AUTONOMOUS POLLUTANTS DETECTION USING UNMANNED AERIAL VEHICLES

Gopisetty Harini
M.tech in Embedded Systems, JNTUA College of Engineering, Ananthapuramu.

Abstract:

In today's modern world, it is not possible to identify the dangerous gases in air which are colorless, tasteless, and odorless by human beings. These gases leads to health issues such as respiratory disorder and environmental problems i.e., acid rains, ozone layer depletion. To overcome this issue, we employed unmanned aerial vehicles (UAVs) for the data collection. The embedded technology able to implement any type of drone with a chemical sensing device for environmental monitoring, gas detection. A light weight electronic device based on microcontroller unit that controls world-wide mobile communications, a digitally controlled analog interface to operate gas sensors. The GSM wireless interface for real-time data sharing.

Index Terms: Embedded gas sensing device, Unmanned Aerial Vehicles (UAVs), GSM, MQ2 sensor, DHT11 sensor.

1. INTRODUCTION

Now a day's Unmanned Aerial Vehicles (UAVs) or drones are very famous and universally used for collection of distributed data and remote sensing in scientific research.

Pollution and metropolitan air nature are the considerable environmental risks to public health. Emission of gases are responsible for a variety of respiratory problems and environmental problems. Environmental problem includes ozone layer depletion and acid rains. The exhaust gases from traffic or industry and fires or as a result of accidents with chemicals are released as pollutants into atmosphere. Human beings are not able to identify most of the chemicals which are colorless, taste-less, and odorless. In order to overcome this issue, we need to prevent high concentration chemicals in the air provided by technological improvements to keep environment clean, and also ensure safety in public and industrial environments.

Present many monitoring systems consist of sensors in order to obtain the amount of gas distributed from gas sources. However, the result of low-cost electrochemoresistive gas sensors is produced by the direct interaction of the chemical compounds with the sensor surface. Only the sensors are not the solution for many applications. UAVs can make a significant contribution for environmental monitoring and pollutants detection.

In this paper, we present an electronic embedded platform able to implant any type of drone with a chemo-resistive sensing device for environmental monitoring, pollutants detection, and gas detection applications. We developed a electronic light-weight system, based on a wireless Arduino microcontroller unit that controls a Global System for Mobile Communications (GSM) module, a digitally controlled analog interface to operate gas sensors and the GSM that allow the development of smart applications for real-time data sharing. The entire 16-cm2 board (4 cm× 4 cm) is battery powered (Li-Gen ace 4000 mah), and the total weight is less than 80 g.

The energy autonomy of the drone for pollutants and gas detection, which deals with the system weight (the payload) and electrical power consumption is the most important design parameter. Finally, we present a design of drone with a payload capacity of 500g; powered battery of 4000mah operates at 10.5v to 12.6v, altitude of 300m and radius of 500m.

2. RELATED WORKS:

UAVs or drones becoming today one of the most important technologies in collection of data and remote sensing. The main drawbacks of the current implementations are: 1) The flight autonomy is limited; 2) The size-to-payload ratio; 3)Doesn't sense multiple gases.

Unmanned Aerial Vehicles:

An UAVs are remotely driven aircraft that is operated by a navigator. UAV is a powered, aerial vehicle that uses dynamic forces to lift the vehicle, does not carry a human operator, can be driven remotely, and can lift a lethal or non lethal payload. There are 4 forces that acting on the drone:

- Thrust is a force that moves an aircraft in the direction of the motion. It is generated with a propeller.
- Drag is the force that acts opposite to the direction of motion. It results to slow an object. Drag is created by air pressure differences and friction.
- Weight is the force produced by gravity.
- Lift is the force that holds an airplane in the air. The most of the lift used by airplanes can be created by the wings.

Embedded Sensing System:

Building a monitoring device for Environment to guarantee the pollution is maintained within acceptable temperature and humidity limits. The system functionality was successfully developed using Arduino software. Arduino Nano was used as the brain to command the input and output devices. In this system we are including a MQ2 sensor which detect the multiple gases which are smoke, alcohol, propane, co.

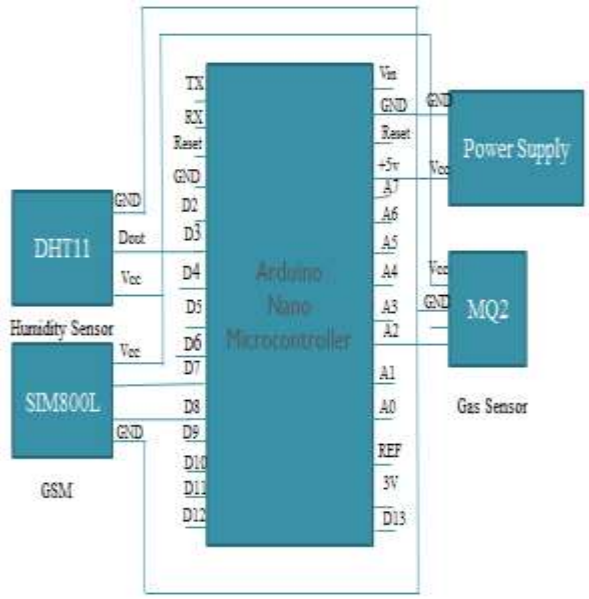
3. PROPOSED SYSTEM:

