DESIGN OF AN AUTOMIZED MICRO AERIAL VEHICLE (MAV) FOR SURVEILLANCE ON LAND, AIR AND IN WATER

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ABSTRACT

The Project aims in designing and development of Micro-Aerial Vehicle (MAV) system, a small flying robot with a rotary wing and an autonomous guidance and control system which is designed for recording Audio and Videos with the use of camera. On Air, land and water the geographical information and navigation system is performed by GPS for communicating with the user. The MAV navigates the waypoint specified by the user and avoids an obstacle in its pathway to reach the destination. The MAV is also designed with Ultrasonic sensor which is used to find the depth of sea and it is programmed by Lab view. MAV play a significant role for human's reconnaissance mission and will be able to approach a dangerous area where human cannot go.

Keywords*:* Autonomous, autopilot, small flying robot (MAV), global positioning system, Ultra sonic sensor

INTRODUCTION

A micro air vehicle (MAV), or micro aerial vehicle, is a class of unmanned aerial vehicle (UAV) that has a size restriction and may be autonomous. Modern craft can be as small as 15 centimetres. Development is driven by commercial, research, government, and military purposes; with insect- sized aircraft reportedly expected in the future. The small craft allows remote observation of hazardous environments inaccessible to ground vehicles. MAVs have been built for hobby purposes, such as aerial robotics contests and aerial photography.

Recently, there has been an ever-growing interest on development of micro air vehicles (MAV) due to its capabilities to fly in indoor/outdoor environments. MAVs can be used to explore terrains and acquire visual information in scenarios where it would be impossible for land vehicles. Additionally, they are very suitable for various applications such as surveillance and reconnaissance operations, traffic monitoring, rescue missions in disaster sites, etc., where manned or regular-sized aerial vehicles are not able to accomplish these missions, even with their full operational capabilities. To accomplish an efficient exploratory navigation in cluttered environments, the MAV must be able to plan and follow three dimensional trajectories avoiding collisions with obstacles and leading through objects. Traditional navigation systems based on the wireless transmitted information, such as Global Positioning System (GPS), is widely used to assure the self-position task. However, most indoor environments remain inaccessible to external positioning systems, limiting the navigation ability of the satellite-based GPS systems.

People are fascinated by three-dimensional space and want to travel the space freely. However, people have their physical limits which they cannot accomplish to fly high by themselves. That is why they have tried to create machines such as aircraft or spacecraft. Although the achievement of making a flight is not easy, the passion of traveling in the air has enabled people to keep developing the production field of three dimensional machines. In addition, in case of natural or artificial disasters, a small flying robot can be very effective for surveying the dangerous areas and narrow space where people cannot go. Because a small flying robot with fixed wing system is rather hard to control, only well-trained people can operate it and it is difficult to reconnoiter a certain area precisely. For surveillance use, a small flying robot with rotary wing system has better performance in missions such as vertical takeoff, hovering capability and low speed performance. Besides, a small hovering robot with an autonomous guidance and control system can offer stable condition and easy control.

Vision-based navigation arises as a complementary system for the GPS. Although based on stereo techniques and share many properties with stereo cameras, RGB-D cameras achieve better performance in the spatial density of depth data. Since RGB-D cameras illuminate a scene with a structured light pattern, they can estimate depth in areas with poor visual texture. Thus structured light RGB-D camera is chosen as the vision-based system which plays a supplementary role in the GPS-denied environment. However most RGB-D cameras function in a limited range and cannot achieve a satisfactory navigation when used as the only sensor for long distances. As a result, we combine GPS with an on-board RGB-D camera to provide the MAV with fast and reliable state estimation and collision-free path planning. There have been previous studies conducted on the MAVs' path planning with avoidance of collision. The Rapidly exploring Random Tree (RRT) variant is proposed by Yang [K. Yang] to generate collision free piecewise paths and linear Model Predictive Control (MPC) is applied to follow this path.

