THE MOBILE ROBOT DEVELOPMENT FOR AIR POLLUTION TELE DATA CAPTURE

Dirman Hanafi, Khairul Azlan A. Rahman
Advanced Mechatronic Research Group (ADMIRE), Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia, Batu Pahat, Johor, Malaysia
Email: dirman@uthm.edu.my

Abstrak *- In the Modern era, the environmental issues have given significant impact to the human live. The air pollution indoor and outdoor environment sometimes dangerous to the human health and it needs to be justified. To fulfill this purpose, in this research tele-measurement process and technique based on the mobile robot with equipped by several air quality parameters sensors is developed. The robot is controlled using remote control and wireless communication system. The air quality in target area will be monitored by using sensors which will capture data and send it to the Central Control (laptop) for analyzing. And then to be able to monitor the certain area investigation, the mobile robot is guided by using wireless camera. From the experimental test, the robot able move to target area, capture the area condition and the air parameters monitor.*

Keywords: *air pollution, tele-measured, mobile robot*

INTRODUCTION

Air pollution is the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or damages the natural environment into the atmosphere. The atmosphere is a complex dynamic natural gaseous system that is essential to support life on planet Earth. Stratospheric ozone depletion due to air pollution has long been recognized as a threat to human health as well as to the Earth's ecosystems. Indoor air pollution and urban air quality are listed as two of the world's worst pollution problems (Turner, 1994).

Air pollution has long been a problem in the industrial nations of the West. It has now become an increasing source of environmental degradation in the developing nations of East Asia. China in particular, because of its rapid push to industrialize which is experiencing dramatic levels of aerosol pollution over a large portion of the country (David, 2009).

Air pollution is a major environmental health problem affecting the developing and the developed countries alike. The effects of air pollution on health are very complex as there are many different sources and their individual effects vary from one to the other. It is not only the ambient air quality in the cities but also the indoor air quality in the rural and the urban areas that are causing concern. In fact in the developing world the highest air pollution exposures occur in the indoor environment. Air pollutants that are inhaled have serious impact on human health affecting the lungs and the respiratory system; they are also taken up by the blood and pumped all around the body. As far as humans are concerned an air pollutant may cause or contribute to an increase in mortality or serious illness or may pose a present or potential hazard to human health. (Straif, 2013; Pohanish, 2012; Kampa, *et. all*, 2008).

A mobile robot is an automatic machine that is capable of locomotion. Mobile robots have the capability to move around in their environment and are not fixed to one physical location (Ying *et. all*, 2009). Therefore the mobile robots are often used in situations where low dimensions (such us gas pipes or mines) as much as dangerous environments (radioactivity, toxicity, etc.) forbid the human presence. The potential of robots to accomplish such tasks depends on how well they can locate and interact with objects in their environment. When a mobile robot moves in a low structured environment, it is necessary fit it up with perceptual capabilities.

The machine vision and image processing are very broad areas of research, and there are an ever-growing number of creative and useful methods for retrieving information from images.

In this paper, a multi-functional mobile robot is presented (*Ying et. all, 2009*). The hardware involves the ultrasonic sensor, Bluetooth device (Choo, *et. all*, 2002), wireless camera and DC servo motor. To complete the object localization, one single ultrasound sensor is programmed in order to seek the object. A human-machine interface is developed to remotely control the mobile robot. The exploration of a tiny and harsh environment can be carried out by using the wireless communication and camera. Hardware description language is used in the controller design and the peripheral I/O circuit. Human-machine interface is completed by C language (Ying, 2002).

ROBOT DEVELOPMENT

The project's target is to be able to measured data in dangerous area and also to transmitting and receiving data via wireless communication which is Bluetooth System (You *et. all*, 2006; Dijksta and Mortena, 2001; Gordan, 2001; William and Janet, 1998). The project system overview is shown in Figure 1.

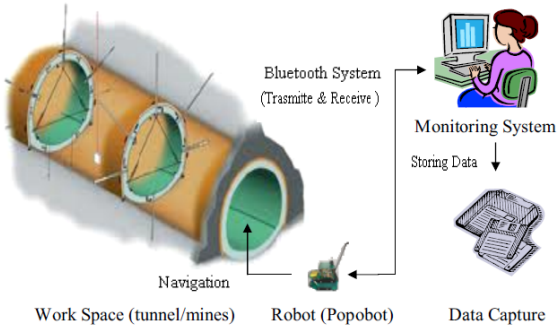

Figure 1. Project System Overview.

System Requirement

The system requirement is based on outputs of the system features. Figure 2 below describes the system features that are divided into three main categories. There are, robot movement, display and capture function.

