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DESIGN AND IMPLEMENTATION OF COMPUTER CONTROLLED AIRCRAFT (CCA) PROTOTYPE

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ABSTRACT

A Computer Controlled Aircraft (CCA) is controlled from a microprocessor with its control and timing circuitry on a single integrated chip. Microprocessor control has been used virtually in all facets of human endeavour. This work builds a prototype CCA as a demonstration of how this type of system is designed and built. A unique feature of this work is the use of a remotely located Software system to control the aircraft, a deviation from the conventional hardwired circuitry in this type of design. The prototype was built from locally made materials. The control software was coded in a high level visual programming language in Windows platform. The unlicensed radio frequency spectrum was used in order to avoid the cost of licensing the operation of the prototype. Our prototype was constructed and subjected to series of test-runs in the presence of our University's principal officers. The merit of this work is to serve in training

Keywords: *Computer Controlled Aircraft, Microprocessor Controlled, Software Aircraft Control, Prototype of Aircraft System,*

1. INTRODUCTION

Computer Controlled Aircraft (CCA) also called Unmanned Aerial Vehicle (UAV), flies with no man onboard. Their design varies in size from a private jet down to devices that can fit in the palm of a man's hand. Some are flown using remote control while some others are fully autonomous, using onboard Computer to take off, fly and land. In the remotely controlled type, the category to which our design falls, the ground operator must be able to re-direct the aircraft at any time. Automated take-off and landing requires accurate position control and seamless sequencing through various maneuvers [1, 2, 3].

A CCA must detect and respond autonomously to emergency conditions such as loss of radio uplink from the ground operator, loss of global positioning system (GPS) navigation data and engine failure. The need for human piloting, whether from outside or inside the craft, is eliminated for tactical UAVs [1, 4]. The vehicle essentially flies itself while an air vehicle operator directs the flight path using a mouse on a digital map display. The ground operator directs the CCA flight path using a waypoint table. Simple waypoints specify locations in three dimensional space for the CCA to fly through. Location is specified by latitude, longitude and altitude. More complex waypoints define line and paths to be followed through three dimensional spaces. The ground operator preloads a mission in the waypoint table and uploads it as required during flight to redirect the CCA where to go when radio uplink from the ground operator fails. The work done is divided into three modules: power module, control module and aircraft module. The control module consists of the Central processing unit, the software and the interface/transmitter.

The need to design a Computer Controlled Aircraft (CCA) arises from the following reasons among others: to create an alternative when the pilot looses control, to be used in the design of flying bombs and missiles, to serve as aerial targets or drones to shoot during military training, to be used by military intelligence to monitor or spy a particular space and to be used to visit delicate places containing dangerous maters and chemicals [1, 2, 3, 4].

2. PROTOTYPE DESIGN

A. Structural Design

The streamline structure of a glider is shown in figure 1 while figure 2 illustrates the prototype external features.

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On older types of glider the wing was of large area when observed from ventral view and of thick profile when viewed from the front. The length of the wing from wing tip to wing tip is called the wingspan or simply the span. The fuselage is the body of the glider. It provides accommodation for the pilot, houses the controls and instruments, and necessary control rods and cables which activate the control surfaces on the glider's wings and at the tail. The tailplane is the horizontal surface at the rear of the glider. It is either fitted directly onto the fuselage or on the fin, sometimes just above the fuselage but more often at the top of the fins.

