the panel was a white space (Enter main Number to SMS) provided to the user to enter the mobile number of the fire fighting department that receives SMS in case of fire detection. The space labeled Bluetooth serial port allowed one to select the virtual serial port assigned by the computer to Bluetooth enabled mobile phone by clicking its pull down arrow. The rest of the 8 white spaces on the right were allocated to any other relevant personnel that had to be informed. At the right upper most corner of the front panel was a button that allowed one to manually abort the execution of the codes by clicking. Block diagram in figure 5 was made of five rectangular boxes. At the left part of the block diagram was an icon of a sub VI that configured the status and the control port for data input and read the port twice at five seconds interval to confirm if both inputs were equal and greater than zero in order to execute the rest of the codes. If the second reading was zero the program repeated itself until the condition above was met. This feature was provided to reduce false alarming and activation of the sprinklers when not necessary. The two innermost boxes were stacked sequences having the codes that send short text messages to various recipients including the fire department. The third innermost rectangular box was a case structure that executed all the codes inside it when the value read from the parallel port was not "0" (indicating presence of fire). The second outermost stacked sequence contained the code that activated the sprinklers corresponding to the data read from the parallel port.

Bluetooth

In order to enable the sending of short text messages to the target remote mobile phones, Bluetooth enabled mobile phone was paired with Bluetooth enabled computer. However for computer which did not have inbuilt Bluetooth, Bluetooth dongle was attached to it. Successful pairing of the two devices was achieved when the two were separated by a radius not more than 10 meters. To pair the Bluetooth mobile phone with the computer, Bluetooth icon in "*my computer"* as in figure 6 (for windows XP Service Park 2) was double clicked to opens up window shown in figure 7. From the Bluetooth tasks, "*Add a Bluetooth Device* "was clicked. When this was done a wizard shown in figure 8 was opened. Instructions from the wizard led to pairing of the Bluetooth phone with the computer through a virtual serial port that computer assigns to the device when paired. Computer thus assume to be sending data serially to the mobile phone through the assigned virtual serial port. Figure 9 shows the photograph for the designed computer based fire fighting system.

RESULTS AND DISCUSSION

When all the components of the system had been assembled with Bluetooth in both the computer and the mobile phone enabled and paired, virtual serial port assigned by the computer to the Bluetooth mobile phone was selected by clicking the pull down arrow shown in the front panel (labeled Bluetooth serial port) and the mobile numbers that were to receive SMS alert were entered in the spaces provided and the software run. Provided no smoke was introduced to any of the sensors, computer constantly read zero from the parallel port and all indicators remained green. However when smoke was introduced in some of the sensors in form of smoldering papers, alarms were initiated by the respective sensors within a period of 5-10 seconds and the computer read a value corresponding to the sensors containing smoke.

This in turn led to execution of the code making respective indicators on the front panel to turn red five seconds after alarms initiation as was programmed. In the next 10 seconds sprinklers were activated which sprinkled water on the smoldering papers putting off the burning papers. Within a period of 60-70 seconds all the 9 preset short text messages were send to the respective recipients bringing the end of the first cycle of program execution.

