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# A Multi-Purpose CO Poisoning Detection System using Mobile Phones

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***Abstract*—Carbon monoxide poisoning exhibits an inordinate danger to lives and health of people and all life forms. It is a highly dangerous, colorless, odorless and tasteless gas that can intoxicate people in a very short span of time. A statistics say that around 400 Americans die a year due to unintentional carbon monoxide poisoning.[1] Carbon monoxide poisoning has captivated a great threat through years. Some of these reported cases of death include physically and mentally challenged people, babies and infants.**

**A number of methodologies have been proposed to detect carbon poisoning in the past, but the most prominent conventional methodology of warning the user through an alarm based detection system seems to be ineffectual in some cases where the user is unaware of the alarm (in cases of babies, infants left behind in the car) or not being able to realize a possible threat, due to their disability, either physical deformity (deafness) or mentally challenged cases.**

**This project provides a solution to such cases by suggesting a multi-purpose detection system which makes use of latest technology, by implementing Arduino Uno R3 Microcontroller and Raspberry pi portable computer, to detect the carbon monoxide level, once the critical level is reached the end user is communicated through a warning text message. This system can be implemented in cars, houses and other places where remote monitoring plays a vital role and moreover, our primary target users who are disabled will be highly benefited and their lives can be saved by avoiding unintentional exposure to carbon monoxide gas, thereby reducing the death toll.**

***Keywords— Carbon Monoxide Poisoning, Warning Text Message, Remote Monitoring, Multi-Purpose System.***

## I. INTRODUCTION

Carbon monoxide (CO) is a colorless, odorless, tasteless gas that can cause sudden illness or death upon inhalation.[1] This gas due to its implicating characteristics is a potential hazard which basically starves all the organs, especially brain and heart of oxygen on exposure by passing the CO molecules into the bloodstream and easily binds with blood when compared to oxygen by forming carboxyhemoglobin (COHb), because the affinity of Hb for CO is over 200 times stronger than it is for oxygen. Thus, the percentage of total Hb in the blood that is in the form of COHb is a biomarker of CO exposure.[2]

Treating CO poisoning may be a difficult task. Symptoms may include headaches, dizziness, tiredness, flue-type symptoms, nausea and even loss of consciousness.[3] Carbon monoxide (CO) emission from vehicles and other external sources like incomplete combustions of fossil matters, wildfires etc., affects the environment. Even, an unintentional CO leakage not identified properly, from on-road vehicles or refrigerators impacts directly on human health and may even result in death, if inhaled on higher proportions. This may happen in few minutes time. For these reasons, Carbon Monoxide (CO) is often known as the "Silent Killer". All the people are at high risk for CO poisoning especially unborn babies, infants and people with chronic heart disease, anemia, or respiratory problems are more susceptible to its effects.[1]

Each year, more than 400 Americans die from accidental CO poisoning, more than 20,000 visit the emergency room and more than 4,000 are hospitalized due to CO poisoning.[1] There are many news reports reporting identified and non-identified deaths due to carbon monoxide poisoning in Australia, which triggered some rigorous campaigns from the part of governmental and non-profit organizations.

In order to overcome this imminent threat, we are proposing a multi-purpose control system which not only detects but, alerts and help the user in controlling the CO affected environment.

## II. DRAWBACK OF CO DETECTOR ALARMS

The traditional methodology of alerting the user through alarm trigger when the threshold CO level has reached not only warns the user but also helps them to evacuate the CO exposed area to a safe zone where immense level of oxygen is available. Although, it is hugely useful for most of the people, but still lack its effectiveness under certain specific condition. For the challenged people who are physically or mentally disabled this CO alarm system seems to be ineffective mode of communicating or alerting system as they won't be able to respond to any CO poisoning threats. Thus it would be a non-beneficial system as it lacks its true purpose for these set of people under particular scenario.

