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Electronic Control of Unguided Airborne Vehicle (UAV)

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Abstract
The paper deals with building an electronic remote control circuit for Unguided Airborne Vehicle (UAV) based on implementing Dual Tone Multiple Frequency decoder (DTMF) .A microcontroller is used in the design to analyze and execute the commands arriving to the UAV . A Liquid Crystal Display (LCD) is implemented to show the results during the circuit development and test phase. The control of the UAV is done from the ground using a mobile or a personnel computer (PC) supplied with a modem. The DTMF decoder output is connected to the microcontroller which analyzes the commands and accordingly execute them on the control parts in the UAV . The microcontroller issues orders and display the operations on the LCD .
The circuit design assumes the presence of an operating GSM network for the transmission of the control commands .The airborne platform model is a small aircraft carrying the electronic circuit on board. Three stepper motors are used as a means of control to the wings, elevators and rudders in the UAV. .The electronic circuit on board the UAV is well protected to ensue safety of the hardware and perfect performance.
Keywords : microcontroller ,LCD , GSM , DTMF, Control , UAV . .

I. INTRODUCTION

The new generations of technology has redefined communication. Any where we find mobile communication networks installed . But the application of mobile phone cannot just be restricted to sending messages or starting conversations. New innovations and ideas can be generated from it that can further enhance its capabilities. Remote management of several electrical and electronic devices (such as home appliances, office appliances, and even what this paper deals with "control of UAV's") is a subject of growing interest .In recent years we have seen many systems providing such control applications.

II. METHODOLOGY

First of all, it is necessary to analyze the system operation. According to the analysis procedures, the circuit is designed. The designed circuit performs remote mode of operation to control a UAV. The sequence of operations to be performed remotely are:

- Activation of the small engine for take off operation .
- Control of the elevators in the UAV to make it airborne.
- Send ground commands for turning the platform left.
- Send ground commands for turning the platform right.
- Send ground commands for ascending the platform .
- Send ground commands for descending the platform .
- Control of the elevators in the platform to make it land..

Figure (1) below shows the block diagram of the platform remote control circuit design by using DTMF technology.