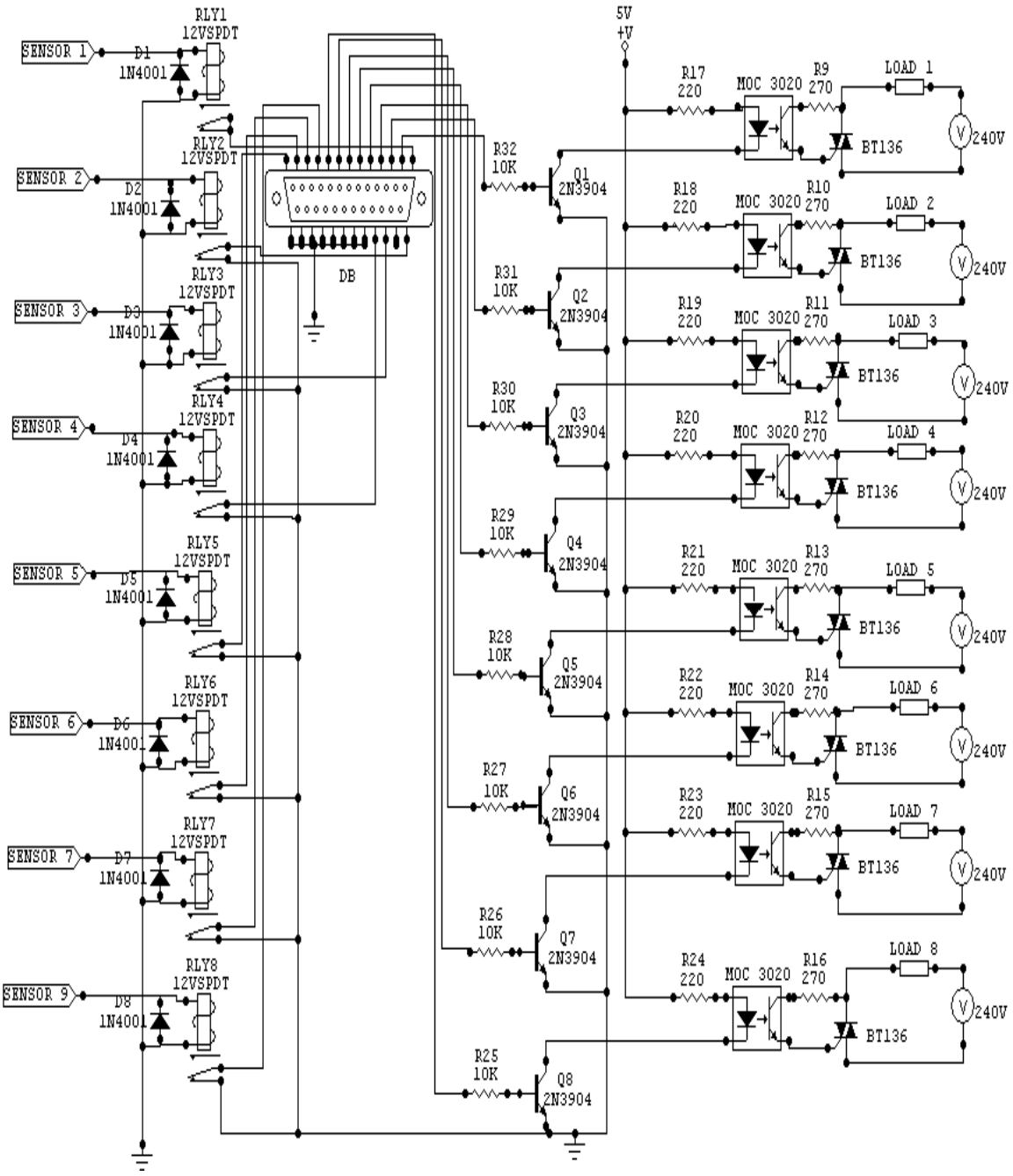

Fig. 3. Schematic diagram of an interfacing board showing how sensors and actuators were interfaced to the computer through computer parallel port

