Multi-Functional Microcontroller Based Monitoring, Alarming and Protection System

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Abstract
The sides of security, health & safety, and energy saving are more focused in home and industrial locations. Many studies in different objective of these sides are proposed to have engineering solutions. Almost of solutions are focused on remote wirelessly monitoring function. However, this type of monitoring have slowly response in case using for activating of controlling or protection function for the same parameters which under wirelessly monitoring. To have quick response of manipulation process for any physical parameter, and to have efficient energy saving as well as secured system; this paper proposes a locally individually monitoring, alarming, and protection electronic system. The design of the presented system adopts microcontroller unit to do the required activities. The system uses different types of detectors based on the type of physical phenomena which need to system functions. The proposed design the effectiveness of promising system which can be suitable for home and industrial locations.


INTRODUCTION
In last decades, the factors of health and safety requirements and energy saving in residential and work places that have highly attention in research studies for guarantying better life conditions as well as reduce the extra power consuming which loss due electric power misuse. For these objectives, different research studies including home automation proposals were presented. Remotely wireless monitoring, and/or protection systems are also proposed for home or industrial locations for the same reasons. A developed smart system for detachable wireless sensing and environment monitoring functions is proposed in [1], a peripheral interface controller PIC microcontroller with detachable smart transducer in addition to wireless communication XBEE are implemented. The proposed system is characterized by ideality for distributed environment wireless monitoring application.

The study of [2] focused monitoring levels of temperature, smoke, and alcohol of a green house. The area of the house which under study was secured in the proposed system through using Radio Frequency Identification (RFID) to give authentication to enter into limited premises of secured areas. The system includes LCD display to show the current values of the parameters under test, the system includes also buzzer part which turn ON at the over levels of smoke and alcohol in the area under test. A related user mobile will receive automatically the case information through GSM module. In [3], a microcontroller based system is proposed for continuous monitoring of soil moisture, temperature, and an infrared thermometer records. Three types of sensors namely soil moisture sensor, temperature sensors, and a digital infrared thermometer all are used to in the presented system to have high data collection reliability and high level of storage data.

Functions of continuous monitoring, buzzer alarming, turning off gas valve, and wirelessly security alerting via GSM modem all presented through the work of [4]. The introduced system is starting by array of distributed gas sensors for gas leakage detection and entering the instantaneous data to the microcontroller unit that to analyze and making the suitable decision then through Zigbee technology transfer signal wirelessly. In [5], Ziyu Liu works on doing automatically controlling function to the methane tank that for energy source controlling through control the output gas concentration of methane. The proposed system is done based on PIC (Peripheral Interface Controller) microcontroller. The input data of temperature and gas sensors are analyzed through the designed algorithm which programed in the microcontroller. Based on the currently levels of parameters under test, the suitable decisions will be made on the gas value switching state.

An automatically Liquefied Petroleum Gas (LPG) leakage detection, monitoring and wirelessly alarming system that is proposed in [6]. The system is planned to work in vulnerable areas for gas leakage stopping. The system includes LPG sensor, microcontroller unit, LED and buzzer alarm. The system in [6] also works on doing alerting messages to the related customer’s mobile phone through GSM module. In research study of [7], Li-Chien Huanga, et al., present design, and implementation steps of a monitoring and protection system. the system was able to do protection mechanisms to traditional power distribution systems that to have enhancement in the system functions through dynamically setting the overload outlets limit. The system is also able to do temperature control for self-protection function to the electric outlet for fire prevention. The work in [7] offers also wirelessly communication for remote monitoring and protection through ZigBee pairs. In addition to the mentioned, the system improves the security and intelligence actions which needed to the traditional power distribution systems.

The work of [8], proposes a developed Wireless Data Acquisition System (WDAS) for monitoring function to a
certain weather station. The physical connection between emitter and receiver is removed through the presented system. A set of sensors are designed to use in the system for sensing functions to different factors which are namely solar radiation, pressure, wind speed, wind direction, humidity, fall rain, and temperature. A précised electronic conditioning circuits are designed to the collected data and then through wireless unit, the data interfaced to a PC via RS232 connection. The collected data demonstrated on the computer by using LabVIEW program for more flexibility in the data processing. The proposed system offers the measured data to any used via internet on-line.

Other studies in [9] – [16] are also focus on monitoring, analysis and/or remotely controlling to many parameters of electrical distributed AC and/or DC loads such as load voltage, load current, and load transferred power. These research studies are adopting different wireless methodologies based on the related objectives. The research studies in [17]-[19] are also proposed monitoring and controlling function systems based on discrete electronic components design.