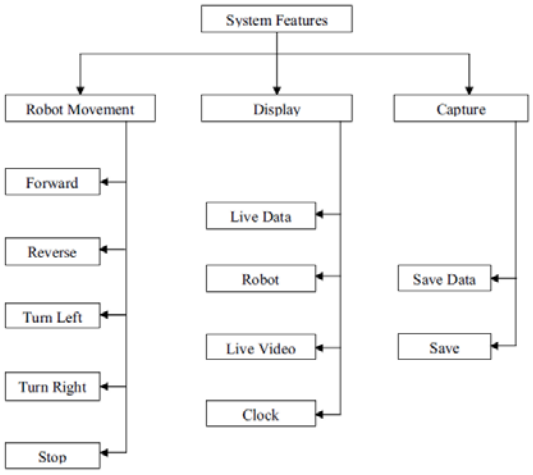

Figure 2. System Features.

There are five main movements of robot which are forward, reverse, turn left, turn right and stop. There also have four other movements that robot can do: turn left reverse, turn right reverse, anti-clock wise and lastly clock wise. The basic concept of all movements is either one of the motor will off or all motor will on at the same time. For moving forward, all motor must on at the same time in same direction. For turning left, the left motor is turn off and only the right motor is turn on (Hanafi *et. all*, 2013).

In the display function, there are four task are displayed on the LCD and monitor. The LCD display only has function to display the live data and robot movement, while the laptop monitor displays all the tasks above: live data taken by temperature sensor, gas sensor and humidity sensor (Sheng and Tang, 2011). The live video is taken by wireless camera, robot movement is controlled by user and lastly the clock is taken from the laptop clock.

The last function is data capture. The data that display on the monitor can be captured and saved in user's laptop. The data captured represent the target area condition and can be used to analyze the pollution level. Besides that, user cans take the image at target area using wireless camera that has been install in robot. The data captured has been saved in text file extension while the image captured is in jpeg file extension.

System Architecture

The system developed has four input hardware units data collection, they are temperature sensor, gas sensor, humidity sensor and wireless camera. It has one output hardware display of process data (LCD), one user interface output (GUI by using Visual basic 6), one data capture program (VB6) and one wireless system communication (Bluetooth module) unit. All of these units are controlled by a microcontroller. The main power supply for this system is by using the rechargeable batteries (7.2V for microcontroller, 4.8V for DC motor and 9V for wireless camera). The overall architecture of this system is show by Figure 3.

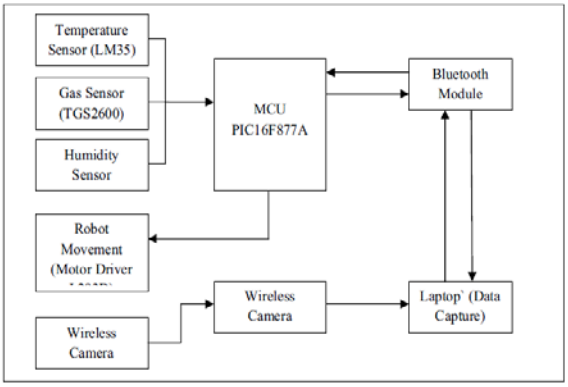

Figure 3. Overall Operation of Project

2.3 System Operation

Air pollution can happens due to of gas and temperature level was high from normal thus resulting the danger situation to work force. In order to avoid the pollution from happen, in this project one system that can measure and record the level of temperature and gases has been developed. The system is user friendly and practically. It equipped with temperature sensor gas sensor and wireless camera, their reading and capture will display in laptop monitor. Then these data also will record in laptop.

The robot developed is called Pobot and its movements is controlled by wireless system. The figure below describes the procedure in how the robot is operated and navigated into target area.

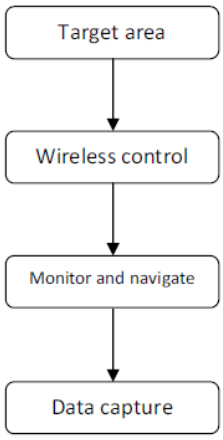

Figure 4. Step State Figure

Firstly, the target area that user

want to monitor should decide. For example, the tunnel and mines where sometimes exists the poisonous gas cases and gas explosion that very dangerous to the human. The Pobot will navigate by user or operator to enter the location using wireless camera to give visualization of the way to target and information around.

When the Pobot arrives at the target area, the operator can give instruction to capture around, measure the gas concentration, temperature and the humidity through GUI interface in laptop display. At the same time the figure and the data are send to laptop using Bluetooth as the communication system. The data and figure are save and record in laptop.

All the data reading and capturing are saved by clicking one button on the GUI panel in laptop. The system has saved all the reading automatically every ten seconds until user clicks the stop button. All the data can be printed. This saved data is useful to do the analysis for the air quality at the target area.

2.4 Robot Construction

Figure 5 is the actual contraction of the mobile robot develop. It is the complete form of the Pobot. While figure 6 shows the GUI and its bottom panels for navigating the Pobot movement, reading the temperature and humidity, and capturing the area.