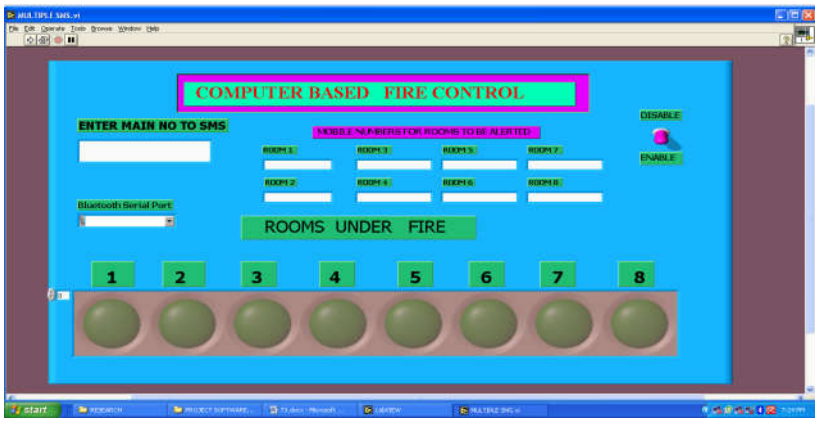

Fig. 4. Front panel for the designed firefighting system

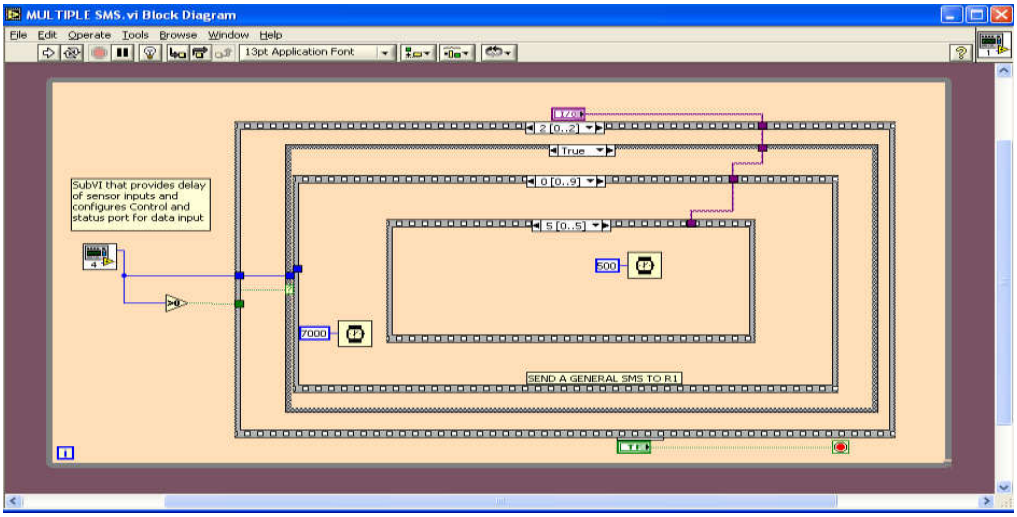

Fig. 5. Block diagram for the designed fire fighting system

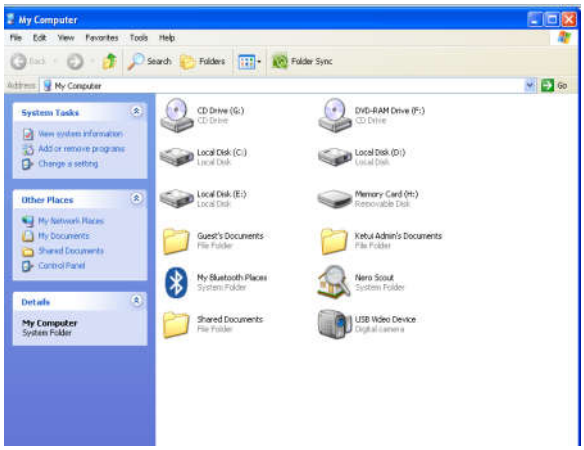

Fig. 6. Bluetooth icon displayed in windows XP Service Park 2

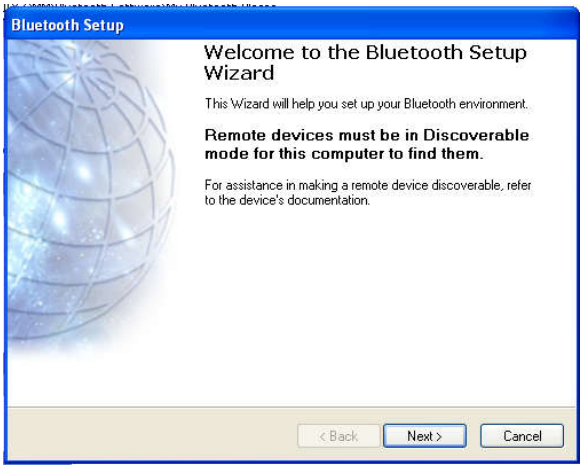

Fig. 8. Bluetooth set up wizard

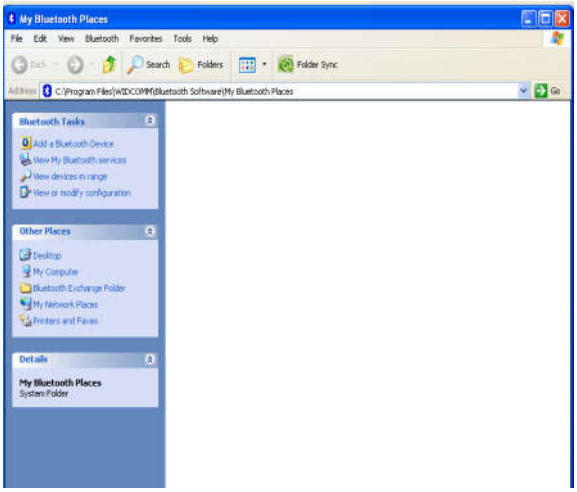

Fig. 7. Bluetooth window for my Bluetooth places.

