International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: 6.614
Available Online at www.journalijcar.org
Volume 7; Issue 9(A); September 2018; Page No. 15248-15251
DOI: http://dx.doi.org/10.24327/ijcar.2018.15251.2781

Research Article

DESIGN AND DEVELOPMENT OF AN AIRBORNE FLOATING DEVICE FOR COMMERCIAL APPLICATIONS

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A R T I C L E I N F O

Article History:

Received 6th June, 2018
Received in revised form 15th July, 2018 Accepted 12th August, 2018
Published online 28th September, 2018

Key words:

Airborne floating device, Dynamic balloon advertisement and monitoring.

A B S T R A C T

For environmental analysis and monitoring wireless sensor instrumentation system controlled by remote hosting device provides the data to ground stations by establishing the connection in between ground and high altitude balloons (HAB). Drone provides the visual data but cannot fly for long duration with additional payload and power source. This paper discusses the airborne floating device (AFD) using of low altitude balloons (LAB), sensors, camera and advertisement unit. The device controlled by wireless Remote would smoothly float in the air by maintaining the equilibrium condition of payload. Device can perform multiple functions such as Sensing of air quality with live display panel, video and photography with real time wireless transmission data on ground stations, LED based Logo and free floating of device. The device is designed to replace printed marketing balloons and providing the live data of air quality in major air polluted areas with advertisement unit.

INTRODUCTION

The Idea of weather balloons for analysing the temperature and atmospheric pressure come out in the early19th Century. Technology and innovation stepped up from pollution measurement to Space applications (Erke Aribas and Evren Daglarli *et al,* 2017). It is not easy to fly an aeroplane or helicopter at low altitude but the helium balloon operated device is preferred for such applications. These systems are accurate, safer and can be controlled with the radio transmitter. This system can be used in case of typhoon, earthquake, tsunami, volcano for analysing the situation for long duration (Satoshi Kubo; Akinori Sakaguch and Takashi Takimoto *et al,* 2014). Apart from this a floating device will be the future of the advertisement, entertainment, security, monitoring and surveillance sectors. It will support the applied research for collecting the complex weather, air quality and temperature data and further can transmit to ground stations and can also be shown live in device display panel during the flight.

Balloons are helium or hydrogen based which are two and three times lighter than air. Helium powered low altitude balloon (LAB) are developed with mechanical controlled system (MCS) for multipurpose applications. System involve flight control unit, payload, air quality sensor, camera and LED logo developed for analysing the air quality in different air polluted traffic areas. (Elie N. Mambou, Gabriel M. Yamga, J. Meyer and H.C Ferreira *et al,* 2016).

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Wireless instrumentation system installed on airborne helium balloon for providing the quick data to local ground stations. Apart from this design for providing the environmental data and helps during the emergency communication services (Veena Divya.K, Dr. R. Swetha.R, Rajasree P.M and Vidy M.J *et al,* 2017). Radio controlled system helps for achieving the safe landing and maintaining the stability of flight with 3-axis gyroscopic sensor (Jack A. Jones *et al,* 2000).

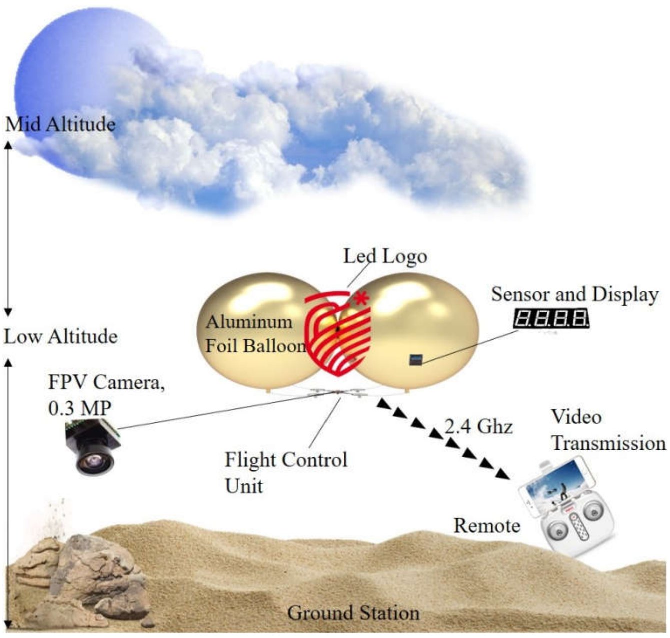

Figure 1 Concept of floating device

There are three different visions in floating concept of balloon, one is stability and air floating of device where the device will be setup with gyroscopic and accelerometer sensor, second making it more advance with integration of digital sensors depends on applications and third where the aesthetics can be reshaped according the applications. The device requires less energy for flying because of maintain the equilibrium condition (Colozza, A. and Dolce, J.*et al,* 2003).