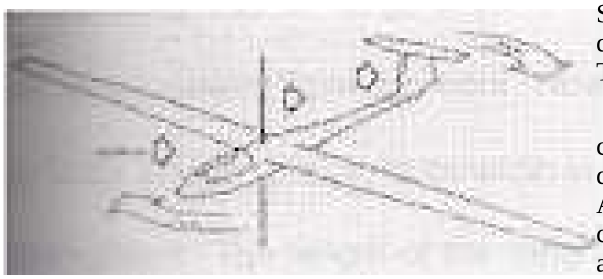

Figure 1: streamline structure of a glider

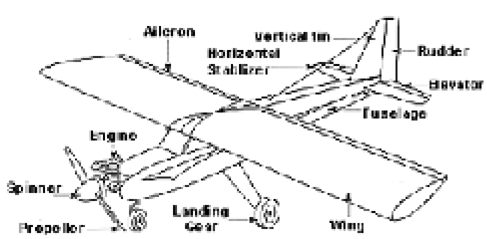

Figure 2: The prototype external features

The following materials were used to construct the Glider body: Float, Cardboard, Aluminum, Plastic, Iron Rod, Glue, Plastic Gum, Motor, Crystal Oscillator, Transistors, Capacitors, Inductor, Resistors, Variable Capacitor, Variable Resistor, Autocoupler, Wood, Nylon etc. The bottom part of the Aircraft was made of plastic materials. The wings are made of floats and carbon paper. Other parts are made up of cardboard while the blade is made up of plastics. The materials listed above were put together with the use of super glue and plastic gum. The wheel was made with metal rod and placed at one third of the aircraft where the weight is acting. All the body material was covered with aluminum foil. The motor which gave the aircraft a forward movement was placed at one third of the aircraft along with the rechargeable battery and the receiver circuit, to enable the centre of gravity to act at that point. The speed of the motor was increased by connecting two parallel capacitors to the power input of the motor.

The University Research Unit supported this work in sponsoring the purchase of all materials used.

B. Control Design

The control column often referred to as the stick is linked to the elevator and the ailerons. Forward or aft movement of the control column will move the elevator down or up respectively. Moving the control column to the left simultaneously causes the aileron on the left to move down. The control column controls the glider's speed and direction. Simply put, the glider will move in the same direction as the pilot moves the control column [6]. The controls are shown in figure 3.

The transmitter and receiver were built around a crystal oscillation of 27mhz which enables 37km distance between the operator and the aircraft. Amplitude modulation was used because we are considering distance and we are not transmitting audio signal [5].

For any circuit to be interfaced with the Computer, it must have a high impedance input and high impedance output in order not to drain too much current from the system. That is why Autocoupler was used to connect the parallel port. together with the transmitter. The software that controls the aircraft prototype was implemented in Delphi 5.0 [5, 6. 7, 8].

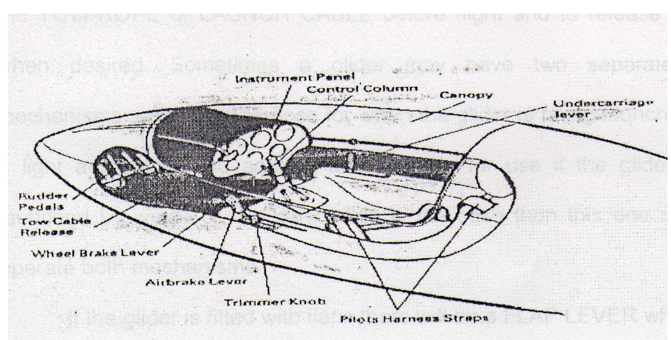

Figure 3: The controls

3. ILLUSTRATION OF GLIDER MOTION

The motion of the glider on ground and in air is controlled by gravitational, lift, thrust and drag forces. The force of gravitation is well understood from elementary physics and it is constant. The lift force generates lift and drag. Lift force is produced by the dynamic pressure of the airflow over the wings and the amount of lift, and drag, generated by the wings is dependent on: the angle of attack, the shape of the wings, the density of the air, the

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velocity of the airflow and the wing plan-form surface area.

Newton's formula for calculating lift is given by [7]:

$$\text{Lift} = C_L \times \tfrac{1}{2}\rho V^2 \times S$$

Where

C_L represents the proportion of total dynamic pressure converted to lift. The value of C_L in ultra light aircraft, without using flaps, normally ranges between 0.1 and 1.5; or 10% to 150% of the total dynamic pressure is converted to lift.

ρ is the density of the air.

V is the velocity of the airflow.

S is the wing plan-form surface area.

The effects of these forces are illustrated in figures 4 to 7.

