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Evaluation of Impact Effect on UAV using Piezosensor

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Abstract:

In this present work piezosensors are implemented with Unmanned Aerial Vehicles (UAVs) for real time structural health monitoring application. This piezoelectric sensor is used to sense vibrations with various external disturbances during flight and the received data is stored. This information is transmitted and processed simultaneously for further various applications. This piezoelectric sensor continuously monitors the external disturbances and the corresponding pressure; the data is transmitted and stored to the ground station and SD card, respectively. The transreceiver module which is implemented on UAV transmits the data from UAV to the ground station. This system will be beneficial to manufacture the low cost safety system for UAV

Keywords: *UAV (Unmanned Aerial Vehicle), piezoelectric sensor, Structural health monitoring, Impact effect, Guided wave.*

Introduction

Nowadays passenger and goods transfer through air increases tremendously due to which increase in use of aircrafts and manufacturing of aircrafts, aircraft maintenance is to be improved [1]. Tremendously increasing in air industry demands aircraft which are less costly, efficient to operate and friendly in nature. In which structural integrity of aircraft structures should be ensured in structural health monitoring of system [2]. In structural engineering to do research on Structural Health Monitoring is very important but practical applications need to study more. Structural health monitoring concepts mostly based on monitoring of existing standards and development of new standards integrating design, maintenance and management of constructed facilities are addressed [3].

Improvement in aircraft structure by making it more reliable ,increasing safety of structures and also reduce operational cost of aircraft structural health monitoring plays a vital role in air industry. Information regarding damage state and condition of aircraft structure is provided by the built in sensor which are implemented on aircraft body. Piezoelectric sensors are mostly used transducer for such applications[4]. For more than two decades composite materials are used in air industry because of their very strong behavior of resistance to corrosion, rigidity and stronger in nature than other materials . Integrated system of hardware and software used in SHM which is used for various application[5]. For reliable system detection of accurate behavior of structure sensors are required .In structural health monitoring smart materials ,transmission and processing of data within structure, uses of smart materials and sensors integration is done in SHM .In that impact and structure damage can be detected with the help of sensors [6]. For wireless communication sensors are embedded with microprocessors and are used for monitoring, controlling, and for maintenance. Key issues in SHM are damage detection, locating damage in structure, prediction of fatigue life and damage extent estimation [7]. Many methods are used to monitor impact effect on aircraft, smart composite skins of aircraft have impact monitoring capability but for further advancement need to be done by monitoring the impact

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continuosly.Piezoelectric sensors and guided waves are proposed to monitor the impact effect and to increase reliability [8]. Susceptibity to impact damage is major concern in composite material. Recent developed system which has capability of online impact monitoring in structural health monitoring. Wireless digital impact monitor (WDIM) using PZT are developed with Light in weight, increased efficiency, low power consumption and compressed in size advantages.[9]. Effective technique to safely monitor and aging infrastructures and to increase the life cycle cost of material is SHM. Monitoring the structural changes to infrastructures and to avoid catastrophic failure SHM is used [10]. Air transportation vehicles uses various methods like vibration based method to detect shape irregularities over the system [11].

As composite materials have magnetic susceptibility and conductive property which makes difficult to detect damages on composite material. With the help of sensing coils, magnetostrictive particles single layer and also by using magnetic excitation which is concentric nonconductive detection in delamination of carbon fiber is done [12]. Uses of carbon-fiber composites for aircraft increases day by day . In that important thing is: to check present and future conditions of load in proper way .For the system of heterogeneous materials a structural health monitoring (SHM) development has to be done [13]. In past decades method of noninvasive was major challenge in manufacturing of aerospace. For the aircraft structural health monitoring piezoelectric sensors/ actuators used for the generation and manufacturing of guided waves. [14].Due to necessity of greater safety and security wireless sensors are used .Rapidly growing wireless technology is important for structural health monitoring[15]. Lowering structural strength and stiffness can be cause due to delaminating of structure. To detect delamitation in structure Lamb wave method is used [16]. Non-destructive testing methods are used for detecting cracks in structure. It's difficult to detect and development of fatigue cracks using high penetration on the structure[17]. Improvement in tailoring the excitation via evolutionary algorithms can use for damage detection sensitivity to improve SHM application[18],Tremendously increasing use of UAV, specially small UAV's due to their easier operation and they are easily available in market with low cost. [19] Newly advanced wireless technologies of communication are more reliable, cost effective and safe than terrestrial communication technology. Increasing use of UAV need proper network for communication which becomes necessity for reliable operation, for that UAV network characteristics are need to be studied [20-22]. In this present work piezosensors are implemented with Unmanned Aerial Vehicles (UAVs) for real time structural health monitoring application. In that piezoelectric sensor are used for impact effect detection on UAV. This system will be beneficial to manufacture the low cost safety system for UAV. The core function of our project is to evaluation of impact effect on UAV using piezosensors.

