

# Autonomous Gas Detection Using UAV with GPS Tracking System

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## ABSTRACT

The main objective of this proposed system is Gas Detection and Mapping with Unmanned Aerial Vehicle. Unmanned aerial vehicles are (UAVs) or drones are nowadays very popular and widely used in scientific research for distributed data collection and remote sensing. 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. Unmanned aerial vehicles are (UAVs) are nowadays largely employed in civil applications. One of the most promising applications is the environmental monitoring. We propose a battery-powered Nano-ardino 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 quadcopter. The system is suitable for any type of mobile carrier (UAVs or wheeled robots) thanks to its lightweight and compact form factor.

### 1.1 Introduction to embedded system

An embedded system is nearly any computing system other than a desktop computer. An embedded system is a dedicated system which performs the desired function upon power up, repeatedly. Embedded systems are found in a variety of common electronic devices such as consumer electronics ex. Cell phones, pagers, digital cameras, VCD players, portable Video games, calculators, etc.,

Embedded systems are found in a variety of common electronic devices, such as: (a) consumer electronics

- cell phones, pagers, digital cameras, camcorders, videocassette recorders, portable video games, calculators, and personal digital assistants; (b) home appliances -- microwave ovens, answering machines, thermostat, home security, washing machines, and lighting systems; (c) office automation -- fax machines, copiers, printers, and scanners; (d) business equipment -- cash registers, curbside check-in, alarm systems, card readers, product scanners, and automated teller machines; (e) automobiles--transmission control, cruise control, fuel injection, anti-lock brakes, and active suspension. Embedded systems are a combination of hardware and software as well as other components that we bring together into products such as cell phones, music player, a network router, or an aircraft guidance system. They are a system within another system as we see in Figure 1.1

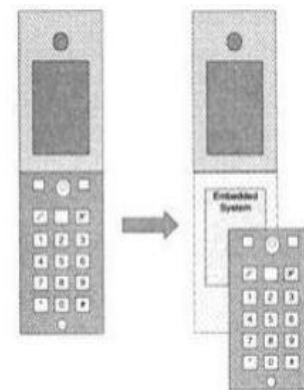
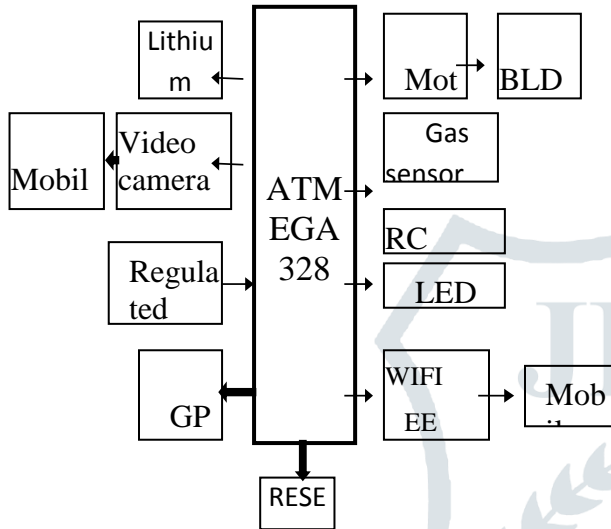


Figure 1.1: A simple embedded system

### 2.1 Introduction with Block Diagram

The Atmel Pico Power ATmega328/P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328/P achieves throughputs close to 1MIPS per MHz this empowers system designed to optimize the device for power consumption versus processing speed.



The device is manufactured using Atmel’s high density non-volatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed In-System through an SPI serial interface, by a conventional nonvolatile memory programmer, or by an On-chip Boot program running on the AVR core. The

Pin No.	Name	Type	Description
1-2,5-16	D0-D13	I/O	Digital input/output port 0 to 13
3,28	RESET	Input	Reset (active low)
4,29	GND	PWR	Supply ground
17	3V3	Output	+3.3V output (from FTDI)
18	AREF	Input	ADC reference
19-26	A0-A7	Input	Analog input channel 0 to 7
27	+5V	Output or Input	+5V output (from on-board regulator) or +5V (input from external power supply)
30	VIN	PWR	Supply voltage

Boot program can use any interface to download the

application program in the Application Flash memory. Software in the Boot Flash section will continue to run while the Application Flash section is updated, providing true Read-While-Write operation. By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the Atmel ATmega328/P is a powerful microcontroller that provides a highly flexible and cost effective solution to many embedded control applications.