It is not possible to identify the dangerous gases in air which are colorless, tasteless and odorless by the human beings which leads to health problems like respiratory disorder and environmental problems (i.e., acid rains, depletion of ozone layer). Such gases are detected by using UAV and embedded sensing system.

UAV is defined as a powered, aerial vehicle that uses a dynamic forces to lift the vehicle, does not carry a human operator, can be remotely piloted, can lift a payload i.e., a sensing device to detect the gases, temperature and humidity in the environment.

In this sensing device we are using MQ2 gas sensor to detect alocohol, co, butane gases that are present in the atmosphere near oil industries which leads to acid rains. Another, DHT11 sensor used as the humidity and temperature sensor. This proposed system is used as environmental monitoring device.

The block diagram representation for the proposed system is as below:



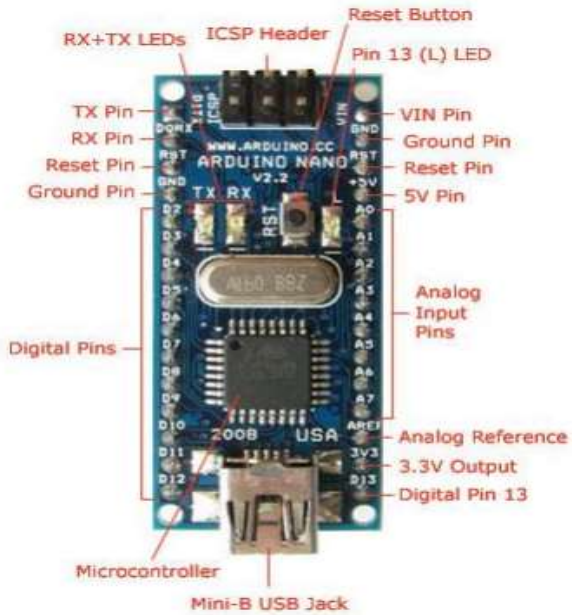
4. SYSTEM ARCHITECTURE:

5. SYSTEM HARDWARE:

Hardware components include Arduino Nano microcontroller, MQ2 gas sensor, DHT11 humidity and temperature sensor, GSM modem, Lipo battery for power supply and an UAV.

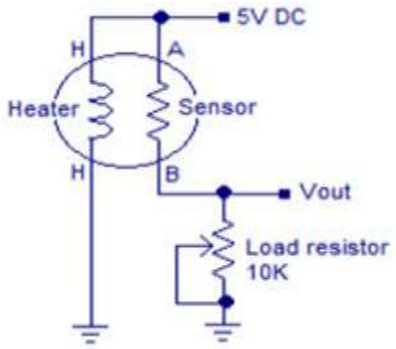
ARDUINO MICROCONTROLLER:

The Arduino Nano is a complete, small, and bread-board friendly board depend on the ATmega328. It operates with a Mini-B USB cable rather than standard one. The ATmega328 contains UART TTL (5V) for serial communication, which is provided on digital pins 0(RX) and (TX).

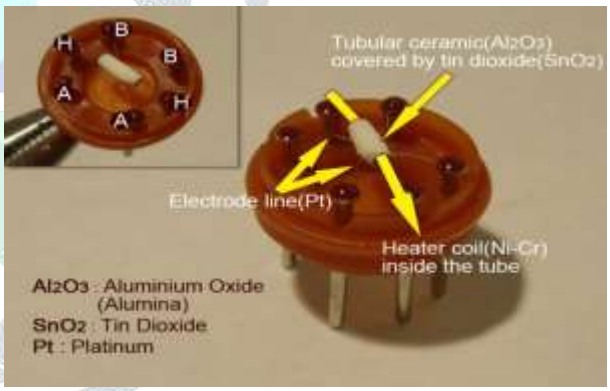


GAS SENSOR:

Gas sensor MQ2 module is a electrochemical device useful for detecting H2, LPG, CH4, CO, Alcohol, Smoke or Propane gases. MQ2 sensor (0.1mg/L to 10mg/L) consists of 6 pins. we use only four of them 2 for heating system(H) and other two for connecting ground(A,B) and power. Basically MQ2 sensor is a alumina tube covered by tin dioxide. There is aurum electrode between them. The coils and the alumina tube works as heating system. When coil gets heat, tin dioxide becomes semiconductor, results in more movable electrons which means it is ready to flow more current. When alcohol molecules present in the air meet the electrode converts into acetic acid results in more current flow. This leads to decrease in the resistance.