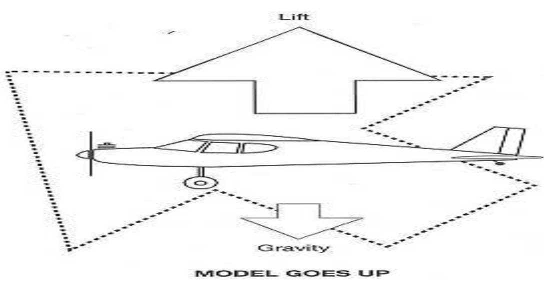

Figure 4: More Lift than Gravitational Pull

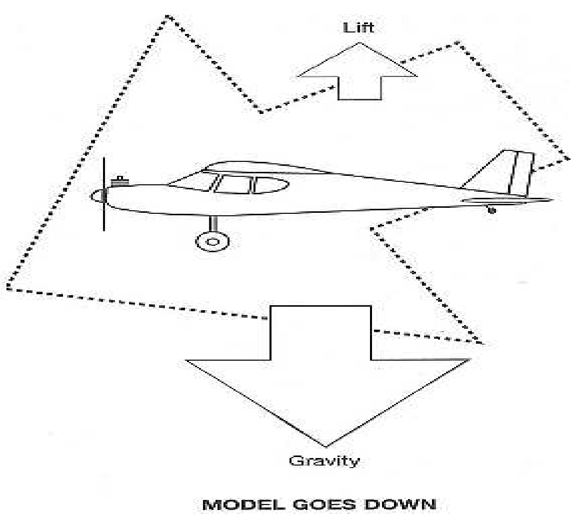

Figure 5: More Gravitational Pull than Lift

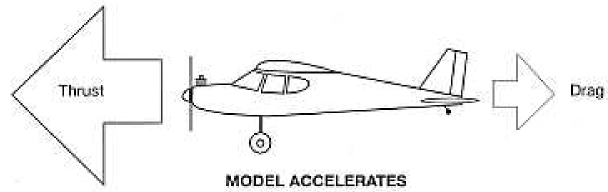

Figure 6: More Thrust than Drag

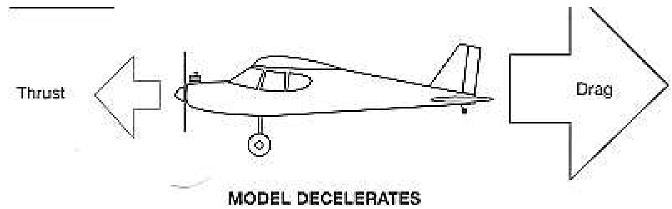

Figure 7: More Drag than Thrust

4. PROTOTYPE TEST-RUNNING

Figure 8 shows the full picture of the prototype aircraft and the interface device constructed. Figure 9 shows the picture of the prototype flying in the sky at the motion ground of Ladoke Akintola University of Technology, Ogbomoso. It was also tested a number of times at various open grounds, in the presence of members of the committee of Deans of the University and a good number of students.

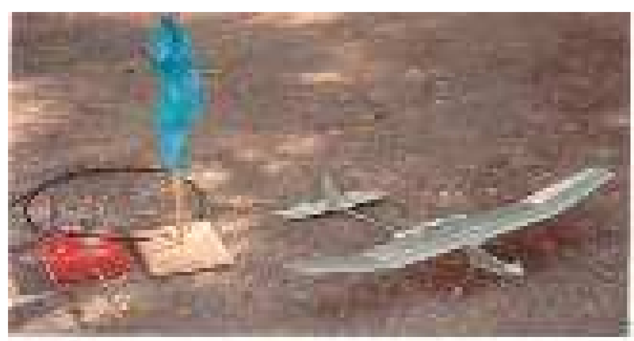

Figure 8: Full Picture of the Prototype Aircraft and the Interface Device Constructed

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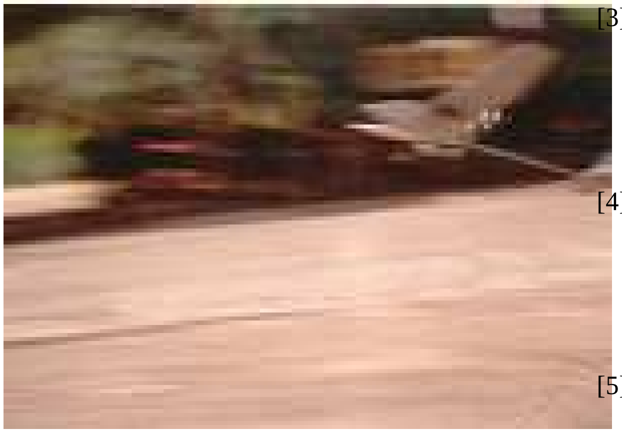

Figure 9: Picture of the Prototype Flying in the Sky

5. CONCLUSION

The design of making use of a Microcomputer as a control tool for Glider, involves the use of computer program to stimulate the working principle of an Aircraft. The use of the software program will also create a lot of flexibility in the centre system such as altering the auto land steps. Aircraft be transmitted via network of computers. The Aircraft is able to land safety when out of control. The control module control, the total activities of Aircraft while supply module supplies the required current in the circuit Further work in the project will be focused on the following ares: 1. The installation of failure or fault indication system. 2. Improvement on the application program 3. Implementation on the Network of the systems.

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