

# ENVIRONMENT MONITORING USING QUADCOPTER INTERFACED WITH ARDUINO

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**Abstract** - Humidity and temperature are common parameters to measure environmental conditions. In this paper, **Arduino** based quadcopter measures ambient temperature, humidity and display it on monitor using puTTY configuration. A temperature **LM35** and humidity sensor is used with Arduino uno and interfaced with **quadcopter** to monitor the environmental changes at different region of atmosphere. This project consists of three sections - one senses the humidity and temperature by using **humidity and temperature sensor**. The second section reads the sensor module's output and extracts temperature and humidity values into a suitable number in percentage. The third sections involves viewing the stored data from the arduino using **puTTY configuration**.

**KeyWords:** Arduino, LM35, puTTY configuration, Quadcopter, Humidity sensor.

## 1. INTRODUCTION

A quadcopter is an aerial vehicle that uses four rotors for lift, steering, and stabilization. Unlike other aerial vehicles, the quadcopter can achieve vertical flight in a more stable condition. The quadcopter is not affected by the torque issues that a helicopter experiences due to the main rotor.

Here we are using LM35 temperature sensor and humidity sensor with arduino and it is interfaced with quadcopter to monitor the changes in environment where humans are unable to monitor some regions such as regions suffering from fire accident, Industrial accident with emission of poisonous emission. Finally we collect the data in the arduino and view those data in monitor using puTTY configuration.

## 1.1 QUADCOPTER

A quadcopter is an aerial vehicle that uses four rotors for lift, steering, and stabilization. Unlike other aerial vehicles, the quadcopter can achieve vertical flight in a more stable condition. The quadcopter is not affected by the torque issues that a helicopter experiences due to the main rotor. Furthermore, due to the quadcopter's cyclic design, it is easier to construct and maintain. As the technology becomes more advanced and more accessible to the public, many engineers and researchers have started designing and implementing quadcopters for different uses.

## 1.2 WORKING PRINCIPLE

A quadcopter consists of four motors evenly distributed along the quadcopter frame as can be seen in figure 1.2.1 below. The circles represent the spinning rotors of the quadcopter and the arrows represent the rotation direction. Motors one and three rotate in a clockwise direction using pusher rotors. Motor two and four rotate in a counter-clockwise direction using puller rotors. Each motor produces a thrust and torque about the center of the quadcopter. Due to the opposite spinning directions of the motors, the net torque about the center of the quadcopter is ideally zero, producing zero angular acceleration. This eliminates the need for yaw stabilization. A vertical force is created by increasing the speed of all the motors by the same amount of throttle. As the vertical forces overcome the gravitational forces of the earth, the quadcopter begins to rise in altitude. Figure 1.2.2 shows the vertical movement of the quadcopter. As above, the circles represent the spinning rotors, the larger arrows represent the direction the rotors are spinning, and the black arrows represent the forces caused by the spinning rotors. Pitch is provided by increasing (or decreasing) the speed of the front or rear motors. This causes the quadcopter to turn along the x axis. The overall vertical thrust is the same as hovering due to the left and right motors; hence only pitch angle acceleration is changed. Figure 1.2.3 shows an example of pitch movement of a quadcopter. As the front motor slow down, the forces created by the corresponding rotor are less than the forces created by the back rotor. These forces are represented by the blue arrows. These forces cause the quadcopter to tip forward and this movement is represented by the red arrow.

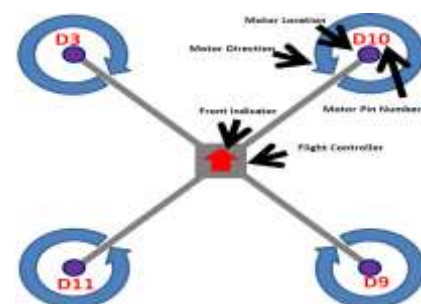


Figure 1.2.1: Quadcopter: Motor rotation directions.

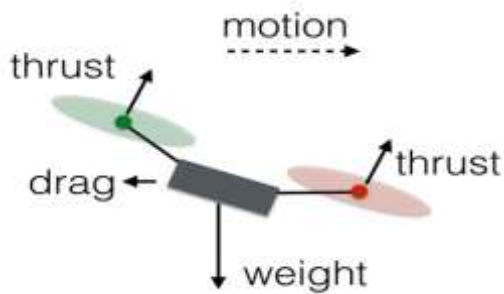


Figure 1.2.2: Quadcopter: Vertical thrust movement.