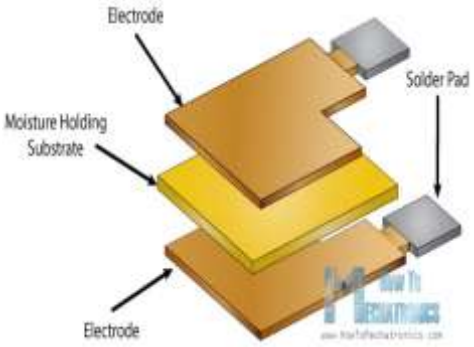


Internal Structure of MQ2 sensor

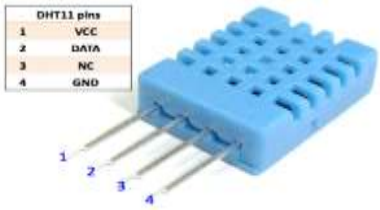


DHT11 SENSOR:

DHT11 is a humidity and temperature sensor. This DHT11 sensor results a digital signal output. It consists of humidity sensing element and a NTC temperature (0 to 80%) sensor. Humidity sensor (20 to 90%) contains a dielectric material enclosed by a pair of electrodes creating a capacitor. On silicon substrate, lower electrode is created using platinum gold, or other material. A polymer layer is installed on the electrode. This layers used to sense humidity. Gold layer is coated on top of this polymer layer acts as top electrode. The top electrode also allows water vapour to pass into the sensing layer through it. Due to this conductivity increases. It consists of 4 pins: Vcc, Data, NC, Gnd.



Humidity Sensing element



DHT11 sensor

SIM800L MODULE:

The SIM800L module supports quad-band GSM/GPRS network, available for GPRS and SMS message data remote transmission. The communication between SIM800L and microcontroller is done via UART port. The range of supply voltage is 3.4V ~ 4.4V.

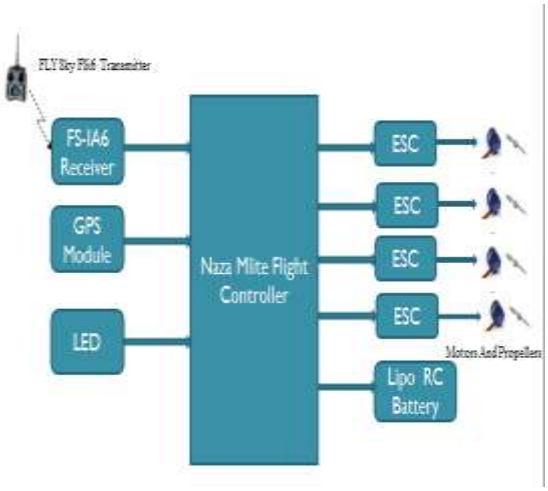
LIPO BATTERY:

Suitable for 110, 130, 180, 320, and 520 FPV racing quad copter, Rc car, boat.

Voltage: 11.1v; Discharge rate: 30C

UNMANNED AERIAL VEHICLES:

The block diagram for the drone which can carry out the sensing device is as below:



6. IMPLEMENTATION AND RESULTS:

Arduino IDE is the tool used to dump the source code into the controller.

Step1: Connect the Embedded sensing device to the PC using Mini B USB cable.

Step 2: Copy the code into the Arduino tool, compile and dump the code into the controller by selecting the upload button.

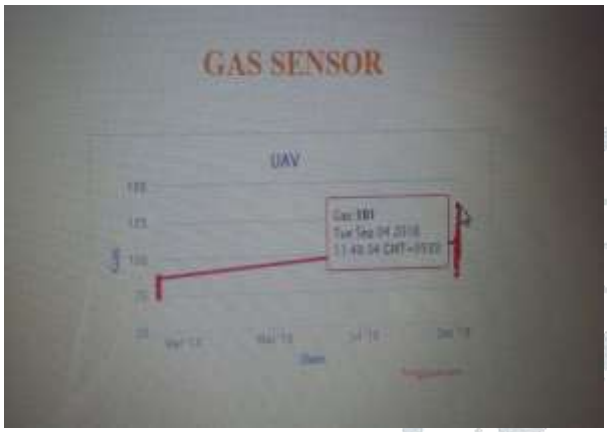
Step 3: Open the tools menu and select the COM port.