To avoid any delay in decision making which may happened due remote wirelessly data monitoring and analysis, and to avoid any probability of stopping online information which may doing negative consequences, as well as to have highly response integrated detection, monitoring and protection system. This paper proposes an integrated system investigate the mentioned protection functions through locally and individually activities. The presented work adopts locally system design which avoids using wireless data communication module and using only array of sensors, microcontroller unit, and array of relays out.

PROPOSED PROTECTION SYSTEM

The proposed system focuses on presenting high response integrated electronic monitoring, alarming, and protection functions. The system design offers sensing function to the many important parameters of two sides in homes and/or industrial locations. The two sides are represented by health and safety side and energy saving side. Figure 1 shows main block diagram of the proposed system, the design includes three stages; input stage, microcontroller unit stage, and output stage. The parameters under test included in the first stage that are namely RFID, LPG, temperature, humidity, smoke, and darkness, these parameters are sensed in different ways based on the adopted type of selected sensor. Some sensors are producing analog voltage within a certain range, while other sensors produce signals in digital forms. The detected values are entering microcontroller unit from correct analog or digital input terminals. Input data will be analyzed inside microcontroller unit make suitable decision for each output terminal of the third stage of the system. The last stage (third stage) includes 6 digital outputs which are used to activate separately the required action through switching ON or OFF to the related relay.

Figure 1. Main block diagram of the proposed system

INPUT STAGE OF PARAMETERS DETECTION

This stage is responsible on data collecting of the desired parameters, the type of data is determined based on the work principle of each sensor, for example RFID reader produce a string of numbers, LPG detector and smoke detector both produce analog voltage with different ranges and different voltage changing rate, darkness detector produce digital voltage in high or low logic level as indication result for night or day time respectively, and so on.

A. Radio Frequency Identification (RFID) Reader

RFID reader is an integrated circuit printed board designed and manufactured for doing the function of cards identification through sensing the radio frequency signaling and produce a limited string of two voltage levels. When RFID reader connected to the micro controller unit (the selected MC in the proposed design is Arduino Uno micro controller), the related string tag code of the used card will be sensed and used in programming for comparing with stored strings of a certain allowed persons cards for security purposes as will be shown later in this paper. As shown in Figure 2, the selected RFID reader in the proposed system design is ID-20LA [20], [21] which has longer sensing distance than the other two RFID readers ID-12LA, and ID-3LA.

Figure 2. RFID Reader; (a) Type ID-20LA RFID Reader, (b) RFID USB Reader

B. Liquefied Petroleum Gas (LPG) Detector

MQ-6 is a selected gas leakage detector [22], [23] in the presented design, the desired specifications of the detector are
high sensitivity to LPG leakage, iso-butane, propane, and on the other hand, the selected LPG detector has small sensitivity to alcohol, and smoke. Figure 3 shows sensor physical view and wire connection. A simple drive circuit is required to connect with this detector for accurate response for producing analog voltage range proportional with ambient LPG gas concentration. The sensor is also characterized by high, stable response. Detector has a big range of resistance variation with respect to the gas concentration. The suitable series resistor value is 20 kΩ as shown in Figure 4.

Figure 3. MQ-06 gas detector; (a) physical view, (b) wire connection

Figure 4. MQ-06 detector drive circuit

C. Temperature and Humidity Sensor
The two parameters of temperature and humidity are incorporated in one sensing device; the name of this device is Digital Temperature and Humidity sensor RHT03 [24]. The selected capacitive type sensor is characterized by full temperature range compensation, high precision, relative humidity and temperature measuring, producing digital signal, outstanding stability of long-term, do not need for extra component, low power conception, and transition distance up to 100 meters. The operating range of humidity is 0-100% RH with measuring accuracy is -2% RH (Max +5% RH) while resolution or sensitivity humidity 0.1% RH. The operating range of temperature is -40~80 Celsius with accuracy +-0.5 Celsius and the resolution of measured temperature is 0.1 Celsius. The sensor produce 40 bits for each measuring sample of temperature and humidity, these 40 bits are divided in a certain sequence to represent the two parameters as shown in the sample example below. Figure 5 shows physical view, and wire connection of the digital temperature and humidity sensor RHT03. Sample example [24]; micro controller unit has receive 40 bits sample from the sensor circuit;

