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Development of a Remote Control System for an Unmanned Vehicle Using Mobile Phone Based Network.

Md. Syed Ali Molla[1], Md. Abdullah Al Mamun[2], Md. Abdul Alim[3] and G.M. Sultan Mahmud Rana[4]

[1-4]Department of Mechanical Engineering, Khulna University of Engineering (KUET), Bangladesh

[1]mmsali03@yahoo.com, [2]mamun.2k8@gmail.com, [3]m.a.alim08@gmail.com, [4]gsmrana@gmail.com

Abstract-*The RF circuits used in controlling surface vehicle suffer from many drawbacks such as limited working range, limited frequency range and limited control. Moreover sunlight can interfere with the infrared signal during on a bright sunny day. A mobile phone network can overcome these limitations for controlling an unmanned vehicle. It provides the advantages of robust control, working range as large as the coverage area of the service provider in comparison with that of an IR system where no interference with other controllers. This paper presents a mobile phone guided remote control system for the control of unmanned vehicles motors in the test bed. Furthermore, this paper describes the usage of the Dual Tone Multi-Frequency (DTMF) function of the mobile phone, and builds a microcontroller based circuit to control the vehicle to demonstrate a wireless data communication. Practical result obtained showed an appreciable degree of accuracy of the system and friendliness through the use of a microcontroller.*

Keywords: Unmanned Vehicle, GSM Network, Mobile Phone, DTMF Tone.

1. INTRODUCTION

Research is going on different types of unmanned vehicle like on the development of USVs (Unmanned surface vehicles), UAVs (Unmanned Aerial Vehicles) and unmanned water surface vehicle.

During the 1950s throughout the 1960s, General Motors showcased the Firebirds, a series of experimental cars that were described to have an "electronic guide system can rush it over an automatic highway while the driver relaxes".

In the 1980s, a vision-guided Mercedes-Benz robotic van, designed by Ernst Dickmanns and his team at the Bundeswehr University Munich in Munich, Germany, achieved a speed of 39 miles per hour (63 km/h) on streets without traffic [1].

In 1994, the twin robot vehicles VaMP and Vita-2 of Daimler-Benz and Ernst Dickmanns of UniBwM drove more than 620 miles (1,000 km) on a Paris three-lane highway in standard heavy traffic at speeds up to 81 miles per hour (130 km/h), although semi-autonomously with human interventions. They demonstrated autonomous driving in free lanes, convoy driving, and lane changes with autonomous passing of other cars. That same year, Lucas Industries developed parts for a semi-autonomous car in a project that was funded by Jaguar Cars, Lucas, and the UK Department of Trade and Industry [2].

In 1995, Dickmanns' re-engineered autonomous S-Class Mercedes-Benz undertook a 990 miles (1,590 km) journey from Munich in Bavaria, Germany to Copenhagen, Many major automotive manufacturers, including General Motors, Ford, Mercedes Benz, Volkswagen, Audi, Nissan, Toyota, BMW, and Volvo, are testing driverless car systems as of 2013. BMW has been testing driverless systems since around 2005, Audi sent a driverless to 2010 [3-4].

In 2010, Italy's VisLab from the University of Parma, led by Professor Alberto Broggi, ran the VisLab Intercontinental Autonomous Challenge (VIAC), a 9,900-mile (15,900 km) test run which marked the first intercontinental land journey completed by autonomous vehicles. Four driverless electric vans successfully completed the 100-day journey, leaving Parma, Italy, on 20 July 2010, and arriving at the Shanghai Expo in China on 28 October. The research project is co-funded by the European Union CORDIS program.

In 2012, computer scientists at the University of Texas in Austin began developing smart intersections designed for autonomous cars. The intersections will have no traffic lights and no stop signs, instead of using computer programs that will communicate directly with each car on the road [5].

Expert members of the Institute of Electrical and Electronics Engineers (IEEE) have estimated that up to 75% of all vehicles will be autonomous by 2040 [6].

The Google driverless car project maintains a test fleet of autonomous vehicles that has driven 300,000 miles (480,000 km) with no machine-caused accidents as of August 2012,. In 2012, Stanford's Dynamic Design Lab, in collaboration with the Volkswagen Electronics Research Lab, produced Oxford University's 2011 WildCat Project created a modified Bowler Wildcat which is capable of autonomous operation using a flexible and diverse sensor suite.

In February 2013, Oxford University unveiled the RobotCar UK project, an inexpensive autonomous car capable of quickly switching from manual driving to autopilot on learned routes [7-8].