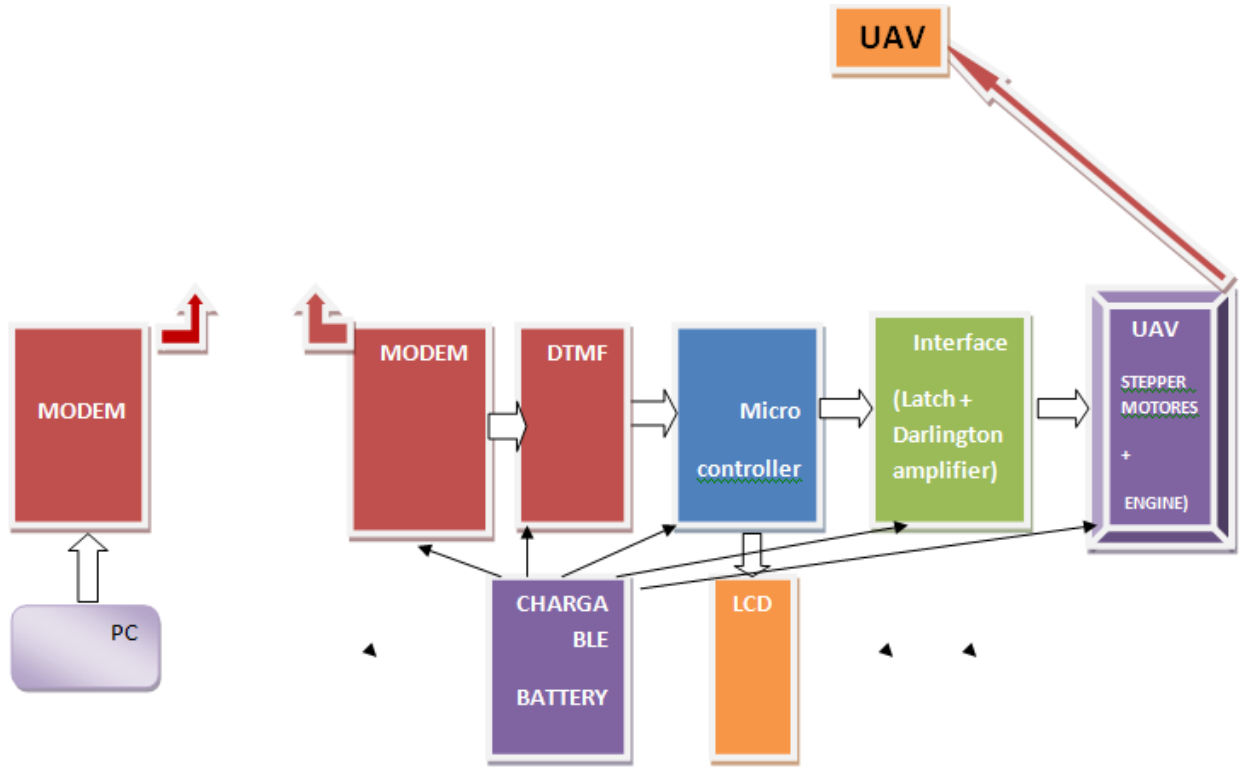

Figure (1) block diagram of the UAV remote control system

The block diagram is an illustration of how to implement the design and the various parts involved in it. The ground control circuit is used as a transmitting section from which the commands to the platform are send. The commands contain guidance instructions to the platform. The received commands by the microcontroller get processed to carry out the required operations. An LCD is used for display to ensure correct system operation during the development phase.

III. HARDWARE COMPONENTS

The main hardware components in the design are :

1. Microcontroller (Atmega32) :

Atmega 32 is a microcontroller from Atmel 8-bit family with 32KB flash memory is used. It is a forty pins integrated circuit. It contains four programmable ports plus an in build ADC.

2. GSM modem:

GSM Modem is used as a means for commands transmission to the UAV. It is very compact in size and easy to use as plug. The Modem is designed to interface PC.. and the microcontroller .

3. LCD 40x2:

The LCD 40x2 is used in the system design for display.

4. DTMF Decoder

DTMF is short for Dual Tone Multi Frequency. The tones produced when dialing on the keypad on the phone could be used to represent the digits, and a separate tone is used for each digit. Pressing any key generate unique tone which consists of two different frequencies one each of higher and lower frequency range. The resultant tone is convolution of two frequencies . Figure (2) shows mobile keypad Frequencies.

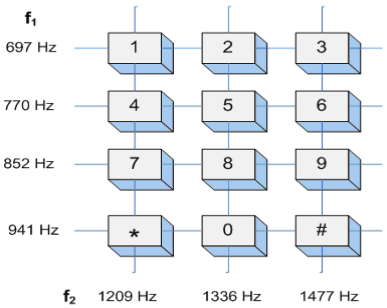

Figure (2) Phone keypad for DTMF generation

Each of these tones is composed of two pure sine waves of the low and high frequencies superimposed on each other. These two frequencies explicitly represent one of the digits on the telephone keypad. Equation (1) shows the generated signal .

$$f(t) = AH \sin(2\pi fH\, t) + AL \sin(2\pi fL\, t) \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where;

AH, AL are the amplitudes.
fH, fL are the frequencies of high & low frequency range.

5. PC Computer:

PC computer hosts developed software to control remotely the UAV. The PC is connected to a GSM modem. The software dictates the processor to handle the controlling process. A corresponding signal is then sent to the other GSM modem onboard the UAV.

6. HD74LS373 Latching IC:

The HD74LS373 is an eight bit register. It is used as a buffer which stores signals for future use. Different types of latches are available. HD74LS373 octal D-type transparent latch will be used in the system.

7. ULN 2803A Darlington IC:

The ULN2803A is a high-voltage, high-current Darlington transistor array. The device consists of eight NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads. The collector-current rating of each Darlington pair is 500 mA. The Darlington pairs may be connected in parallel for higher current capability.