0000 0010 1000 1100 0000 0001 0101 1111 1110 1110 16 bits for RH data 16 bits for T data check sum
Check sum = 0000 0010 + 1000 1100 + 0000 0001 + 0101 1111 = 1110 1110
RH = (0000 0010 1000 1100)/10 = 65.2% RH
T = (0000 0001 0101 1111)/10 = 35.1

In case the highest bit of temperature is 1, it means the temperature is in minus Celsius degree; For example, let 16 bits T data: 1000 0000 0110 0101, T = minus 10.1

Figure 5. Digital Temperature and Humidity sensor RHT03; (a) physical view, (b) wire connection

D. Smoke Detector
MQ-7 is a selected smoke detector [25], [26] in the design of proposed monitoring and protection system. MQ-07 is characterized by high sensitivity to carbon monoxide, stable and long working life. Figure 6 shows physical view of the detector and standard connection circuit. The selected detector is able to detect CO-gas concentrations in range of 20 to 2000 ppm at open or close locations. The output voltage of the detector is analog voltage with range proportional with smoke concentration, the work principle is represented by variable resistor with resistance range, and to have big range the suitable series resistor is 10 kΩ which explained in Figure 7.

Figure 6. Smoke Detector MQ-07; (a) physical view, (b) wire connection

Figure 7. MQ-07 detector drive circuit
E. Darkness Detector

Darkness detector is represented by light Dependent Resistor (LDR) which is a photo-resistor or a variable resistor with value inversely proportional with incident light intensity increment [27]. The principle of LDR is reducing the element resistance when increasing the intensity of incident light. For the suitable detector circuit connection, a series resistor is necessary for voltage divider and consequently produces an analog voltage range with a certain instantaneous value based on the instantaneous incident light. Figure 8 shows the physical view of LDR and the detector circuit connection while Figure 9 shows the behavior of LDR resistance with respect to the incident light intensity.

![Figure 8](image1.png)

**Figure 8.** Light Dependent Resistor (LDR), (a) physical view, (b) wire connection

![Figure 9](image2.png)

**Figure 9.** Behavior of LDR with respect to the incident light intensity

### MICRO CONTROLLER UNIT

The selected micro controller unit for the proposed design is Arduino Uno which is an electronic integrated board designed and manufactured for a simple hardware and software implementation process in the projects of micro controller based. As shown in Figure 10, Arduino board includes 14 digital terminals which can be programmed individually as input or output terminal. Arduino board also includes 6 analog input terminals for receiving analog voltages with 10 bits levels of analog to Digital Converter (ADC) levels which represent different analog phenomena [28].

![Figure 10](image3.png)

**Figure 10.** Arduino Uno terminals explanation

In this paper, Arduino Uno is design to receive three analog voltages Ai1, Ai2, and Ai3 which representing LPG gas leakage detector output voltage, Smoke detector output voltage, and darkness detector output voltage respectively. The selected micro controller unit is designed also to receive three digital input voltages Di1, Di2, and Di3 which representing temperature, humidity, and RFID reader respectively. The proposed design in including five digital output terminal Do1, Do2, Do3, Do4, and Do5 which representing gate opening relay for RFID reader responding, gas valve closing and gas leakage ventilation relay for LPG gas detector responding, air conditioner switching ON relay for temperature and humidity detector responding, fire alarm activation relay for smoke detector responding, and light switching ON relay for darkness detector responding.

Figure 11 shows the flowchart of the design algorithm to do the monitoring, alarming and protection functions through the proposed system. As shown in Figure 11, the flowchart started by setting the delay time of gate opening as a response to the RFID reader for the case of authorized person. Other settings of the other parameters acceptable levels also entered at first step of the flowchart. The next steps are entering the instantaneous values of each parameter and doing comparison with setting levels then make suitable decision sequentially and repeat the process of entering, comparing, and doing the suitable activity based on the instantaneous state of each parameter.

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CONCLUSION

In this paper, a locally and individually activities manipulation process are proposed through presenting a microcontroller based system, this system is working on monitoring, alarming and protecting the related location properties and peoples. The presented system in this paper is characterized by quick response for its offered functions as well as responsibility for many physical parameters in the working time. The presented system through the design is focused on security side by RFID reader for the tag code and make decision of gate open or not. Other parameters such as LPG gas leakage, smoke detection, temperature increasing, humidity increasing, and darkness time, these parameters are under responsibility of the system let it promise an effective prototype.

REFERENCES