System Evalution and Methodlogy

System designed in five level through systematic innovation approach. In primary levels, Adopted existing electronic components with few minor changes in integration, Wireless communication and data transfer system (DTS). Designed the aesthetics and functional unit of design where introduced LED based advertisement logo with blinking light effects. System considered four balloons and balanced for stable lifting force. In higher levels, Flight unit consists FPV receiver, transmitter and eliminated the additional weight of structure with using of micro components. Air quality sensor (AQS) is setup with a live display panel (LDP). The systemis balanced with payload and maintains the equilibrium condition for free floating of device.

Table 1 Systematic innovation process for system design

Innovation Level	Specification	Percentage
1	Remote, Controlling, Data transfer system	30%
2	LED advertisement panel, Blinking LED	20%
3	Helium balloons, FPV unit, RX TX module, Micro components, Balloon supporting structure	35%
4	Air quality sensor, Live display panel	10%
5	Free floating of device, Equilibrium condition of system	5%

Floating Conditions of Device

In this system we considered Buoyant Force FB which helps for determining the free floating condition of device. It acts toward the upward direction whereas the weight of balloon M_b, payload M_L and weight of helium W_{h2} pushing it in downward direction at y axis.

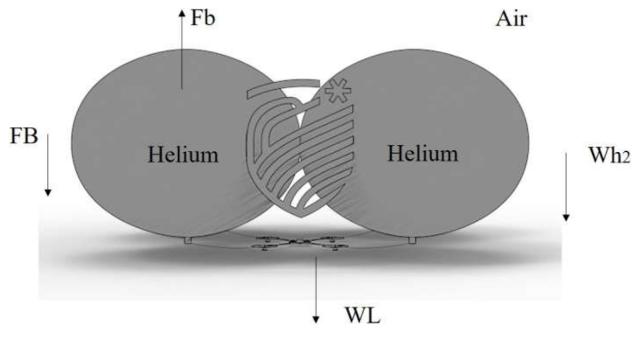

Figure 2 Design Parameters for floating device

Net force on y axis, maximum mass which the balloon can be lift, equilibrium condition of balloon where the device can be freely float on the air and failure condition of balloons calculated by using of equation

$$\sum F = B - wh_2 - w_b$$

$$\sum F_y = \frac{(B - wh_2 - w_b)}{g}$$

Balloon will float in the air when the buoyant force pushing it up is greater or equal to the force pulling it down. That force is gravity and total payload. The buoyant force lifting the object depends on the amount of Air that the object displaces. It also depends on volume of the object.

SWOT Analysis for Market

SWOT analysis was performed for testing the suitable market conditions which is required to match with the strength and opportunity. Weakness and threat analysis helps in implementing the required changes in product and services.

Strength: Product aesthetic, eye catching, no known direct competition, product empower the end user and flexibility of implementation of new business strategies.

Weakness: No global standard, weather and environmental issue, less budget and limited distribution network.

Opportunities: Online platform for marketing, targeting sky advertisement, customer wants new medium of advertising, entertainment and surveillance.

Threats: High initial cost, government regulations and policy on issues like healthcare, safety, privacy and terrorism.

Development of Floating Device

Sensor Interfacing and Coding

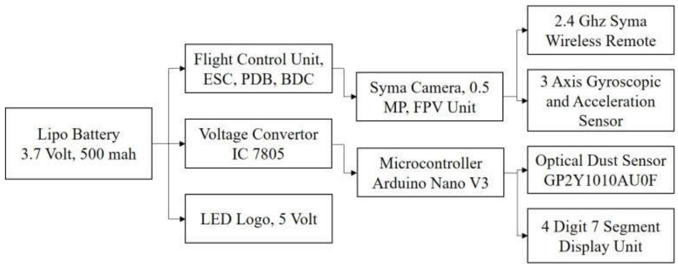

Figure 3 Block Diagram of System

Optical dust sensor GP2Y1010AU0F measures the dust particles presents in the air and displays on 4 digits 7 segment display. Sensor and display is unit interfaced with the arduino V3 Board. Which have atmel atmega382 microcontroller. Code is developed for measuring the voltage and dust particle in micro seconds. When sensor detects the dust particle, it analyzes the size of particle in cubic meter area. A voltage regulator IC 7805 setup with the PCB board for converting and supplying the constant 5 volts to the microcontroller. Air quality sensor (AQS) attached with the balloons for displaying the live data of air quality in different location controlled by remote hosting device.