The ATmega328/P is supported with a full suite of program and system development tools including: C Compilers, Macro Assemblers, and Program Debugger/Simulators

### 2.2 Arduino Nano Board

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.0) or ATmega168 (Arduino Nano 2.x). It has more or less the same functionality of the ArduinoDuemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one. The Nano was designed and is being produced by Gravitech.



Figure 2.2 Arduino Nano

The Arduino Nano can be powered via the Mini-B USB connection, 6-20V unregulated external power supply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source. The FTDI FT232RL chip on the Nano is only powered if the board is being powered over USB. As a result, when running on external (non-USB) power, the 3.3V output (which is supplied by the FTDI chip) is not available and the RX and TX LEDs will flicker if digital pins 0 or 1 are high.

2.2.1 Arduino Nano Pin Layout

D1/TX	(1)		(30) VIN
D0/RX	(2)		(29) GND
RESET	(3)		(28) RESET
GND	(4)		(27) +5V
D2	(5)		(26) A7
D3	(6)		(25) A6
D4	(7)		(24) A5
D5	(8)		(23) A4
D6	(9)		(22) A3
D7	(10)		(21) A2
D8	(11)		(20) A1
D9	(12)		(19) A0
D10	(13)		(18) AREF
D11	(14)		(17) 3V3
D12	(15)		(16) D13

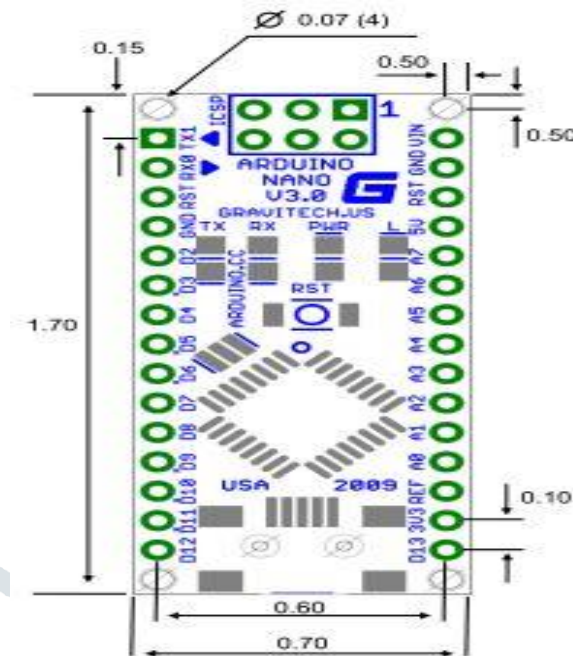


Figure 2.3 Arduino Nano Mechanical Drawing

Table 2.3 Arduino Nano

2.2.2 Arduino Nano Mechanical Drawing

The Arduino Nano has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega168 and ATmega328 provide UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An FTDI FT232RL on the board channels this serial communication over USB and the FTDI drivers (included with the Arduino software) provide a virtual com port to software on the computer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the FTDI chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A Software Serial library allows for serial communication on any of the Nano's digital pins. The ATmega168 and ATmega328 also support I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. To use the SPI communication, please see the ATmega168 or ATmega328 datasheet.

2.3 GPS (Global Positioning System)

LS20030~3 series products are complete GPS smart antenna receivers, including an embedded antenna and GPS receiver circuits, designed for a broad spectrum of OEM system applications. The product is based on the proven technology found in LOCOSYS 66 channel GPS SMD type receivers MC-1513 that use MediaTek chip solution. The GPS smart antenna will acquire up to 66 satellites at a time while providing fast time-to-first-fix, one-second navigation update and low power consumption. It can provide you with superior sensitivity and performance even in urban canyon and dense foliage environment. Its far-reaching capability meets the sensitivity requirements of car navigation as well as other location-based applications.