RF control (often abbreviated to R/C or simply RC) is the use of radio signals to remotely control a device. The term is used frequently to refer to the control of model vehicles from a handheld radio transmitter. Industrial, military, and scientific research organizations make use of radio-controlled vehicles as well.

M. M. Syed Ali [9] conducted research work with pneumatic powered robot and firefighting system. A mobile phone was used to operate the firefighting system and the pneumatic powered robot. The firefighting system and pneumatic power robot were operated and controlled by mobile phone guided GSM Network perfectly. This was shown in national TV and ATN News channel in 2008. Later on M. M Syed Ali took an undergraduate research project on GSM Network Base Remote Control System for an Unmanned Vehicle [10]. This scheme is known as Dual Tone Multi-Frequency (DTMF), Touch-Tone or simply tone dialing. The test result showed that mobile phone guided wireless remote control system is applicable to control, surface vehicle and low height aerial vehicle wirelessly. M. M. Syed Ali also conducted research works on automatic firefighting system and robot assisted firefighting system using this mobile phone guided GSM Network where it is found to work satisfactorily

2. FUNCTIONAL BLOCK DIAGRAM OF THE SYSTEM

In this investigation, phones using GSM network interfaced with a microcontroller is used to remotely control an unmanned vehicle motor thus overcoming distance barrier problem and communication over obstacles with very minimal or no interference but is solely network dependent. Here the design and implementation of an unmanned vehicle consisting of a GSM network (a mobile phone), DTMF decoder, microcontroller and a motor driver is presented.

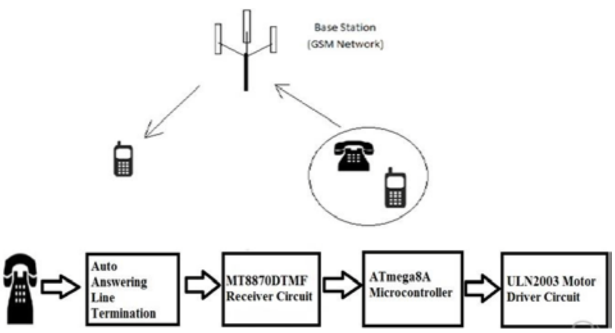

Fig.1: Functional block diagram of the system

The transmitter is a handheld mobile phone. Ordinary low cost mobile phones could be used effectively for this purpose. The diagrams in fig.1 and fig.2 describe the overall system. Here three motors of an unmanned vehicle were controlled by a mobile phone that makes a call to the receiver attached to the robot.

In the first phase of this investigation, a model of aerial vehicle was designed and constructed for laboratory testing. The concerned driving units of the unmanned vehicle were designed to control by remote mobile phone using GSM Network at surface level. In the model unmanned vehicle propeller was designed to run by DC motor instead of Turbo engine. Two more DC motor installed on the wing to drive the Flap of the wing which works during take-off or landing period. While constructing any unmanned vehicle one major mechanical constraint is the number of motors being used. According to the program in the microcontroller, the motors can be operated and controlled from remote area.

3. CIRCUIT DESIGN AND HARDWARE DEVELOPMENT

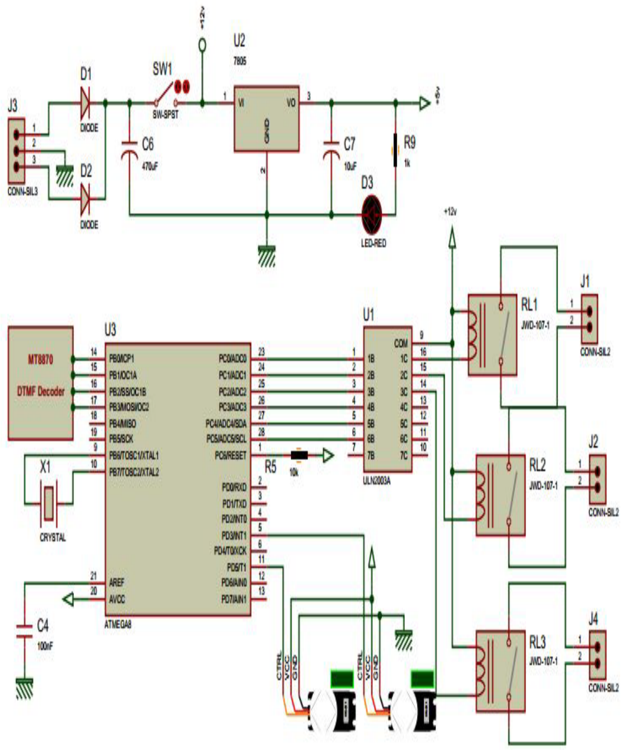

Fig. 2: Schematic diagram of the microcontroller circuit.