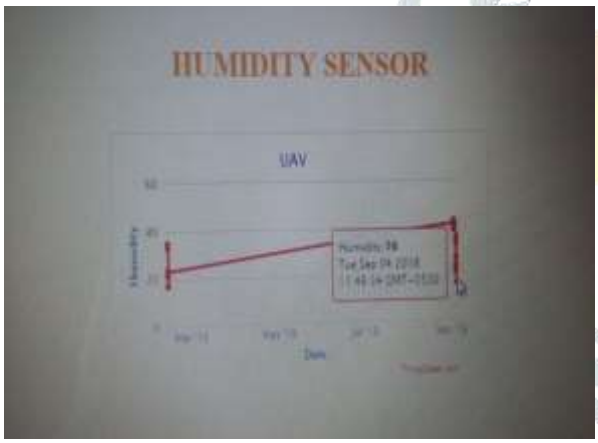
Step 4: After providing the power supply to the device through Lipo battery, the GSM initialization happens.

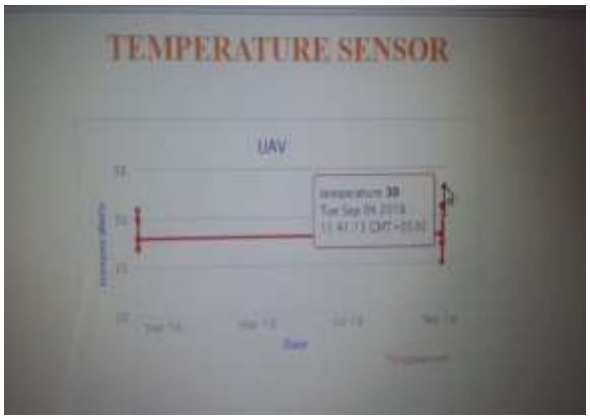
Step 5: Then the device will connect to the server through an IP address.

Step 6: After detecting the temperature, gas, and humidity the device sends the data to the server.

Results:







7. CONCLUSION:

In this paper, we present the design and characterization of an embedded platform meant for environmental monitoring and gas detection applications using UAVs. The main characteristics of the measurement instrument are the low energy consumption and sense multiple gases by overcoming the size to payload drawback. In order to demonstrate the gases in environment we used MQ2 and DHT11 sensors both in stand-alone and mounted as a payload of an UAV.

8. REFERENCES:

[1] Gallego.V, D. Brunelli, and M. Rossi, "Unmanned aerial gas leakage localization and mapping using microdrones," in Proc. IEEE Sensors Appl. Symp. (SAS), April 2015, pp. 1–6.

[2] L. Lorenzelli , Brunelli.D , M. Rossi, F. Remondino, A. Adami, F. Menna, and D. Brunelli, "Portable gas sensing system on UAVs for gas leakage localization," in Proc. IEEE SENSORS, 2014 Nov., pp. 1431–1434.

[3] J. K. Hart and K. Martinez, "Environmental sensor networks Earth-Sci. Rev., vol. 78, nos. 3–4, pp. 177–191, 2006.

[4] C. Wietfeld, A. Lewandows ki, K. Daniel, and B. Dusza, "AirShield: A system-of-systems MUAV remote sensing architecture for disaster response," in Proc. 3rd Annu. IEEE Syst. Conf., March 2009, pp. 196–200.

[5] Allred .J. et al., "An airborne wireless sensor network of micro-air vehicles," in Proc. 5th Int. Conference Embedded Network Sensor System, 2007, pp. 117–129.

[6] Z. Sun, P. Zhang, A. Purohit, and F. Mokaya, "SensorFly: Controlled-mobile sensing platform for indoor emergency response applications," in Proc. 10th Int. Conf. Inf. Processor Sensor Network (IPSN), Apr. 2011, pp. 223–234.

[7] F. Gonzalez, N. Motta, A. Malaver, and P. Corke, " Development and integration of a solar powered unmanned aerial vehicle and a wireless sensor network to monitor greenhouse gases," Sensors, vol. 15, no. 2, pp. 4072–4096, 2015.

[8] M. Rossi and D. Brunelli, "Ultra low power CH4 monitoring with wireless sensors," in Proc. IEEE SENSORS, Nov. 2013, pp. 1–4.

[9] C. Chaiwatpongsakorn, D. Wang, Toruksa .W., T. C. Keener, M. Lu, and D. P. Agrawal, "Monitoring ambient air quality with carbon monoxide sensor based wireless network," Commun. ACM, vol. 53, no. 5, pp. 138–141, 2010.

[10] Y. Lv, J. Yu, J. Li, D. Li, X. Ma, and Q. Dai, "Temperature compensation and data fusion based on a multifunctional gas detector," IEEE Trans. Instrum. Meas., vol. 64, no. 1, pp. 204–211, Jan. 2015.

[11] S. Asadi, P. P. Neumann, A. J. Lilienthal, Schiller J. H., and M. Bartholmai, "Autonomous gas-sensitive microdrone: Wind vector estimation and gas distribution mapping," IEEE Robot. Autom. Mag., vol. 19, no. 1, pp. 50–61, Mar. 2012.