Fig. 9. Photograph for the designed firefighting system

With feedback mechanism the second cycle starts and with sensors alarms off sprinklers were turned off in the 10th second of the second cycle as shown in figure 10. Front panel in figure 11 shows rooms that were detected to be on fire i.e. rooms 1, 3 and 4. The corresponding short text message that was sent to the target remote mobile phones read *"Rooms 1, 3 and 4 on fire"* as shown in the recipients mobile phone of figure 12 . To test the response of temperature sensors to fire components, 100W bulbs were placed below the sensors. Alarms from the sensors were initiated within 5-20 seconds followed by activation of the sprinklers corresponding to

activated sensors in the next 10 seconds as was programmed. Sending of text messages was achieved within a similar period to that of the smoke sensors as this depended on the computer program.

When 100W bulbs were withdrawn after activation of the sprinklers alarms stopped within 20-50 seconds as depicted from the graphical representation of figure 13. Temperature sensors were then found to respond slower than smoke sensors. This could be attributed to the slow rate of heating or cooling of the sensing elements. However the combined sensors showed great deal of magnificence.

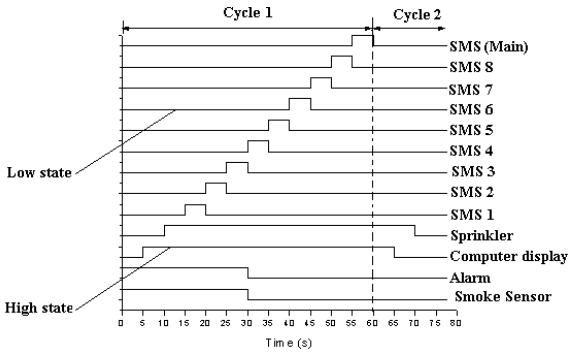

Fig. 10. Graph showing system response to smoke

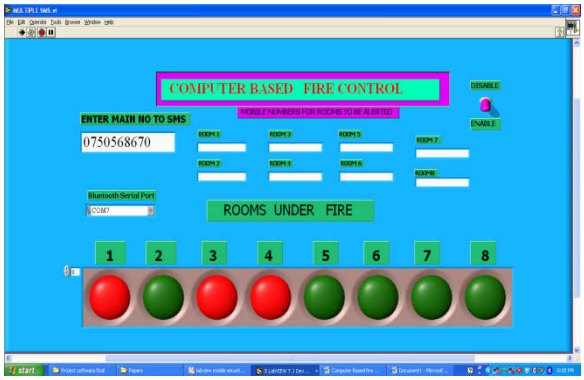

Fig. 11. Front panel for the designed system in the run mode showing rooms 1, 3 and 4 to be on fire

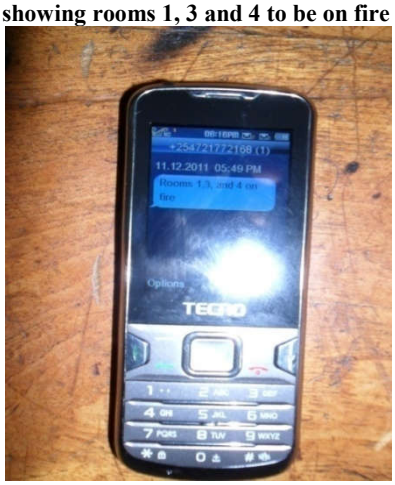

Fig. 12. Target remote mobile phone showing the short text message received from the firefighting system

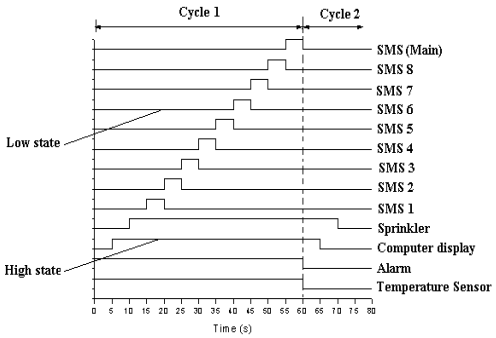

Fig. 13. Graph showing system response to temperature

Conclusion

In this paper we managed to design and fabricate a cheap automatic computer based fire detection, control and notification system. The system responded well for the two fire parameters (smoke and temperature). Temperature sensors took longer time (5-20 seconds) to respond to change in temperature of the surrounding than the smoke sensor which took 5- 10 seconds. This was attributed to the slow heating or cooling of the sensor components. The triggering on and off of the sprinklers worked well as was programmed. Sending of the short text message was also achieved as expected. With the use of different extinguishing agents the fabricated system can be used to control fire in places such as offices, homes, schools, supermarkets and data center. The system may further be improved by making sensors which tolerate very high temperature and immune to dust and vapor.

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