In order to control the vehicle, it is necessary to make the circuit so that signal from the mobile phone can send signal to the input of the microcontroller. Special care should be taken in this regard as these wires are laminated and the lamination must be removed before the wires are connected to the DTMF decoder. The decoder receives the tone and sends the corresponding binary number to the microcontroller. According to the program in the microcontroller, the motor of unmanned vehicle will start moving.

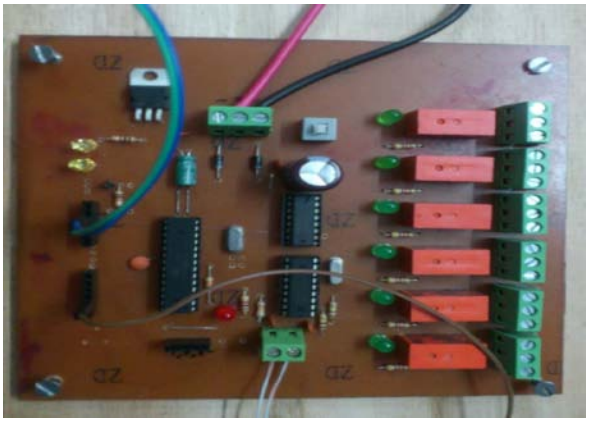

Fig. 3: Main circuit board for Input and Output device with microcontroller.

This hardware circuit is consist of the microcontroller, DTMF decoder, ULN relay driver and the six relay as shown in fig. 3. The ULN2003A is high-voltage high-current Darlington transistor arrays. It consists of seven npn Darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads. The collector-current rating of a single Darlington pair is 500 mA. The Darlington pairs can be paralleled for higher current capability. Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED and gas discharge), line drivers, and logic buffers. The ULN2003A has a 2.7-kΩ series base resistor for each Darlington pair for operation directly with TTL or 5-V CMOS devices. The ULN 2003A are supplied in 16 pin plastic DIP packages with a copper lead frame to reduce thermal resistance.

After accomplishing the circuit, the program is simulated by using Proteus software to check whether it is correct and valid. Simulation is really necessary. Then the program is loaded in the ATmega8 microcontroller by using AVR software. Then the circuit board is made along with the microcontroller. The circuit is checked by LED lights to check whether it works as expected. A 12V relay is connected with the output line from the microcontroller for each motor.

4. CONSTRUCTION OF UNMANNED VEHICLE

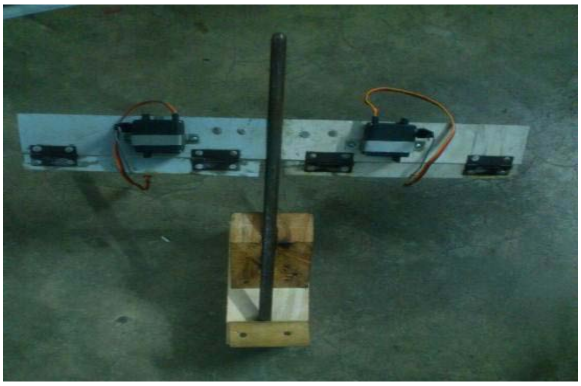

Fig.4: Constructed model of the unmanned vehicle

The constructed model of an unmanned vehicle is shown above in fig. 4 where two wings are mounted on a very rigid steel backbone. Two flaps are mounted on two wings to control lift force and drag force which are urgently required during takeoff or landing. Flaps angles are controlled from the ground controller. A propeller driven by a variable speed DC motors is installed on the ahead of the kite. One more LED is installed instead of Rudder and Elevator controlling motor for the investigation of the UAVs.

5. TESTING

The mobile phone guided wireless control system has been tested in the laboratory properly. During the test, it is found that the signal from mobile phone controls all the controlling systems of the unmanned vehicle in the laboratory. The motors of flaps, ludder and propulsions can be properly controlled by mobile phone. A model of unmanned autonomous vehicle was tested by mobile phone in the laboratory.

6. RESULT AND DISCUSSION

In this research work, the control system of a model Unmanned vehicle was tested. The controlling systems are found to work properly by the Mobile Phone guided Network.

7. CONCLUSION

Designed control system working properly.

- The motor and Flaps on the wing can be rotated and controlled by the mobile phone guided control system.
- Propulsion motor can be operated at variable speed properly by mobile phone guided network.
- Controlling devices for the Rudder and Elevator are found to operate properly.
- The overall control system is found to work in the test bed.

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9. NOMENCLATURE

Symbol	Meaning
GSM	Global System for Mobile Communications
DTMF	Dual Tone Multi-Frequency
LED	Light Emitting Diode