AUTONOMOUS GAS DETECTION AND MAPPING WITH UNMANNED AERIAL VEHICLES

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Abstract: Unmanned aerial vehicles (UAVs) are nowadays largely employed in civil applications. One of the most promising applications is the environmental monitoring (or risk assessment). We propose a battery-powered eNose board that can be embedded with any type of drone. We evaluated the effectiveness of the sensing method by means of field experiments using the prototype as payload of a hexacopter. The results show that the analysis of the target environmental parameters is not perturbed by the air flow generated by propellers. The system is suitable for any type of mobile carrier (UAVs or wheeled robots), thanks to its lightweight and compact form factor. To further extend the limited flight autonomy of the carrier, we developed an optimal monitoring algorithm for gas leakage localization, a simulating framework to evaluate its performance, and we provide a design space exploration for solar-powered drones.

KEYWORDS: *Unmanned vehicle, Gas Sensor, location detection.*

I. INTRODUCTION

The main pollutants from vehicles are the oxides of carbon and nitrogen, which can be easily detected these days with the help of semiconductor gas sensors. The existing system has data collection and remote sensing using GPS. A mobile robot equipped with embedded systems can collect environmental samples with a much denser spatiotemporal resolution than a human operator also resulting in a safer working condition. Pollution and urban air quality are the major environmental risks to public health. Gas emissions are responsible for a variety of respiratory illnesses and environmental problems, such as acid rain and the depletion of the ozone layer. Pollutants may be released as exhaust gases from traffic or industry and fires or as a consequence of accidents with chemicals.

UAVs or drones have overcome their first military uses, becoming today one of the most important technologies in data collection and remote sensing [2]. This is highlighted by several researches, which list among its advantages a high resolution and positional accuracy. Their relevance for earth system understanding and environmental science research has been pointed out, for example, in [3]. Among others, localization and mapping of geographical areas by means of advanced 3-D imaging techniques have been demonstrated [4], [5]. Its uses for civil purposes include various applications of gas detection, such as obtaining gas distribution mapping, monitoring emissions, and gas source localization in geographical areas where environmental concern is a hot topic [6]–[9]. They have also been investigated for emergency handling in indoor environments [10].

The main problems of all the current implementation are: 1) the limited flight autonomy and 2) the size-to-payload ratio; few efforts have been dedicated so far to the joint optimization of the flight path and energy consumption of chemical sensors.

II. PROPOSED SYSTEM

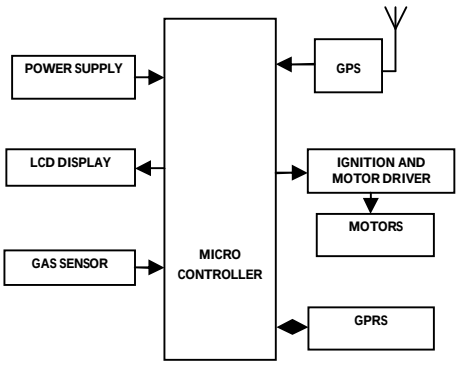

Fig 1: Block Diagram

The process of working of this project is explained as follows. The total equipment of this project is placed inside a vehicle. Here we have GPS (Global Positioning System) module by which we can get the location of the vehicle, the location values are displayed on the LCD (Liquid Crystal Display). In this project we have sensors which are interfaced to the micro controller. Those are gas sensor through which we can detect the gas from the vehicle. These values are also displayed on LCD. Here ADC (Analog to Digital Converter) is used to convert the analog data from the sensors to digital form. Whenever these values exceed the threshold then intimation is given to the RTA including vehicle's exact position. The motor gets stopped if it exceeds the threshold value and posted on webpage through GPRS.

III. BOARD HARDWARE FEATURES

Micro controller: This section forms the control unit of the whole project. This section basically consists of a Microcontroller with its associated circuitry like Crystal with capacitors, Reset circuitry, Pull up resistors (if needed) and so on. The Microcontroller forms the heart of the project because it controls the devices being interfaced and communicates with the devices according to the program being written.

ARM7TDMI: ARM is the abbreviation of Advanced RISC Machines, it is the name of a class of processors, and is the name of a kind technology too. The RISC instruction set, and related decode mechanism are much simpler than those of Complex Instruction Set Computer (CISC) designs.