Yang has evaluated the robustness of the system by flying over, flying beneath or flying through obstacles -using doors and windows of a building. Rasche and Stern applied the approach based on artificial potential fields and a gradient method to calculate paths, which ensures the multiple UAVs complete a fast exploration of unknown, partially or completely known environments consisting of complex objects. In terms of on-board vision system for determining obstacles and objects, Huang developed a system for visual odometry and mapping applying an RGBD camera which enables an autonomous flight in cluttered environments using only onboard sensor data. Similarly, Henry presented a RGB-D Mapping system that utilizes a novel joint optimization algorithm to generate dense 3D maps of indoor environment.

In this paper, we require that the MAV accomplishes the task of identifying a window and fly through it, in order to access into a building. The fulfillment of this objective will be quite significant for various military and civil missions of MAVs. In this work, we present a solution to the real-time optimal trajectory generation of a MAV by integrating MPC and vision-based window estimation. Power, size, and time constraints can be met by decreasing the complexity of a SONAR system. Single, separated transducers can be utilized instead of arrays of transducers. This will significantly decrease the amount of data that can be gathered around the environment.

PROPOSED SYSTEM

System Design: There are two kinds of small flying robot with rotary wing system. One is a flying robot with co-axial rotor system. The other is a flying robot with a single rotor system and guide vane set. The robot with co-axial two rotor systems has an advantage of reducing rotor dimension. But on account of a difficulty of flying direction control and increment of weight by using two power motor systems, we chose a flying robot with single rotor and guide vane. The robot with co-axial two rotor systems has an advantage of reducing rotor dimension. But on account of a difficulty of flying direction control and increment of weight by using two power motor systems, we chose a flying robot with single rotor and guide vane having anti torque and direction control functions.

We adapted one rotor blade set and 2 control surface linked with a servomotor to provide directional control and effective anti-torque function, which is more stable than the previous model. It consists of a rotor blade set, electronic speed controller, electronic motorand lithium polymer battery, etc.Small flying robot with rotary wing about 550 mm diameter has outer impact protection frame composed of flexible carbon/epoxy rods. The total weight of the designed flying robot was estimated about 1200g. And expected flying duration time was about 10 minutes. A stabilizer was installed to increase the hovering stability by reducing structural vibration. Moreover, flight control box for autopilot system was mounted on top center of the carbon/epoxy frame

One of the most important sub-systems of our flying robot is the auto-pilot system for autonomous guidance and control. The flight control system (FCS) made of GPS sensor, and IR sensor for altitude control. Our goal of the flight control system was to make it possible to carry out autonomous hovering and way points flying. The estimated weight of the designed FCS is about 2400g

MAV on land and air: LabVIEW coding is loaded into the Arduino board, and from the ground station, instruction to the MAV is send (destination point) via zigbee communication and after getting the instruction, with the use of GPS it will track its path of the destination and reaches it. In its way if its find any obstacles during its flight it will overcome it with the use of IR sensor.

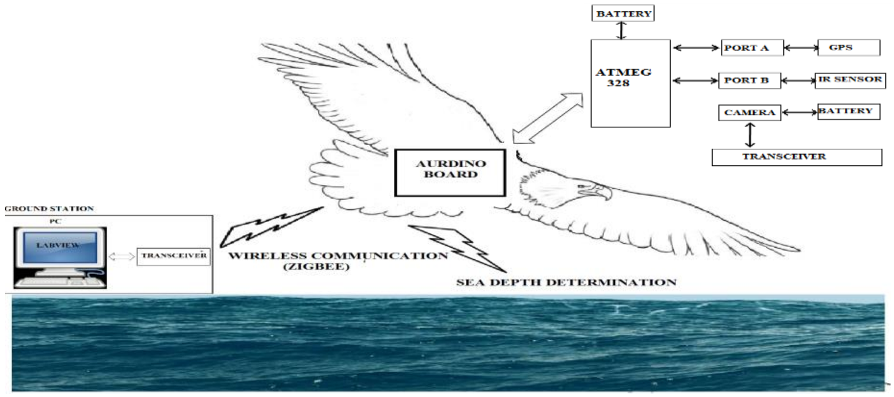

Figure.1.Block Diagram

MAV on sea: The MAV floats like a boat on the surface of the sea in the place where depth has to be determined. The MAV is designed with an ultrasonic sensor. Using this ultrasonic sensor, the MAV sends the signal to the bottom of the sea,once the signal reaches the bottom surface it starts reflecting the signal send by the sensor.By this the depth of the sea can be determined. The determined depth will be in centimeters. This is the hardware working of MAV.Using LabVIEW the program is developed for determining the depth and arduino program is also coded.this program is loaded in to the arduino board and thus it determines the depth.