Roll is provided by increasing (or decreasing) the speed of the left rotor speed and right motors. This causes the quadcopter to turn along the y axis. The overall vertical thrust is the same as hovering due to the front and back motors; hence only roll angle acceleration is changed. Figure 1.2.4 shows an example of roll movement of a quadcopter. As the right motor slows down, the forces created by the corresponding rotor are less than the forces created by the left rotor. These forces are represented by the blue arrows. This causes the quadcopter to tip to the right and this movement is represented by the red arrow. Yaw is provided by increasing (or decreasing) the speed of the front and rear motors or by increasing (or decreasing) the speed of the left and right motors. This causes the quadcopter to turn along its vertical axis in the direction of the stronger spinning rotors. Figure 1.2.5 shows an

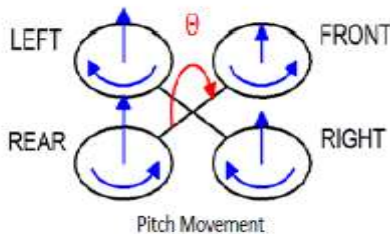


Figure 1.2.3: Quadcopter: Pitch movement.

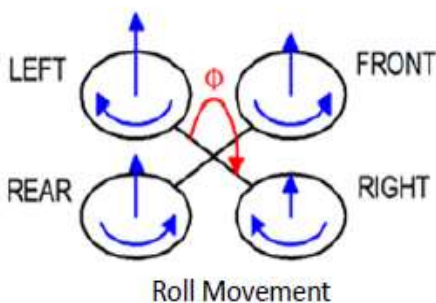


Figure 1.2.4: Quadcopter: Roll movement.

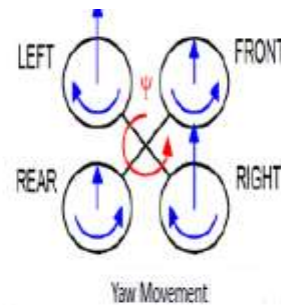


Figure 1.2.5: Quadcopter: Yaw movement.

Example of yaw movement of a quadcopter. As the front and back motor slows down, the forces created by the corresponding rotors are less than the forces created by the left and right rotors. The quadcopter will begin to rotate in the same direction as the faster spinning rotors due to the difference in torque. Pitch movement, Roll movement and yaw movement are the basic rotation of quadcopter to fly in the region of space.

### 1.3 QUADCOPTER HARDWARE

The first step to building a quadcopter is to understand the components that it uses to fly. A quadcopter consists of the following essential parts:

- Frame
- Motors
- ESC (electronic speed controller)
- Propeller
- Battery
- Flight Controller
- RC Receiver

#### 1.3.1 Frame

The frame of a quadcopter is the main structure, or the skeleton upon which the rest of components will be attached. Once you have decided on what you want your craft to do (Aerial Photography, Racing, Micro Freestyle etc.), you need to



Frame

Decide what size best suits your requirements. The size of the frame will determine what size props you will use (or vice versa), in turn the size of the props will determine the size of the motors, which will specify the current rating of your ESC's. When choosing a frame it is important to check that the mounting for the FC (Flight Controller) and the motors match your choice for these components. Full featured flight controllers are most common with 30.5 x 30.5mm mounting pattern. Motors for 5" props often have a 19 x 12mm mounting pattern.

Note: 1st time builders should choose a well documented frame that is easy to work with. This is a great looking frame that is robust and spacious with great access to the components, but a little limiting on the choice of parts. Check out the review of the Diatone 2018 GT M200. This frame also offers great protection to the components which is important because you will crash it!!

### 1.3.2 Flight Controller



Flight controller

The Flight Controller (aka "FC") is the brain of a quadcopter, it has sensors on the board so it can understand how the craft is moving. Using the data provided by these sensors, the FC uses algorithms to calculate how fast each motor should be spinning for the craft to behave as the pilot is instructing via stick inputs on the TX (Radio Transmitter). Most of the wiring on your quad will be focussed around the FC. It needs to have the RX (receiver) connected, so it can be told what the pilot wants the craft to do. Each of the ESC signal and ground wires need to be connected for the FC commands to be carried out by the motors. With the introduction of BetaFlight OSD (On Screen Display). More functions often means more wires. For beginners an "all singing, all dancing" FC might sound fantastic, but the wiring might become very tightly spaced making it difficult to solder. Remember to test fit your components to your frame before you start trimming wires. Measure twice, cut once!

**Note :** Some AIO FC's will have a selection of various different components integrated onto the board from receivers to VTX, now even ESC's are being integrated with FC's though this is quite controversial.