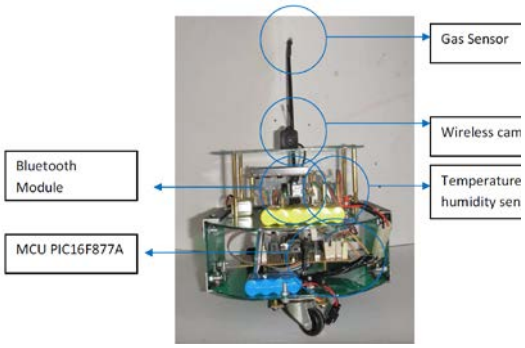

Figure 5. Robot construction.

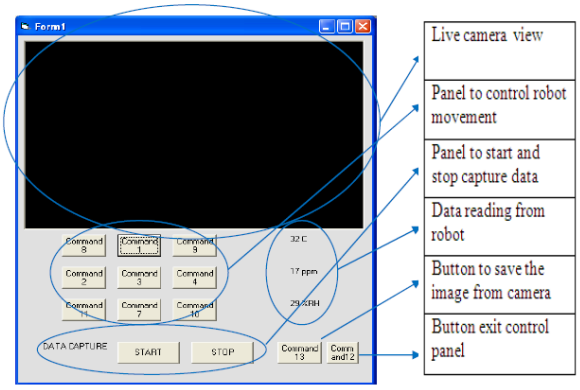

Figure 6. Robot navigation and data capture control panel.

3. RESULT

Two tests have been done for analyzing the performance of the mobile robot and tele data capture system. First test is tele data capture system abilities test. The instructions are given to sensors to measure the gas concentration, temperature and humidity on the target area, then send them to laptop as measuring center. The data are transmitted from target area to the measuring center using Bluetooth communication system. Figure 7 show the data that are display in laptop. While Table 1 till 3 are comparison between sensor reading and standard meter.

The second test is wireless camera performance test. This test is derived by giving the instruction to camera to capture around the target area through push the button on GUI. The figure result is also send to measuring center using Bluetooth communication system. Figure 8 and 9 show the figure that has been capture by camera and received by laptop for two location samples.

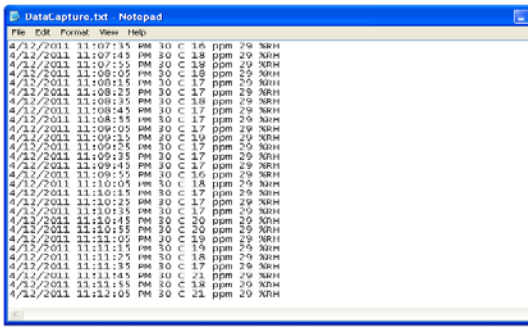

Figure 7. Sample of data record

Table 1. Comparison reading between standard meter and gas sensor (TGS 2600) sensor

Reading		Percentage error
Digital Meter	Sensor	
16.2	16.1	0.62
19.4	19.2	1.00
25	24.7	1.20
24	24.1	0.42
Average percentage error		0.81

Table 2. Comparison reading between standard meter and temperature sensor (LM 35Z)

Reading		Percentage erro
Digital Meter	Sensor	
30	29.6	1.33
30.7	30.5	0.67
31.3	31.0	0.96
31.6	31.4	0.63
Average percentage error		0.90

Table 3. Comparison reading between standard meter and humidity sensor (HH10D)

Reading		Percentage erro
Digital Meter	Sensor	
80.59	80.6	0.012
80.70	80.7	0.000
80.00	79.9	0.125
79.50	79.4	0.125
Average percentage error		0.066

Figure 8. Sample of image capture location 1

Figure 9. Sample of image capture location 2.

4. CONCLUSION

The Development of Mobile Robot for Air Pollution Tele Data Capture (Pobot) has been produced to overcome the limitation of human being to the poisonous gas which is can kill them and also the limitation of wired mobile robot. The project was designed based on the presence accurateness of sensitivity for all air pollution sensors which are temperature sensor (LM 35), gas sensor (TGS 2600) and lastly the humidity sensor (HH10D). All these sensors has it owns advantages in order to fulfill this project target. Also based on the communication of Bluetooth connection has been analyzed to of serial communication by using Bluetooth technology.

All the sensors are effective and give smaller average error compare to the standard meter. The error is about the different value form the standard meter and sensors output. The wireless camera is successfully embedded in Graphical User Interface software and was resembled to perform the live video and save it into Jpeg image format and for data capture, it has saved into text file format.

Therefore, air pollution monitoring and data captured wirelessly via Bluetooth are very useful in order to monitor and maintain the environment air quality compare data capture by using wired. This will prevent human being from poisonous gases accidents.

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