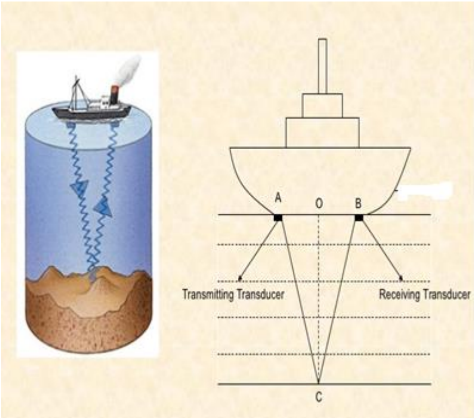

Figure.2.MAV on sea

Basic principle of sensors:

Ultrasonic sensor: Ultrasonic sensor transmit the ultrasonic waves from its senors head and receives the ultrasonic waves reflected by an object.By measuring the length of time from the transmission to reception of the sonic wave,it detect the position of the object.

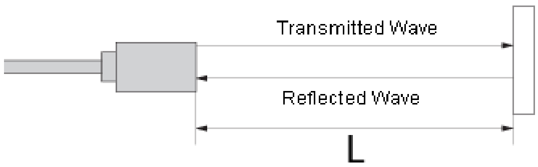

Figure.3.Basic working of ultrasonic sensor

The sensor has a transmitter and the receiver in it for sending and receiving the ultrasonic waves.And it has a 4 pins in it.The 4 pins are VCC,Echo,Trigger and the ground.The supply and the ground pin are connected to the arduino board to which power is given.Echo is to send the ultrasonic waves and Trigger is to see the output i.e depth of the sea is determined

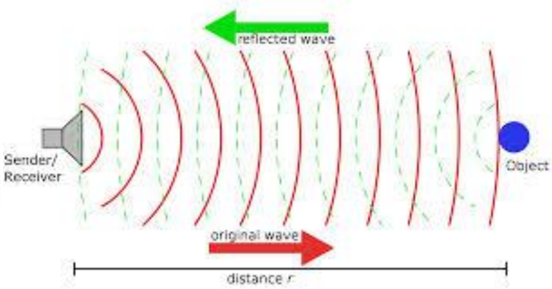

Figure.4.Ultrasonic sensor **Figure.5.Working of the Ultasonic sensor**

IR sensor: An infrared sensor is an electronic instrument which is used to sense certain characteristics of its surroundings by either emitting and/or detectinginfrared radiation. Infrared sensors are also capable of measuring the heat being emitted by an object and detecting motion.

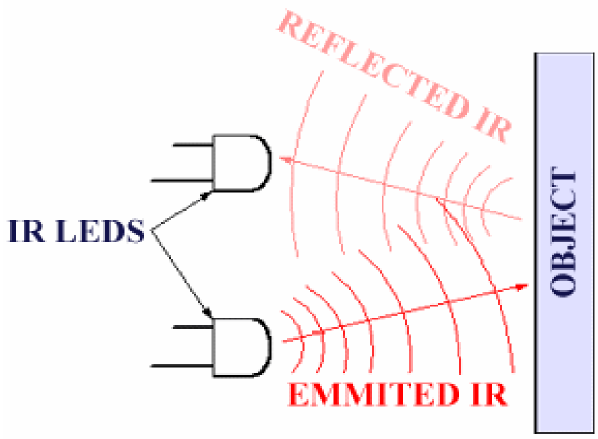

Figure.6.Working of IR sensor

Features of Arduino:

Figure.7.Arduino atmegaa 328

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog input16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to acomputer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

i) Memory: The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library)

ii) Input and Output: Each of the 14 digital pins on the Uno can be used as an input or output, using pin Mode(), digital Write(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms.