Liquid-crystal display (**LCD**) is a flat panel display, electronic visual display that uses the light modulation properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images or fixed images which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock.

Co2 sensor:

They are used in gas leakage detecting equipments in family and industry, are suitable for detecting of LPG, i-butane, propane, methane, alcohol, Hydrogen, smoke. The surface resistance of the sensor Rs is obtained through effected voltage signal output of the load resistance RL which series-wound. The relationship between them is described:

Rs\RL = (Vc-VRL) / VRL

Fig 2: Co2 sensor

GPS:

Global Positioning System (GPS) technology is changing the way we work and play. You can use GPS technology when you are driving, flying, fishing, sailing, hiking, running, biking, working, or exploring. With a GPS receiver, you have an amazing amount of information at your fingertips. Here are just a few examples of how you can use GPS technology.

GPS technology requires the following three segments.

- Space segment.
- Control segment.
- User segment

Space Segment

At least 24 GPS satellites orbit the earth twice a day in a specific pattern. They travel at approximately 7,000 miles per hour about 12,000 miles above the earth's surface. These satellites are spaced so that a GPS receiver anywhere in the world can receive signals from at least four of them.

Control Segment

The control segment is responsible for constantly monitoring satellite health, signal integrity, and orbital configuration from the ground control segment includes the following sections: Master control station, Monitor stations, and Ground antennas.

User Segment

The GPS user segment consists of your GPS receiver. Your receiver collects and processes signals from the GPS satellites that are in view and then uses that information to determine and display your location, speed, time, and so forth. Your GPS receiver does not transmit any information back to the satellites.

The following points provide a summary of the technology at work:

- The control segment constantly monitors the GPS constellation and uploads information to satellites to provide maximum user accuracy
- Your GPS receiver collects information from the GPS satellites that are in view.
- Your GPS receiver accounts for errors. For more information, refer to the Sources of Errors.
- Your GPS receiver determines your current location, velocity, and time.
- Your GPS receiver can calculate other information, such as bearing, track, trip distance, and distance to destination, sunrise and sunset time so forth.
- Your GPS receiver displays the applicable information on the screen.

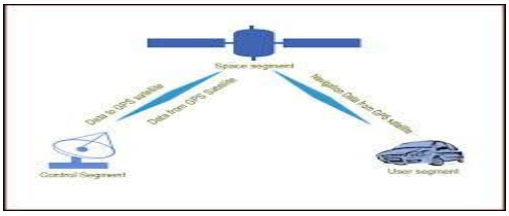

Fig 3: GPS Working

GPRS:

GPRS (general packet radio service) is a packet-based data bearer service for wireless communication services that is delivered as a network overlay for GSM, CDMA and TDMA (ANSI-I36) networks. GPRS applies a packet radio principle to transfer user data packets in an efficient way between GSM mobile stations and external packet data networks. Packet switching is where data is split into packets that are transmitted separately and then reassembled at the receiving end. GPRS supports the world's

leading packet-based Internet communication protocols, Internet protocol (IP) and X.25, a protocol that is used mainly in Europe. GPRS enables any existing IP or X.25 application to operate over a GSM cellular connection. Cellular networks with GPRS capabilities are wireless extensions of the Internet and X.25 networks.

Fig 4: GPRS module

DC Motor:

A DC motor relies on the fact that like magnet poles repels and unlike magnetic poles attracts each other. A coil of wire with a current running through it generates an electromagnetic field aligned with the center of the coil. By switching the current on or off in a coil its magnetic field can be switched on or off or by switching the direction of the current in the coil the direction of the generated magnetic field can be switched 180°.

Fig 5: DC Motor

IV. CONCLUSION

In this paper, we present the design and characterization of an embedded platform meant for gas distribution mapping and leakage localization applications using UAVs as mobile carrier. The main features of the measurement instrument are the low power consumption and the small form factor, achieving long autonomy on its own rechargeable battery. Field experiments demonstrate the sensitivity of the measurement instrument equipped with VOC-targeted MOX sensors both in stand-alone and mounted as a payload of an UAV.

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