### 1.3.3 RX (Radio Receiver)

Transmitters (TX) and receivers (RX) are not universal and you need to buy an RX that is compatible with your TX, an FrSky Taranis transmitter cannot work with a FlySky receiver. These days it is most likely that you will be using either PPM or a digital Serial protocol, which will only require 1 signal wire for all of the channels, plus power (3.3v or 5v) and GND



RX(Radio Receiver)

The signal wire will be connected to one of the UART terminals on your FC (Flight Controller). Some FC's actually have integrated receivers, if you are taking this route make sure that it is using a compatible protocol.

Builders tip: Make a note of which UART you have connected your RX to, so you can easily configure the FC to communicate with the RX in BetaFlight Configurator.

**Note:** Spektrum based receivers usually require 3.3v while FrSky and FlySky RX require 5v. Never supply 5v to an RX that only requires 3.3v

### 1.3.4 ESC – Electronic Speed Controller

An ESC is a device that interprets signals from the flight controller, and translates those signals into phased electrical pulses to determine the speed of a brushless motor. Make sure that both your FC and ESC's are capable of running the same ESC protocol ie. DShot 600.



Electronic Speed Controller

When selecting an ESC, remember that the current rating must be higher than the amperage drawn by your combination of motors and props.

These days an ESC has 4 input terminals, 2 are for signals coming from the FC. Signal and signal ground are wired to the FC, the 2 heavier wires are for Positive and Negative, they carry the high current to the ESC to supply the motor. These Positive and negative are wired to the PDB. An ESC has 3 output terminals, one for each of the wires of a brushless motor. Some ESC's now offer telemetry.

**Builders tip:** If you are using an FC with an integrated PDB then all 4 wires going to the ESC input will come from the FC. 4-in-1 ESC's are becoming popular as they can shave a few grams off your AUW (All Up Weight or takeoff weight \*inc. Battery and other peripherals). A 4-in-1 ESC can connect to the FC in different ways, and they are not universal – Unless you know exactly what you are getting, I advise you purchase a 4-in-1 ESC as a stack combined with the FC **Note:** The specs provided on the data sheets of motors are under static thrust test conditions. Props spin easier in free air and therefore motors use between 20% and 30% less current in flight conditions than that shown in static tests. If the maximum amperage draw of a motor is the same or just under the maximum current rating of your ESC it should be fine.

### 1.3.5 Motors



Motors

The motors are the main drain of battery power on your quad, therefore getting an efficient combination of propeller and motor is very important. Motor speed is rated in kV, generally a lower kV motor will produce more torque and a higher kV will spin faster, this however is without the prop attached.

There are many aspects to motor performance aside from raw thrust, high among these is how much current the motor draws from the battery. Remember to check the specs of your motors for their maximum amp draw, and ensure that your ESC's are rated to withstand this amperage.

**Builders tip:** The brushless motors that are most commonly used on a miniquad have 3 wires, it doesn't really matter which of the 3 output terminals these are connected to on

the ESC, swapping any of the 3 will change the direction of rotation. Motor rotation can be set in BL\_Heli configurator.

**Note:** Remember to ensure that the motor mounting screws are not too long and that they do not touch the stator windings of the motor. This contact can cause a short in the windings, spelling the end for your motor, also make sure that any grub screws are fitted and tightened.

### 1.3.6 Propellers



Propellers

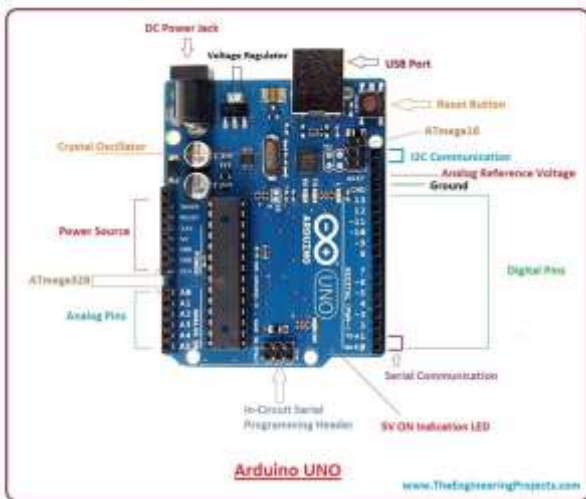
There are possibly thousands of different types of propeller for quadcopters, with multiple options in almost every size. A heavier propeller will require more torque from the motor than a lighter prop, also blades with a higher AOA (Angle Of Attack – aka “aggressive props”) encounter more resistance from the air and require more torque. When a motor has to work hard to turn, it draws more Amps. Finding a balance between the thrust produced and the amperage used by the prop and motor combination is a balancing act that every quad pilot goes through, there is no “right answer”.