2.5 Global Positioning System Fixed Data

Table 3.6 GGA Data Format

Name	Example	Units	Description
Message ID	\$GPGGA		GGA protocol header
UTC Time	053740.000		hhmmss.sss
Latitude	2503.6319		ddmm.mmmm
N/S indicator	N		N=north or S=south
Longitude	12136.0099		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	1		See Table 5.1-3
Satellites Used	08		Range 0 to 12
HDOP	1.1		Horizontal Dilution of Precision
MSL Altitude	63.8	meters	
Units	M	meters	
Geoid Separation	15.2	meters	
Units	M	meters	
Age of Diff. Corr.		seconds	Null fields when DGPS is not used
Diff. Ref. Station ID	0000		
Checksum	*64		

Applications

1. Personal positioning and navigation
2. automotive navigation
3. Marine navigation

2.6 GSV---GNSS Satellites in View

Table 2.1 RMC Data Format

Name	Example	Units	Description
Message ID	\$GPRMC		RMC protocol header
UTC Time	053740.000		hhmmss.sss

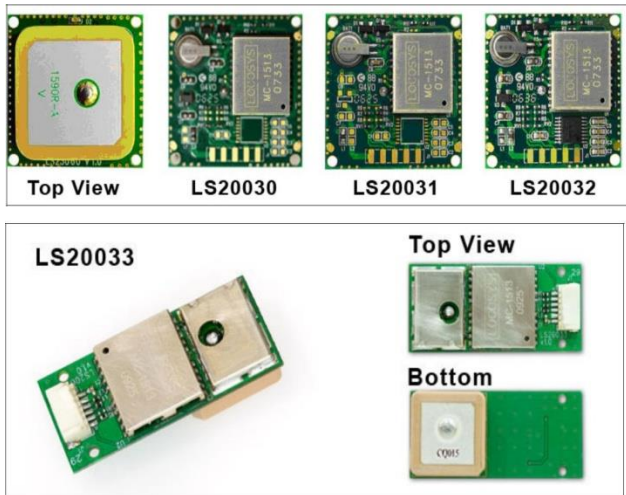


Figure 2.4 GPS (Global Positioning System)

2.4 Features

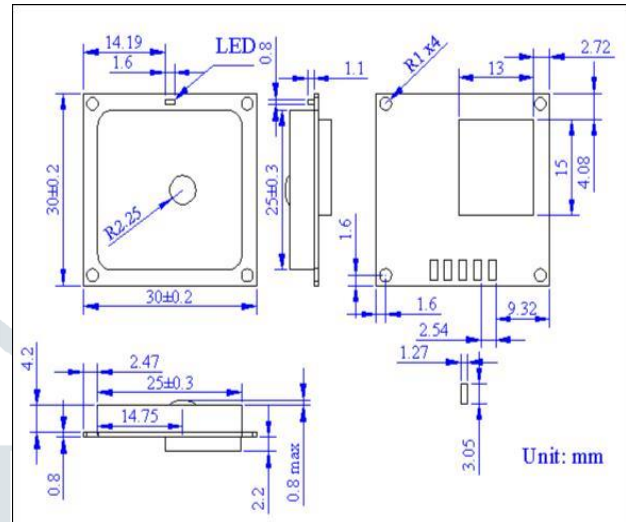
- Media Tek high sensitivity solution.
- support 66-channel GPS
- Fast TTFF at low signal level.
- support AGPS
- Up to 10Hz update rate.
- capable base of SBAS (WAAS, EGNOS, MSAS)
- LED indicator for GPS fix or not fix (not in LS20033).

Status	A		A=data valid or V=data not valid
Latitude	2503.6 319		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12136. 0099		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Speed over ground	2.69	knots	True
Course over ground	79.65	degrees	
Date	10010 6		ddmmyy
Magnetic variation		degrees	
Variation sense			E=east or W=west (Not shown)
Mode	A		A=autonomous, D=DGPS, E=DR
Checksum	*53		
<CR><LF>			End of message termination

<CR><LF>			End of message termination
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**2.8 Mechanical specification**

LS20030, LS20031, LS20032



**Figure 2.3 Mechanical specification**

**2.9 GAS Sensor (MQ2)**

**FEATURES**

- High sensitivity to LPG, iso-butane, propane
- Small sensitivity to alcohol, smoke.
- Fast response.
- Stable and long life

**APPLICATION**

Simple drive circuit They are used in gas leakage detecting equipment's in family and industry, are suitable for detecting of LPG, iso-butane, propane, LNG, avoid the noise of alcohol and cooking fumes and cigarette smoke.

