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Mobile Robot Based Odor Source Localization Using Metal Oxide Gas Sensor.

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ABSTRACT
Autonomous search of odor sources is a problem that once solved can bring large improvements to tasks like humanitarian demining, airport patrolling, and hazardous chemical leaks detection. The main obstacles to the research in this area are the properties of current gas sensors (slow, weakly selective and poorly sensitive) and the difficulty to estimate the physical characteristics of natural odor plumes due to the "disturbances" caused by turbulence, namely meandering and intermittence. This present work describes on the design and development of a mobile robot equipped with semiconductor gas sensors which has been designed to locate the odor sources. A search algorithm is proposed to give movements to the robot in the direction of odor source.
***Keywords:** gas sensor, mobile robot, odor sensing, embedded system.*

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I. INTRODUCTION

Olfaction is a rich source of information although its value tends to be underestimated in our daily life. Perception of a certain odor is a direct indication of the presence of the corresponding chemical substances. We can distinguish rotten food from fresh food by sniffing the smell even if the appearanceremain fresh. Generally the first sign of a fire is not a visual image of flame but the sensation of burnt smell. The olfaction cues are also used in variety of animal behaviors. Dogs are famous for their ability to track odor. Male moths can follow airborne sexual pheromones over long distance to find their mates [1]. Odor tracking by electronics means has been a field of much research in recent years. Many advances have been made by trying to mimic the olfactory tracking abilities of animals such as dogs or moths. These behaviors have been reproduced in robots by using electronics noses, or "e-noses" in short. An e-nose is a collection of sensors connected to electronics and software algorithm used to detect the odor and odor concentration in an area. The idea of applying the sensor of smell to robotics arose from the need for an objective, quantifiable method to locate and identify odor in potentially hazardous area [2]-[5].

In recent years, advances in electronics, sensors and computing have made the manufacturing of compact electronics nose devices possible, and particularly suitable for integration into platforms such as mobile robots or intelligent appliances. To date most applications for olfaction on robotics

platforms have focused on the use of gas sensors in mobile robotics for the investigation of odor based navigation strategies [6]. A mobile robot for odor localization could present a number of benefits to society and the environment. One of the main advantages of such a system is an increase in safety. It could be useful to locate harmful gases or leaks, to test air quality and monitor emissions [5]. Considering the potential application of this field, the present work details the development of mobile robot for odor source localization using only a single sensor.

II. SYSTEM DESIGN

A mobile robotic platform is developed, which is operated by using embedded hardware platform. The hardware incorporates an AT89C52 microcontroller based interface that controls sensor and the motors of the robot. Fig 1 shows the functional block diagram of the system. Fig 2 shows the circuit which is used for robot movement control and odour sensing system. The system is controlled by AT89C52 working at 11.0592MHz. A 0808 ADC is used to convert the analog voltage form the gas sensor to digital voltage which is used as an input to the microcontroller. One channel is used for odour sensing system. A MQ-5 Gas sensor is used for odour sensing in the mobile robot. The gas sensor is sensitive to general combustible gases.

The forward and backward movements of the robot are controlled by a single LM293D motor driver chip. The L293D is a quadruple high-current half-H driver. The stepper motor for steering mechanism is control by stepper motor controller, L297 along with dual full bridge driver, L298. The L297 stepper motor controller IC generates four phase diver signal for the two phase bipolar and four phase unipolar step motor in micro-controlled applications. The motor can be driven in half step, normal and wave drive mode and on-chip PWM chopper circuit permit switch-mode control of the current in the winding. A feature of this device is that it requires only clock, direction and mode input signal. The L297 is used with the L298, full bridge driver.L298 is an integrated monolithic circuit. It is a high voltage, high current dual full bridge driver designated to accept TTL logic level and drive inductive load such as relays, solenoids, DC and stepper motors. Two enable input are provided to enable or disable the device independently of the input signals.