**Builders tip:** Remember that your props have to be really tight, it helps to have a tool to grip the motors while tightening the prop nuts. If the props slip this will cause erratic behaviour in flight.

**Note:** Props these days are generally well made, but they may still be unbalanced. If you are getting vibration or ‘jello’ in your camera, check your props are undamaged, unbent and balanced, before your start disassembling!

### 1.3.7 Arduino

Arduino is an open-source electronics platform that makes hardware and software easy to use. The board is able to read inputs from a sensor and turn it to output.



Arduino UNO

Nowadays, Arduino is available with different processors, sizes and price and easy to get them. In this project, the main functionality of Arduino Nano is to interface with sensors, and read data from the connected sensors and send them to Raspberry Pi through USB serial port.

### 1.3.8 Battery



Battery

LiPo batteries are the power sources of the quadcopters. LiPo is used because of the high energy density and high discharge rate. LiPo batteries are rated by their nominal voltage (3.7v per cell), cell count in series, (shown as a number followed by 'S') ie 4S = 14.8v, capacity in mAh (ie.1300mAh) and discharge rate or 'C' rating (ie. 75C).

**Builders tip:** The battery is the single heaviest component of your quad, just because you put a bigger battery on it, it doesn't mean it will fly longer.

**Note:** buying cheap "no name" batteries is not recommended you will find inconsistencies in cell voltage, inflated claims of capacity, and they will suffer from "voltage sag".

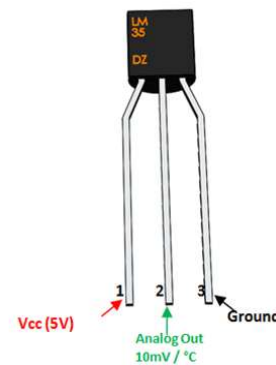
## 1.4 MOTIVATION

This project created a platform to learn about unmanned aerial vehicles such as a quadcopter. This expands the scope of the computer engineering education to include the control and the understanding of the mechanical components. The quadcopter has many applications that we are interested to develop like mapping and reconnaissance especially in a disaster and dangerous area. It also open up the possibilities to broaden the understanding and applications of control systems, stabilization, artificial intelligence and computer image processing as it applies to the quadcopter.

## 2. SENSORS

This Temperature LM35 Sensor and Humidity Sensor features a calibrated digital signal output with the temperature and humidity sensor. Its technology ensures the high reliability and excellent long-term stability. A Arduino board is interfaced with these sensors. This Sensor includes a resistive element and a sense of wet NTC temperature measuring devices. It has excellent quality, fast response, anti-interference ability and high cost performance advantages. Each sensors features extremely accurate calibration of humidity and Temperature calibration. The calibration coefficients stored in the Arduino database, internal sensors detect signals in the process, we should call these calibration coefficients. Small size, low power, making it a variety of applications and even the most useful applications.

### LM35 pin configuration



LM35

### 2.1 LM35 Regulator Features:

Minimum and Maximum Input Voltage is 35V and -2V respectively. Typically 5V.Can measure temperature ranging from -55°C to 150°C

Output voltage is directly proportional (Linear) to temperature (i.e.) there will be a rise of 10mV (0.01V) for every 1°C rise in temperature.

±0.5°C Accuracy

Drain current is less than 60uA

Low cost temperature sensor

Small and hence suitable for remote applications

Available in TO-92, TO-220, TO-CAN and SOIC package

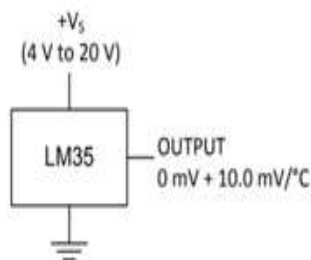
**LM35 Temperature Sensor Equivalent:**

LM34, DS18B20, DS1620, LM94022

**LM35 Temperature Sensor:**

LM35 is a precision Integrated circuit Temperature sensor, whose output voltage varies, based on the temperature around it. It is a small and cheap IC which can be used to measure temperature anywhere between -55°C to 150°C. It can easily be interfaced with any Microcontroller that has ADC function or any development platform like Arduino.

Power the IC by applying a regulated voltage like +5V (Vs) to the input pin and connected the ground pin to the ground of the circuit. Now, you can measure the temperate in form of voltage as shown below.

