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Embedded Wireless Automatically Watering Plants using UAV

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Abstract. In this paper is intended to study and develop embedded systems for use in controlling the operation of the Unmanned Aerial Vehicle (UVA) to work effectively under automatic control system. As well as to design flight control 4 blades, which uses an ATmega328 microcontroller controls the four motors and fly under equilibrium conditions. The embedded system is defined boundary conditions for UAV to suit the operation of the UAV. The Wi-Fi signal is used to transmit data in order to bring the instruction set processor to control the operation of UAV and displayed to the user immediately. Operation of the UAV based on the conditions that were set by the user to suit the scope of work that user need. Nowadays, high technology machines and robots for use in agriculture is very much in some areas. In order to reduce the work of human and still operates efficiently as well. Thus was born the idea to put apply including embedded systems and robotics in order to be used in agriculture to function effectively. Appropriate to the environment and work under human control.

Introduction

In this era of new technology aircraft have occurred in the both of the commercial and military aerospace. At the commercial passenger aircraft developed every day to passengers, more freight and travel time reduced phase space human spacecraft and space shuttle to space exploration and development of telecommunication systems. And the military has developed a model airplane out many different tasks such as fighter aircraft, attack aircraft bomber aerial refueling aircraft, transport aircraft, patrol aircraft and training aircraft. Most aircraft would need to have an operator to control the operation of the vehicle. The potential risk to the worker was working. Currently, the technology is to control unmanned aircraft to reduce the risk to occur such as the use of remote control and the use of automation in the workplace. The advantage of this works in risk areas and work long time. Small four-rotor helicopter (Quad rotor) [1] was developed to be a small-unmanned aircraft (Unmanned Aerial Vehicle, UAV) [2] is a kind of unmanned vehicles. This vehicle will be used for renovation. Explore the terrain in areas that are very remote way of payment. Or used, as a live weather in the area is high without the need for the driver to reduce the risk of airborne data collected in order to save the cost of hiring large planes.

Motion of Quad Rotor Theory

The force required to lift UAV follow by the Newton's laws $\Sigma F = 0$ so to make a Quad rotor is floating. Sum of lift force must be greater than total weight of Quad rotor. In Fig. 1 as shown the conceptual diagram varying the rotation speed of each motor controls the Quad rotor attitude. The front of rotor (Mf) and back of rotor (Mb) pair rotates in a direction of clockwise, while the right of rotor (Mr) and left of rotor (Ml) pair rotates direction in a counter-clockwise. This configuration is devised in order to balance the drag created by each of the spinning rotor pairs.

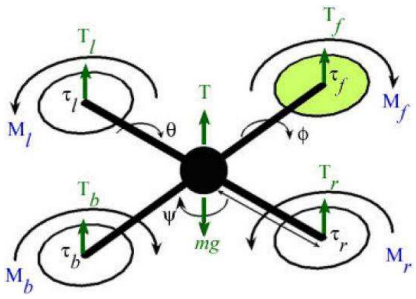

Fig. 1 Conception diagram of a Quad rotor

Four-rotor of aircraft is control achieved by changing the speed of the propellers, which causes torque and lift of each blade change. The four Quad rotors are control principles in various ways as follows. Floating stationary (Hovering) achieved by controlling the rotor speed four to speeds equal to the torque from Fig. 2 to see that each pair of blades to rotate in opposite directions. Torque of the rotor, each pair will cancel the aircraft is turning. Accelerate and reduce vertical speed (Throttle) for Quad rotor, all blades must increase or decrease the speed as well makes Quad rotor fly up or down.

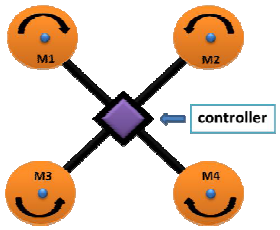

Fig. 2 Hovering diagram

Tilt the left and right (Roll) by Fig. 3 front-left rotor of (M1) and the left (M3) is a speed increase. But right front rotor speed (M2) and right rear (M4) speed is reduced. Cause to tilt to the right. For the left, it is used to tilt the opposite way as Fig. 4.

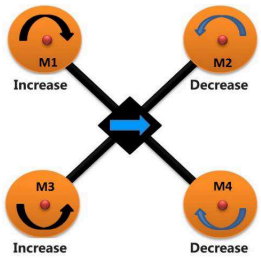

Fig. 3 Roll right diagram

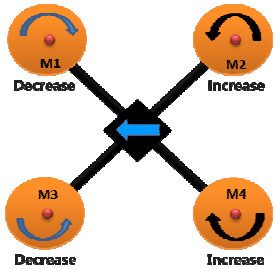

Fig. 4 Roll left diagram

Tilt front and back (Pitch) by this method is similar to tilt left - right. But turning to the Blades Left Front (M1) and right front (M2) has a reduced speed. But the left rear rotor speed (M3) and right rear (M4) will spin faster. Cause the lift at the back and the front rotor is rotating slower than

the front down and made the Quad rotor tilted forward. From Fig. 5 the tilt of the back, it means the opposite, as Fig 6.