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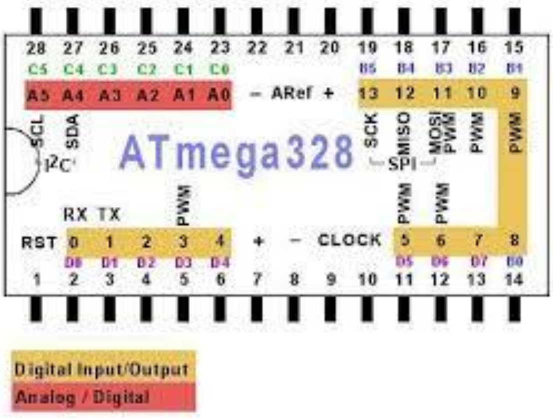

Figure.8.Pin diagram

Arduino interface with labview: NI LabVIEW is a graphical programming environment used by millions of engineers and scientists to develop sophisticated measurement, test, and control systems using intuitive graphical icons and wires that resemble a flowchart. Through the NI LabVIEW Interface for Arduino Toolkit, you can now leverage all of the benefits of NI LabVIEW graphical programming for your Arduino projects. The LIFA (LabVIEW Interface for Arduino) toolkit is a free download which allows a LabVIEW developer to easily get data to and from the ever-popular Arduino microcontroller. The basic architecture behind it is that there is an I/O engine programmed to the Arduino which waits for serial commands from LabVIEW and responds with the requested data or action. This kit includes an Arduino Uno R3 and the LabVIEW Student Edition DVD for Windows and MacOS. Simply load the open-source firmware to the included Arduino Uno, connect it to your computer and install the LabVIEW software.

Wiring diagram:

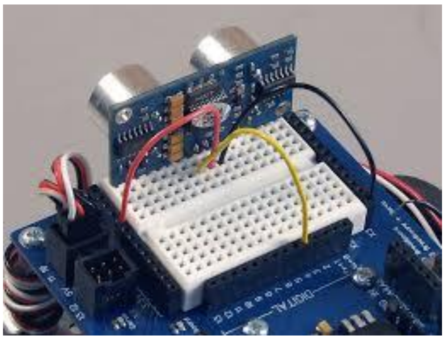

Figure.9.Wiring diagram of Ultrasonic sensor

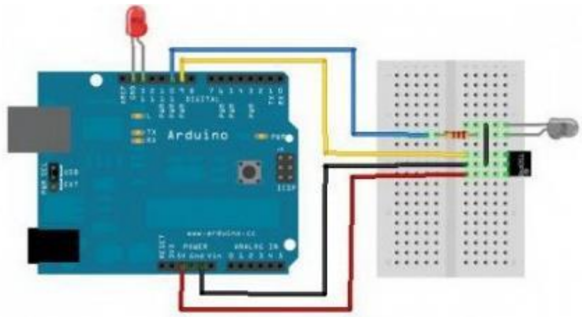

Figure 10 Wiring diagram of IR Sensor

RESULT

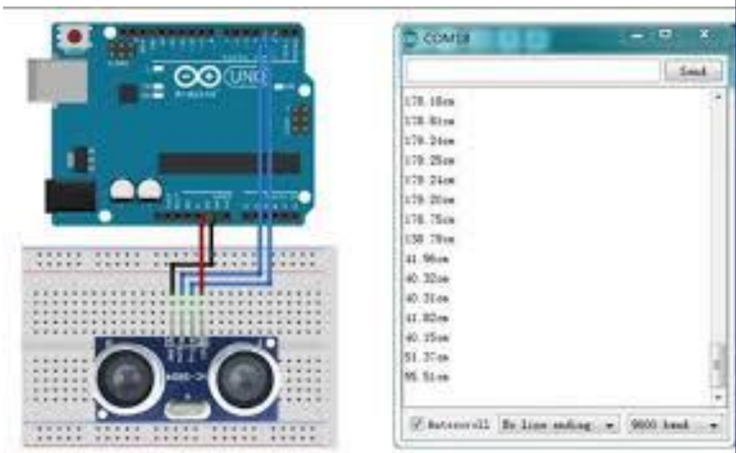

Figure.11.Arduino output of Ultrasonic Sensor

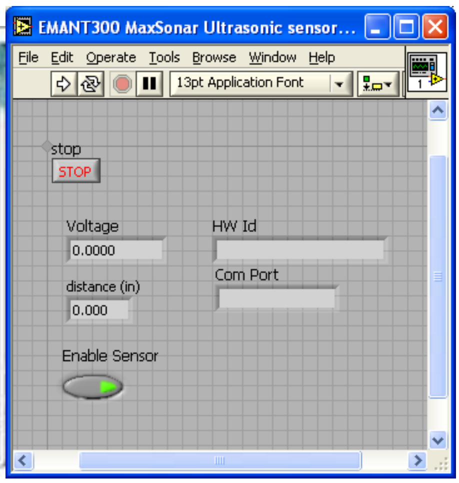

Figure.12.Front panel output of Ultrasonic sensor

After all the connections are given and the arduino program for ultrasonic sensor is loaded into the arduino board,the program is now executed and the output is determined for various distance. And the arduino is interfaced with the LabVIEW, and now the simulated output of the sea.

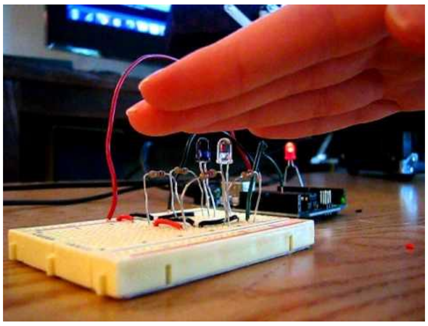

Figure.13.Arduino output of IR sensor

Figure.14.Front Panel output of IR sensor

CONCLUSION

A small robot with rotary wing using one rotor set and were quite successful with semiautopilot system. We calibrated and optimized program using the collected data from sensors. Even though perfect autonomous flight has not done yet, the flight with straight autonomous guidance and control was quite successful if there were no obstacles. But there are several problems to be solved in the autopilot system algorithm and device performance.By expanding this work, we are going to develop a small flying robot with full-autopilot system that can capture and transmit real time video image with auto gain control.

REFERENCES

Soon-Kwan Bae, H. C. Hwang and Kwang-Joon Yoon Nam-Seo Goo,Development of Small Flying Robot with Rotary Wing and Autonomous Control System, Proceedings of the 2007 IEEE International Conference on Robotics and Biomimetics December 15 -18, 2007, Sanya, China

Gerardo Flores, Shuting Zhou, Rogelio Lozano, and Pedro Castillo, A Vision and GPS-Based Real-Time Trajectory Planning for MAV in Unknown Urban Environments,International Conference on Unmanned Aircraft Systems (ICUAS) May 28-31, 2013, Grand Hyatt Atlanta, Atlanta, GA

A. S. Huang, A. Bachrach, P. Henry, M. Krainin, D. Maturana, D. Fox, and N. Roy, Visual odometry and mapping for autonomous flight using an rgb-d camera, Int. Symposium on Robotics Research (ISRR), may 2011.

K. Yang, S. Gan, and S. Sukkarieh, An efficient path planning and control algorithm for ruav's in unknown and cluttered environments, Journal of Intelligent and Robotic Systems, 57(1-4), 2010, 101– 122.

C. Rasche, C. Stern, L. Kleinjohann, and B. Kleinjohann, A distributed multi-uav path planning approach for 3d environments, in Automation, Robotics and Applications (ICARA), 2011 5th International Conference on, 2011, 7 – 12.

P. Henry, M. Krainin, E. Herbst, X. Ren, and D. Fox, Rgb-d mapping: Using depth cameras for dense 3d modeling of indoor environments," Journal of Robotics Research, 31(5), 2012, 647–663.

G.B Kim, N.S. Goo, K.J. Yoon, H.C. Park, Y.H. Yu, Design, fabrication, and performance test of a rotary wing micro aerial vehicle, J. of Aircraft, 43(2), 2006.