This would definitely put their lives into great danger, as the alarm trigger would either be unnoticed by the victim or unresponsive position because of their disability. In the early 2014, three people (Father, Mother and their handicapped son) in a family found dead near Brampton due to CO poisoning. Though their preinstalled home CO alarm was activated in the early stage, but their son was totally helpless as he needs special help to move himself to fresh air. [4] This incident

portrays the in-effectiveness of traditional CO alarm technologies which cost the death of three people. It is highly necessary to resolve this long term issue and save the lives of specialized children.

## III. PROPOSED SYSTEM

To overcome this issue, it is essential to alert the respective parents or the legal guardians who takes care of them .This work focuses on a CO detection system which detects the CO levels and on reaching the critical level, sends a text message to end user's phone i.e. parents or legal guardians in times of CO threats, based on user's number programmed. Also, the CO level is displayed on special LCD touch display. For this we utilize the following blocked sections,

1. Sensor module
2. Microcontroller unit
3. Raspberry pi PC
4. LCD display unit
5. Smart phone/Mobile phone

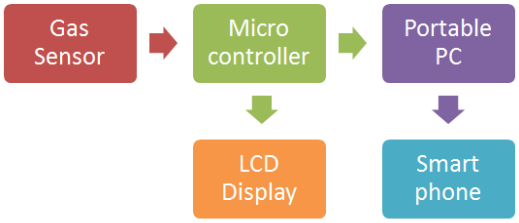


Fig. 1. *Block diagram* of the proposed system

### A. CO detection and control task - logic

The gas sensor detects the carbon monoxide levels and sends the data to the microcontroller, the sensor by itself operates in various phases, namely initial phase, heating phase (60 s) and cooling phase(90 s). The transitions between these phases are denoted through the LED lights. The microcontroller is programmed to continuously monitor the CO levels and once the critical level is reached necessary control actions are taken logically.

### B. Control actions of the system

1. Detect CO levels in analog value
2. Interpret the analog value to digital data and related PPM value
3. Send alert text message based on the PPM value
4. Continuously monitor the changes in CO levels using a LCD touch display

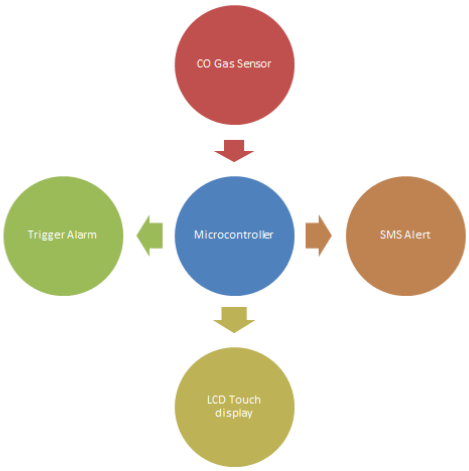


Fig. 2. Control actions of the proposed system

### C. Importance of the system

This system is even more effective and efficient when compared to the existing low level commercial detectors as the system uses a LCD display unit to show the CO levels, a portable computer to send warning texts, this eradicates the possibilities of CO poisoning in cases where the user in incapable of sensing an alarm.

### D. Areas of application

This system is a multi-purpose system which means it can applied in various places based on the requirements and needs.

- ***Cars*** are the primary field of application, where the LCD touch screen can give the continuous CO level monitoring feature and message can help save lives of infants, babies and disabled people or anyone in the car.
- ***Houses*** can also use this system to remotely monitor the CO levels and notifies the user on reaching the critical CO levels and uses the application to help control the CO affected environment.
- ***Industries*** can have the environment controlled by the system, a centralized alarm and various top personnel's numbers programmed CO poisoning can easily be prevented and controlled immediately.

## IV. FUNCTIONALITIES OF THE PROPOSED SYSTEM

The proposed system offers several distinctive functionalities that can improve the process of CO detection and monitoring to a new level, with simple variations in the circuit.