**SPECIFICATIONS**

**Table 2.2 A. Standard work condition**

Sym bol	Parameter name	Technical condition	Remarks
V <sub>c</sub>	Circuit voltage	5V ±0.1	AC OR DC
V <sub>H</sub>	Heating voltage	5V ±0.1	AC OR DC
P <sub>L</sub>	Load resistance	20KΩ	
R <sub>H</sub>	Heater resistance	33Ω±5%	Room Tem

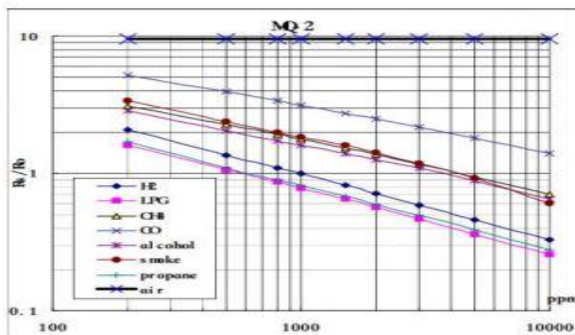
**2.7 VTG---Course over Ground and Ground Speed**

VTG Data Format

Name	Example	Units	Description
Message ID	\$GPV TG		VTG protocol header
Course over ground	79.65	degrees	Measured heading
Reference	T		True
Course over ground		degrees	Measured heading
Reference	M		Magnetic
Speed over ground	2.69	knots	Measured speed
Units	N		Knots
Speed over ground	5.0	km/hr	Measured speed
Units	K		Kilometer per hour
Mode	A		A=autonomous, D=DGPS, E=DR
Checksum	*38		

$P_H$	Heating consumption	less than 750mw	
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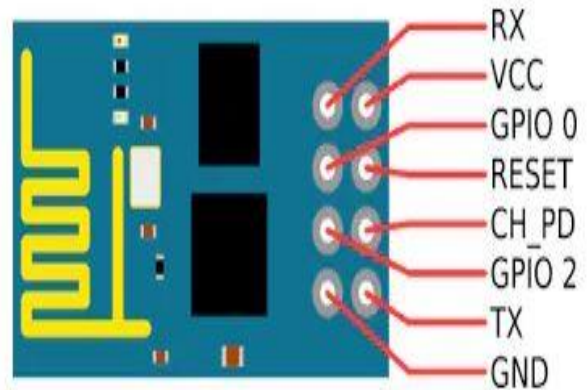
Grove products have a eco system and all have a same connector which can plug onto the Base Shield. Connect this module to the A0 port of Base Shield, however, you can also connect Gas sensor to Arduino without Base Shield by jumper wires.



According to the figure, we can see that the minimum concentration we can test is 100ppm and the maximum is 10000ppm, in a other word, we can get a concentration of gas between 0.01% and 1%. However, we can't provide a formula because the relation between ratio and concentration is nonlinear.

### 2.10 ESP8266 Wifi module

ESP8266 is a 3V WiFi module very popular for its Internet of Things applications. ESP 8266 maximum working Voltage is 3.6V and its very important to note. You must know how to power it, how to serial-connect it with Arduino safely, how to ping and many other things. You should use software like Circuito.io, Tinkercad, Fritzing to simulate and work with the board safely. You should also use Logic Level Controller to use with ESP8266 module.



ESP8266 has 8 pins, namely:

- RX
- VCC
- GPIO 0
- RESET
- CH\_PD
- GPIO 2
- TX
- and GND

### CONCLUSIONS

#### 3.1 Conclusions

In this study, 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 small form factor, achieving long autonomy on its own rechargeable battery. To fulfill the low power design of the complete mobile system and maximize the currently limited flight autonomy , we developed an optimal monitoring Bluetooth module to autonomously drive the carrier based on the feedback from the gas measurement unit and evaluated the boost in performance that can be achieved by introducing a PV harvesting unit directly on board.

#### 3.2 Future Scope

This study can be extended with ultra-detection camera/HD by face detecting and it can be used in military areas.

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