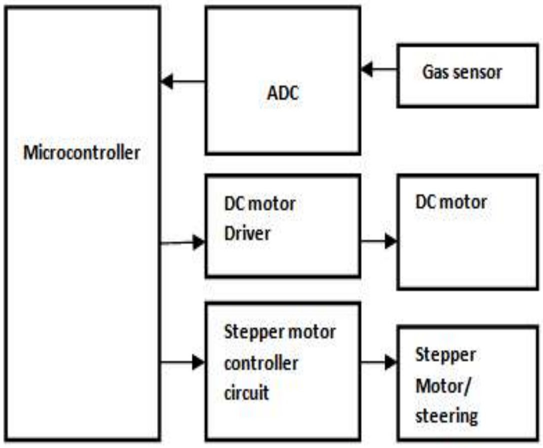

Fig 1.Functional block diagram of mobile robot

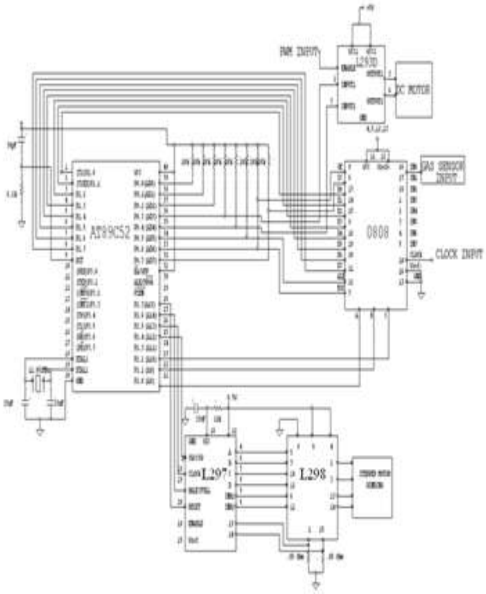

Fig 2. Schematics of the system

III. ALGORITHM

The program is written in C language and compiled to hex file using MikroC PRO compiler for 8051. Mikro PRO for 8051 is a full-featured C compiler for 8051architecture based microcontrollers like 89C51,89C52 etc. The flowchart for the system is shown in Fig 3. The microcontroller takes the sensor reading from the sensor, which is attached to the steering wheel, and stores it in memory. The steering wheel along with the sensor moves to the right in steps of 5^0 and keeps reading until a maximum value is reached or until it reaches the extreme right. Then the sensor moves to the left again in steps of 5^0 and keeps reading until it reaches a maximum value or until the sensor position is at extreme left. In this way the sensor sweeps from one extreme position to other, searching for maximum reading and the robot is moved 3cm forward toward the maximum reading position. If the reading is found to be in the same level in all position of the sensor during a particular sweep then the robot takes a 90o turn towards left. The whole process is repeated until the source of the odor is reached. At the location of the odor source the sensor response will be maximum. A sensor response with a value of 4.2 V is considered to be in the vicinity of the odor source.

IV. RESULT AND DISCUSSION

The test set up was arranged in a closed room. The odor source (ethanol) is kept in a beaker and was let to evaporate in the environment of the room. The reading was taken after half an hour, initially placing the robot at a distance of 50cm and 100cm at different orientation. The time required by the robot to reach the odor source was recorded. Table 1. shows the different configuration and result of the experiment.

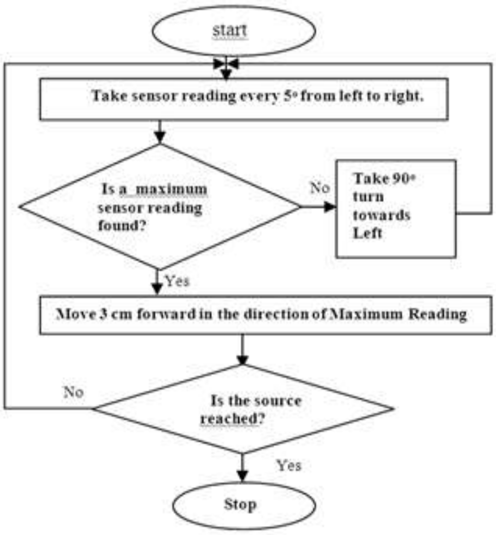

Fig 3.Flowchart of the system

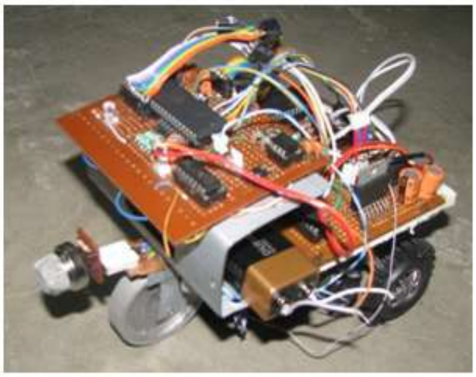

Fig 4. Photo of the odor locating robot.

Table 1: The experimental result for tracking odor source using mobile robot.

	Robot Placement/ Distance in cm	
	50cm	**100cm**
Robot orientation/Angle in degree	**Time took by robot to reach the odor source in seconds**	
0°	53	99
45°	62	103
90°	69	121
180°	78	136

V. CONCLUSION

The mobile odor tracking robot for odor localization is developed using AT89C52 and gas sensor odor . From the experimental results, it is observed that the mobile robot is capable of locating the odor source. Although the experimental conditions were limited, the preliminary results are promising that the mobile robot, which is capable to service a system for localization of odor source. In our system we have used a single sensor for odor localization, which limited the sensor to localize a few odors. A system may be developed which may employ an array of sensors, which will be able to discriminate one odor from another and localize the odor in an environment of interfering odors.

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