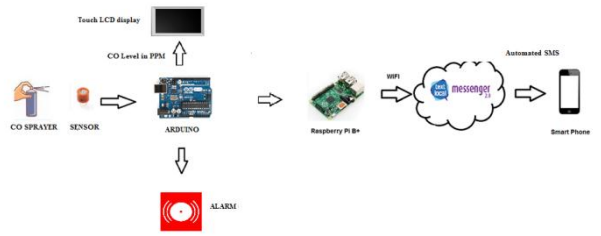


Fig. 3. *Summarized functional diagram* of the proposed system

### *A. CO Detection*

The gas sensor detects the carbon monoxide levels from the CO gas sprayed from the sprayer and sends the data to the microcontroller, the sensor by itself operates in various phases, namely initial phase, heating phase (60 s) and cooling phase(90 s). The transitions between these phases are denoted through the LED lights. The microcontroller is programmed to continuously monitor the CO levels.

### *B. Continuous monitoring of CO levels*

This is a feature designed to allow users to monitor the CO levels as the drive a car or in houses on a LCD touch screen. The sensed CO level is continuously transmitted to the LCD display, to show the critical CO level.

### *C. Automated message to single or multiple users'*

When the critical CO level is reached, the microcontroller calls the pre-programmed mobile number. There can be one or more than one numbers programmed as the end user. An automated message is sent stating that the critical CO level is reached and asking the user to take necessary control actions immediately. This is done, in order to make sure the end user is made aware of the imminent threat.

## V. PROTOTYPE

The prototype is basically developed using the Arduino microcontroller as the central brain, a raspberry pi computer to help process and send an automated warning text message, an LCD touch display providing interactive user interface to display the CO levels which in turn helps in monitoring the variation in CO levels.

### *A. ARDUINO*

Arduino is an open-source physical computing environment which is normally based on the microcontroller (AT-mega series) and it uses a software platform which is well-known as Arduino IDE to program various scripts and execute all sort of electronic projects. It consist of two main component[5]

- Hardware (At-mega microcontroller)
- Software (Arduino IDE- Integrated Development Environment)

To write and execute any program, the code has to be uploaded into the Arduino microcontroller. To achieve this, Arduino IDE software is used which is based on a simplified C++ programming version. A simple USB A – USB B cable is used to perform communication between Arduino and computer, which helps in uploading the program from the preinstalled Arduino IDE software from the computer or laptops. With all the above procedures, the program code can be compiled and uploaded to accomplish the targeted task.


Fig. 4. *Arduino Uno Board[5]*

Arduino reads sensor data from multiple sensors provides PWM, multiple digital pins for inputs and controlling the alarm and supports serial communication which played an important factor for choosing it as the center of this design.

### *B. SENSING CIRCUIT*

In order to achieve the long term stability and durability, a printed circuit board (PCB) is designed which is named as "Sensor circuit board". It is designed using the software tool well known as "Fritzing". Fritzing is an open-source software environment which is an easy-to-use approach where all users can creatively design their own electronic prototypes as how we connect the circuit in the breadboard. [6]

The main component of this sensing circuit is MQ7 gas sensor, which is an electro chemical sensor which consists of micro ceramic tube (AL2O3), Tin Dioxide (SnO2) that acts as a sensitive layer and a small heater. Its high sensitivity to gases like CO and long life, and high stability features, made this sensor as our primary choice for this work.[7]

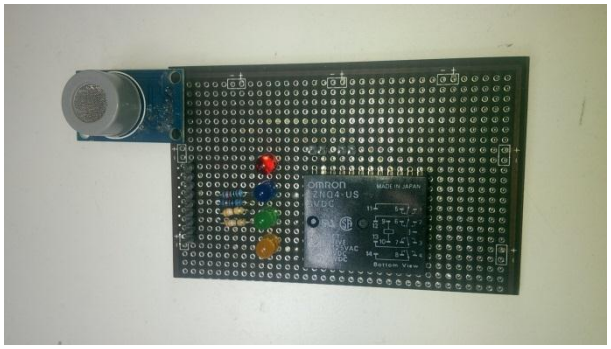

Fig. 5. *Sensor Circuit Board*

### *C. RASPBERRY PI*

Raspberry Pi is a cost effective, small sized portable PC which can be connected to Arduino via serial communication USB to TTL serial cable to create and send automated warning text messages to the programmed end users' mobile numbers.[8] Shell scripts and python scripts are used together to accomplish this task. We use a Edimax to provide Wi-Fi connectivity, which is essential for connecting the Raspberry pi with internet in order to interact with the online text messenger service, "TxtLocal" to send out warning text messages by using the API scripts.