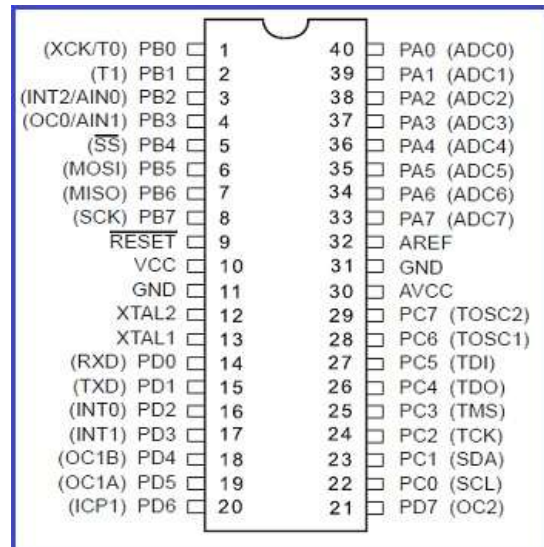


If the temperature is 0°C, then the output voltage will also be 0V. There will be rise of 0.01V (10mV) for every degree Celsius rise in temperature.

**2.3 LM35 Temperature Sensor Applications:**

- Measuring temperature of a particular environment
- Providing thermal shutdown for a circuit/component
- Monitoring Battery Temperature
- Measuring Temperatures for HVAC applications.

**3. AVR Microcontroller Digital I/O Ports**



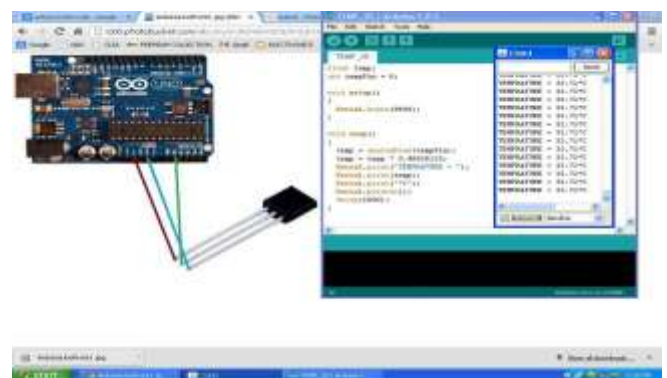
Atmel AVR 8-bits microcontrollers provide pins to **take in/output** information from/to the outside world in the form of logic values. These pins are usually organised in groups of eight and referred to as a port. The AVR use the alphabet to name these port, example **PortA, PortB, etc.** The figure below shows the pins of an AVR 8-bit microcontroller which has four digital I/O ports: **PortA, PortB, PortC** and **PortD**. The pins of PortA are: **PA0 - PA7**.

Notice the alternate name of the Ports pins. The AVR microcontollers are designed to allow dual use of most of its pins. This has the advantage of allowing a developer to use these pins as I/O pins if the function they are provided for is not being utilized.

In this AVR we are only concern with the pins in there Digital I/O function, so for now just forget they have alternate capabilities.

**5. DISPLAYING ON MONITOR USING puTTY CONFIGURATION.**

Finally the stored data in arduino collected using quadcopter is monitored in display using puTTY configuration which is shown in figure3.1



## CONCLUSION

Thus Quadcopter interfaced with Arduino monitored the environment by using temperature sensor LM35 and humidity sensor to measure the fundamental parameters of atmosphere (temperature and humidity). These Unmanned Aerial Vehicle can be used to monitor the regions where humans find difficult to monitor at the field such as forest fire, Area of Emission of poisonous gases

## REFERENCES

- [1] V. Ross. (2011, August) In development: Networks of unmanned quadcopters to ferry medicine to isolated areas. Discover Magazine. Accessed: September 2012. [Online]. Available: <http://blogs.discovermagazine.com/80beats/2011/08/30/in-development-networks-of-%>
- [2] 20unmanned-quadcopters-to-ferry-medicine-to-isolated-areas/#.UTqfsxxgCXg
- [3] G. M. Hoffman, H. Huang, S. L. Waslander, and C. J. Tomlin. Quadrotor helicopter flight dynamics and control: Theory and experiment. Accessed: October 2012. [Online]. Available: <http://hoffmann.stanford.edu/papers/QuadrotorDynamicsGNC07.pdf>
- [4] Hitu Bansal, Dr. Lini Mathew, Ashish Gupta, "Controlling of Temperature and Humidity for an Infant Incubator Using Microcontroller", International Journal of Advanced Research in Electrical and Electronics and Instrumentation Engineering, vol. 4, no. 6, pp. 4975-4982, June 2015
- [5] J. J. Roldán, G. Joossen, D. Sanz, J. del Cerro and A. Barrientos, Mini-UAV Based Sensory System for Measuring Environmental Variables in Greenhouses, Sensors, vol 15, pp. 3334-3350, 2015
- [6] DHT11 temperature and humidity data analysis in Chinese.