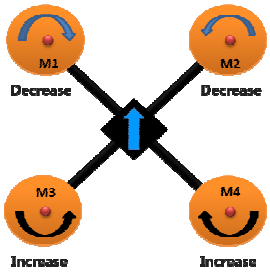

Fig. 5 Moving forward diagram

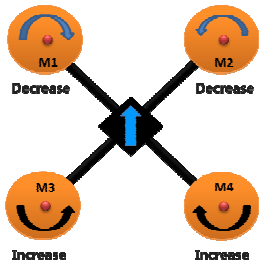

Fig. 6 Moving backward diagram

Counterclockwise - clockwise rotation (Yaw) of the Fig. 7 the speed of the rotor front left (M1) and right rear (M4) over the right front rotor speed (M2) and the left (M3). Then the torque caused by the rotation of the rotor over. The Quad rotor spun counterclockwise. The rotation is clockwise, then the opposite way as Fig. 8.

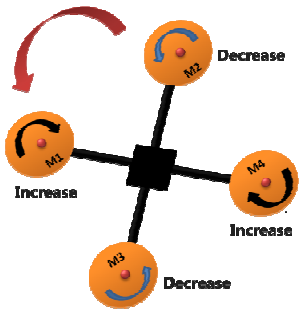

Fig. 7 Counterclockwise yaw diagram

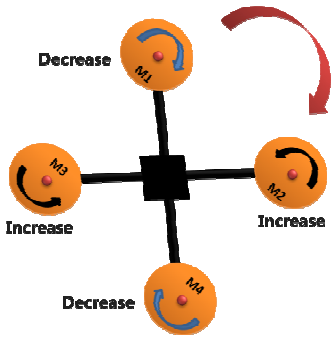

Fig. 8 Clockwise yaw diagram

Hardware Design

A processor board is with microcontroller ATmega328 [3], which controls the operation of all motors, controls UAV including sensors measuring temperature and humidity in order to be processed for batch automatic for control of the UAV. As part of the process in order to display to the user, it uses a microprocessor ARM11 family of processors to use for display steaming video while the performance of the UAV. The processor of board is using ARM11 microprocessor. The processor family is, it is ordered directly to the UAV in order to change the order or set the order aside and boundary conditions are defined. For the structure of the UAV will be used primarily for carbon fiber structures are relatively strong and relatively light weight. And also reduce workload caused by the weight of other parts too. Hub Motor or Brushless DC Motor is brushless. The price of this motor will be higher than with a brush. And control circuits are much more complicated work coil 3 series, but there are many veins and a feedback signal from the hall sensor placed 120 degrees apart or placed nearby. The hall sensor is placed near the edge of the wheel next to the magnets in the motor itself, which should be the power cord from the motor through 8 wire and motors are also available with gear (BLDC Hub Motor [4] with Planetary Gear). The advantage is while rotating will not weigh the same as conventional Hub Motor. But still not as popular as equipment repair difficult, complex, and often with no problems gearbox durability, because nonmetallic. The reason for choosing this motor because there is no exposed parts that wear easily make long-lasting and easy to maintain, no sparks. It does not have power all the time, like blushed make more efficient and consumes less power than the number 4, which will be used to drive the rotor to rotate. Electronic speed control is selected using a power supply with 30 A motor due to electric current up to 30 A motor speed controls to slow rotation and rotation speed. The control signals received from the instruction set. Controlling is using for the container of water is controlled by a servomotor while operating the UAV servo motor is rotated so that the water will flow out of the container properly. The lid of the container of water is injected so that water can be distributed as an aerosol.

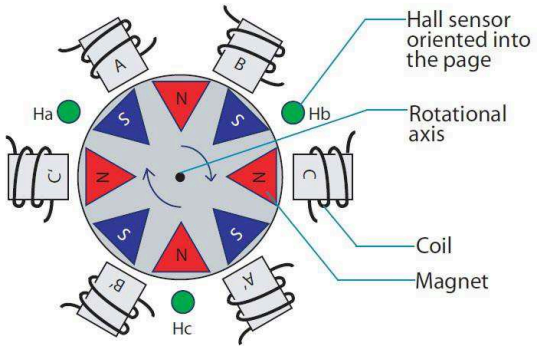

Fig. 9 The permanent magnets of an 8 pole BLDC motor

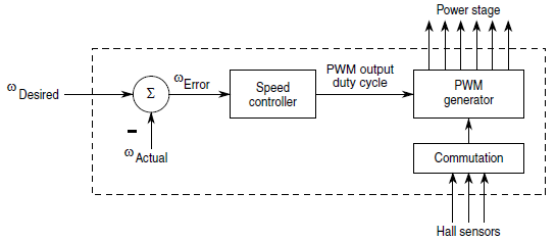

Fig. 10 The Closed loop control of BLDC motor

Software Design

This research develop with C + + to develop a set of instructions. And instruction set developed that has the ability to control the UAV. As well as to develop PHP C Python and JavaScript using functions PHP Execute () to run a command line and will send the return to a string as a command servo motor to get images from the camera. UAV includes receiving value from the sensor to the