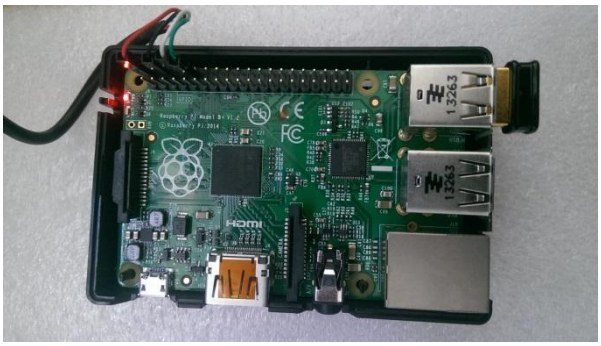

Fig. 6. *Edimax connected to Raspberry pi via USB port*

### *D. LCD TOUCH DISPLAY*

The 4D systems display unit is used to display the varying CO levels on the screen which can be placed inside a car, so that user can easily monitor the levels and also it provides other GUI functionalities which brings in user friendliness to the system.

Fig. 7. *uLCD-32-PTU Display*

## VI. RESULTS AND DISCUSSION

The CO detection system performs the detection and alert task as described below,

- As the MQ7 CO gas sensor periodically senses the presence of carbon monoxide in the atmosphere and analog output value goes to the Arduino input terminal.
- The Arduino converts the sensor analog value to the corresponding PPM value through proper sensor calibration. Also, it keeps track of the PPM and checks it every time, whether it exceeds the threshold PPM level.
- In the meantime, the raspberry which is serially interfaced with the Arduino UNO keeps looking for the notification about the CO poisoning.
- Once the carbon monoxide level goes beyond the predefined critical value, the Arduino sends a unique string to Raspberry pi which activates the alert SMS and send a warning message to the end user's mobile phone by which the end user will be aware of the situation and take necessary safety measures.
- Arduino displays the CO level on the LCD screen and triggers the alarm when critical level is reached.

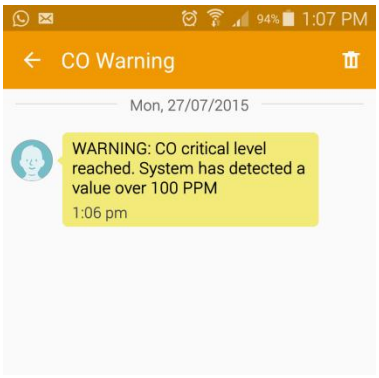


Fig. 8. *Warning Text Message*

## ACKNOWLEDGMENT

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## REFERENCES

[1] *Centers for disease control and prevention - faqs*. Available: http://www.cdc.gov/co/faqs.htm
[2] G. P. David, "Introduction to and Overview of the Field," in *Carbon Monoxide Poisoning*, ed: CRC Press, 2007, pp. 1-4.
[3] *carbon-monoxide-in-your-car*. Available: http://www.silentshadow.org/carbon-monoxide-in-your-car.html
[4] J. Yuen. (2014). *Parents, son dead in apparent carbon monoxide poisoning in Brampton*. Available: http://www.torontosun.com/2014/03/17/carbon-monoxide-kills-3-in-brampton
[5] (2009). *Arduino Uno*. Available: http://arduino.cc/en/Main/ArduinoBoardUno
[6] (2011). *Fritzing*. Available: http://fritzing.org/home/
[7] (2007). *MQ Gas sensors*. Available: http://playground.arduino.cc/Main/MQGasSensors
[8] (2013). *WHAT IS A RASPBERRY PI?* Available: http://www.raspberrypi.org/help/what-is-a-raspberry-pi/