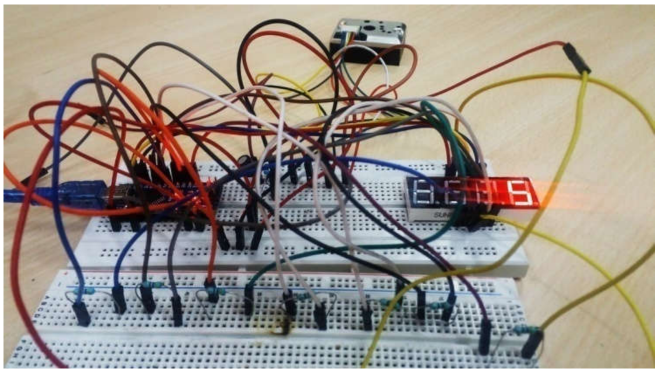

Figure 4 Interfacing of optical dust sensor with display unit

Flight Control Unit and Supporting Structure

Syma Flying Unit of 2.4 Ghz remote frequency is used for controlling the direction, Lift and drag force of balloons. Flight unit having 4 brushed motors with ESC. Where two motors are rotating in clockwise and another two are operating in anti-clockwise direction. Motors are connected with flight controlling unit and receiver. A 0.3 MP camera installed at the front end of body and connected with wireless transmitter module for live video transmission. A 1mm aluminium wire is used for fabricating the light weight structure as shown in figure 6. In one end its joined with bottom of motor and at the another end its connected with a block of thermocol. The corner of thermocol is curvy shaped so the balloon can be easily attached with it. 4 wire setup for maintaining the weight and balance.

Led Logo Development

Thermocol of 10 mm thickness shaped in the university logo by using of printed logo of 210mm * 297mm. A LED strip of 12 volt attached with thermocol and separated at the end of breaking section. LED strip shaped according to width of thermocol and soldered each strip in serial connection at the end of each connection, it connected with a 9 volt battery.

Figure 5 LED advertisement logo

Figure 6 Wire structure

SYSTEM RESULTS

System was executed according to proposed concept and requirements of market as described above. Figure 7 illustrate the final design of device after assembly.

Figure 7 Final design of device

Payload testing

It was tested by leaving the balloons free in the air from the ground for testing the weight carrying capacity under indoor environment. After testing, balloon successfully completedthe flight and achieve the floating condition without operating with instrumentation system.

Figure 8 Payload testing

Testing of Dust Sensor

The dust sensor testing performed with supplied the 5 voltage constantly to arduino board and measured the output data in indoor environment as shown in table 2.

Table 2 Sensor Output data after indoor testing

Voltage Measured	Calculated Voltage	Dust Density
180.00	0.88	0.05
171.00	0.83	0.04
165.00	0.81	0.04

Flight of Device

In this testing phase the flight of device was tested by controlling the syma flight unit. The balloons take off smoothly and fly with some additional thrust which is provided by syma flight unit for controlling the stability and direction of the flight. During the flight the device was transmitting the live video and pictures to the ground station.

Figure 9 Video and photo transmission at ground station

CONCLUSION

Helium balloons with integration of electric motors and sensors improved the performance and life of a flying object. The experimental data and prototype testing supported the hypothesis indicating the better future with the combination of flight control unit and sensors. Experimental flight also shows the relation between the payload and volume of helium. As the volume of helium increases it can carry more payload. The volume should be 10% more of the overall weight of payload for free floating of device. The device completed the flight with carrying the dust sensor, battery, receiver, camera, gyro sensor, acceleration sensor and additional battery pack of 15 grams of weight.

Through this research, experimental and theoretical testing as well as my experience, it is concluded that the helium balloon with electric flight direction unit improved the flight performance and duration of flight. The system is suitable for sky advertisement, videography, monitoring and entertainment applications. It can also be used for academic research and surveillance of disaster areas and can be provide the data to ground stations.

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How to cite this article:

Rajat Saini., Lohit HS and Bala Vignesh (2018) 'Design And Development of An Airborne Floating Device For Commercial Applications', *International Journal of Current Advanced Research,* 07(9), pp. 15248-15251.
DOI: http://dx.doi.org/10.24327/ijcar.2018.15251.2781

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