display and processing and has the ability to program into the memory of the UAV. To control the robot, the developers have been analyzed and the design prototype UAV controller is easy to use. Therefore, users do not need to have knowledge in control prototype UAV. How-ever, since the UAV prototype is an open source base on Linux operating system, therefore every developer has the right to control the UAV prototype development program called console or library to control UAV prototype or develop his or her own. Firmware can also be solved by prototype UAV as well. The basic UAV proto-type is being installed to make the web server to allow users to connect to the proto-type UAV in order to command the UAV. They can also develop software and the operating system on the UAV Prototype Library as well. Digital I/O is a functional programming style 2 are open – close, yes – no, true - false and 1-0. However, in working with complex, such as generating PWM signals to run GPIO or LCD display 7 segments digital I/O are the basis of all. Only as a function of the digital I/O model used to control the time base causes a form to submit data in a different ways. Using input digital input is used to check whether the voltage is +5 volts or 0 volts if the +5 volt pin status is true, but if it is 0 volts pin status is false Programming interface with digital input, it is programmed to check the status of input pin as true or false. Use output digital will be in determination that works as an output digital is status as +5 volts or 0 volts.

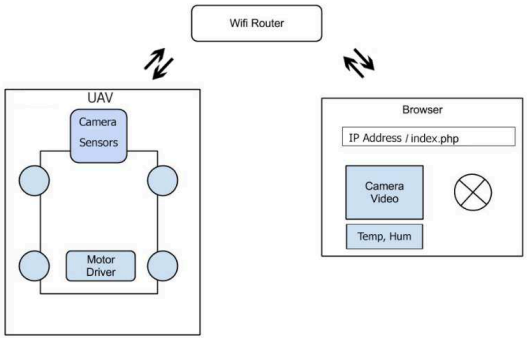

Fig. 11. Principle is controlled through a wireless system

Experimental Results

In this experiment, the researchers implement the test UAV by setting the time to the web server, temperature and humidity to the initial conditions. The system is powered by a 2100 mAh, 11.1 Volt. After that, take the UAV to experiment with vegetables garden at Kasetsart University Sriracha campus. Which at the time specified and match conditions set by the researcher, the rotor is controlled automatically after the motor begins to rotate at a speed at 700rpm. An indication that is the UAV is ready to start operating. When all four rotating motor constant during one period. UAV will fly up to a height of two meters, which means that the motor is rotating at a speed of about 1500-2000rpm. By the way depending on the overall weight of the UAV. When the UAV is in equilibrium at a height of two meters, then a period of time, the robot will have to move forward with the speed relatively constant which the instruction set to instruct the servo motor run up to the water contained in container and then flows down to the ground by gravity. Water flowing out of the water to look into and try to make the distribution of water around the vegetables garden. When the UAV moves a distance that is lined with a distance of ten meters UAV to fly in the balance 4 rotor will rotate with speed equal, and as time passed UAV will move back to the starting point and servo motor will start back working again. When the UAV back to the beginning, Sometimes the UAV, it does not always go back to the beginning, as this may cause the wind to change direction of the UAV. The UAV can be displayed to the user immediately animated features submitted UAV, which has been characterized as the real time camera attached to a UAV that can be displayed in HD and also shows the humidity and temperature to indicate the environment too. However, the processor board used shall be limited, enabling the processing of instructions to slow down, so the performance of the UAV may not be as effective as they should

Conclusions

Study, analysis and create of PID control system of a UAV. The movement is con-trolled automatically. PID affects the response UAV because the PID affects the response to control commands. Because of the P value is a reaction to an error. I value was part of the reaction. The sum of the error over time, start to finish, and D value is the ratio of the reaction and the rate of change of the error. After adjust much or too little will cause the error values are more so cause overshoot and noise and may cause it to be unstable, try adjustments based on theory. For the operation of the UAV at the time the user has defined UAV will fly up to a height and quite fast, so it must have modifying the value to suit the environment and the climate in the area. When the UAV in equilibrium, and then to move forward, and if the wind is quite strong, it may be that the UVA loss of balance, which may cause damage to the devices. When this happens, the user can set the speed of the motor to speed up to make a UAV that can withstand any wind that blows. For while the UAV is that the water will run up the order automatically when the UAV moves forward with phase one of the instruction set are ordered by servo motor automatically. Water inside containers is flown down by gravity and the flow of the particles. But at times, extreme weather conditions or storm will cause water to flow out of the container may be dispersed, which may cause damage to the devices, it is therefore necessary to make the devices covered is resistant to moisture to occur. For display it to the user. Term of that can be displayed depending on the phase of the scattered signal transmission service.

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