8. Stepper motors :

The stepper motors are connected to the control parts in the UAV .They manipulate the control parts in order to guide the UAV. Equation (2) gives the step angel of the stepper motor.

360 Degrees
Step angle = ---------- = 1.8 Degree / Step …….(2)
200 Steps / revolution

IV. SOFTWARE DESIGN

The programmer is a device used to download the hex files from the computer to the flash memory in the microcontroller.
The program used is BASCOM language. Any program in this language will be saved with an extension (.bas). The compilation performs the following two steps:

- Convert (.bas) extension file to assembly codes.
- The compiler automatically converts the assembly codes to executable (.hex) file that can be downloaded into the microcontroller.

A Pony Prog program is used to download the (.hex) file program into the flash memory of the microcontroller.

V. V. ALGORITH

The microcontroller program on board the platform deals with a fixed format of commands coming from the ground control circuit .We assumed the following commands to be processed and executed by the microcontroller in the platform:
… Command 1 : take off command.
… Command 2 Turn right command.
… Command 3 Turn left command.
… Command 4 ascend command.
… Command 5 descend command.
… Command 6 landing command.

The algorithm contains the main program and six subroutines .Three stepper motors are controlled by the microcontroller. The stepper motors in the UAV are as follows :
…. Stepper motor 1 controls the right wing elevator.
…. Stepper motor 2 controls the left wing elevator.
…. Stepper motor 3 controls the rudder.

The algorithm for the system is ;

Start
--- Check the incoming modem dial tone for authorization.
- If authorized , continue processing.
- If not authorized , deny access and wait for an authorized dial tone.
--- Clear all controlled devices .The DTMF code is (0000)2 .
--- Analyze the incoming code from the DTMF decoder.
Code reception:
--- If the code is equal to (0001)2 , then go to take off subroutine.
--- If the code is equal to (0010)2 , then go to turn right subroutine.
--- If the code is equal to (0011)2 , then go to turn left subroutine.
--- If the code is equal to (0100)2 , then go to ascend subroutine.
--- If the code is equal to (0101)2 , then go to descend subroutine.
--- If the code is equal to (0110)2 , then go to landing subroutine.
--- If the code is equal to (0111)2 , then go to terminate the program.
… Go to code reception.
Terminate the program:
… Display termination on the LCD.
End.

Take off subroutine:
… Display take off on the LCD.
… Activate the engine.
… Activate stepper motors 1&2 for max. elevator angle.
… Delay few seconds.

… Decrease the stepper motors 1&2. elevator angle gradually.
Return

Turn right subroutine:
… Display turn right on the LCD.
… Rotate stepper motors 3 clockwise.
Return

Turn left subroutine:
… Display turn left on the LCD.
… Rotate stepper motors 3 anticlockwise.
Return

Ascend subroutine:
… Display ascend on the LCD.
… Rotate stepper motors 1&2 clockwise.
Return

Descend subroutine:
… Display descend on the LCD.
… Rotate stepper motors 1 &2 anticlockwise.
Return

Landing subroutine:
… Display landing on the LCD.
… Activate stepper motors 1&2 for max. air drug angle.
Return

VI. RESULTS

Many commands have been send from the ground control circuit to the UAV. Table (1) shows the results while sending the commands from the control circuit .

Table (1) Results of sending the commands from the control circuit to the UAV

Ground circuit command No.	DTMF output in Binary	Action performed by the Drone
1	(0001)2	Take off
2	(0010)2	Turn right
3	(0011)2	Turn left
4	(0100)2	Ascend
5	(0101)2	Descend
6	(0110)2	Landing

The commands are executed and the platform performed the relative action. During the experiment some malfunctions occurred. The malfunctions are expected to happen.

VII. CONCLSION

This paper adopts a concept to design a system that acts to receive commands to control the platform in all its operations. Display units are connected to the platform to help in monitoring the system operation in the development phase. The control system is based on implementing the DTMF technology that effectively allows control from remote area to the desired location. The system design is dynamic and further development and modification can be done . The system is made simple and user friendly.

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