Experimental Setup

In this present work piezosensors are implemented with Unmanned Aerial Vehicles (UAVs) for real time structural health monitoring application. In that we used piezoelectric sensor for impact effect detection on UAV. This system will be beneficial to manufacture the low cost safety system for UAV.In the proposed system as shown in the fig 1, piezoelectric sensors are used to evaluate the impact effect. If any impact occurred on UAV it will sense by the piezoelectric sensor .

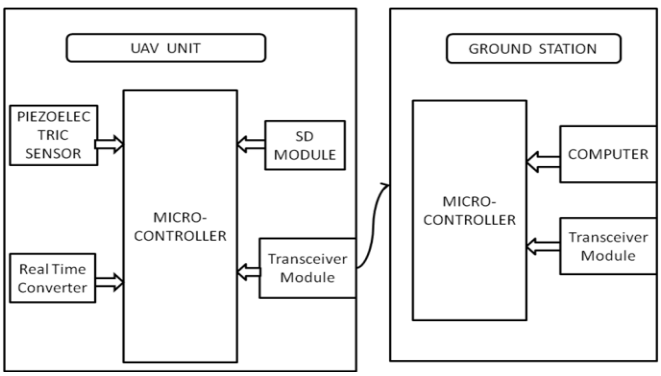

Fig : 1 Proposed damage monitoring algorithm

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After determining the impact by piezozsensor the corresponding data will be provided to microcontroller. In this project the ATmega328 has been used as the main controller. In this newly developed system two different setup or models are present one is on the UAV and other at the ground station. Both the models consist of microcontroller. Setup which is placed on UAV consists of SD Module, real time clock and transceiver which are connected to microcontroller through serial interface. While, ground station model consists of transceiver and computer to display the data provided by the microcontroller.

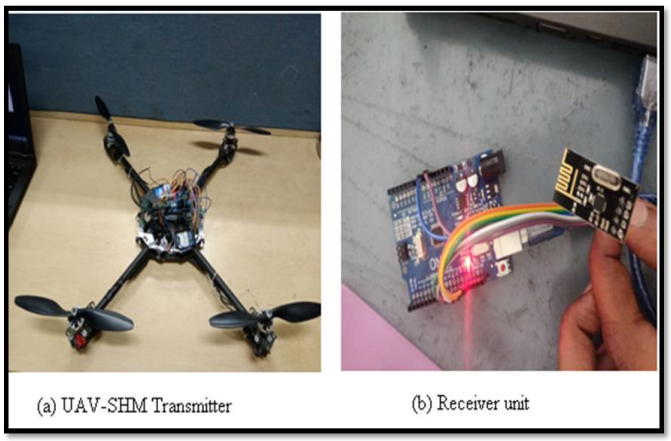

Fig : 2 UAV-SHM demonstration model

In this project piezoelectric sensors, transceivers, microcontrollers, RTC(real-time clock), SD card modules were used at the initial stage which is shown in the fig 2, the codes were entered in microcontrollers for receiving and transmitting the signals. after completing the process of testing transmitting and receiving the data from one microcontroller(UAV) to another microcontroller(ground station) the next step of the process is continued adding codes for RTC, SD module in the transmitting microcontroller. then the SD module and RTC are tested.At last stage of the process, the piezoelectric sensors are added the microcontroller will help to convert analog signals to a digital format which will be sent through the transceiver to the ground station. and the values are been seen when the impact occurs on the sensors each sensor is named to identify the place and location where the impact has occurred.it will be noted as F for front and B for back. The values which is collected when the impact occurs. will send the digital outputs in voltage.

Results and discussion

This system consist of integration of hardware's for the development of project "Evaluation of Impact Effect on UAV using Piezosensor". All modules placed in correct and proper way to make system safe and reliable with this it helps to carry out successful operation of project. The objectives of the project: To manufacture the low cost safety and structural health monitoring system for UAV using piezoelectric sensors testing has done in real time .In the present work of evalution of impact effect on UAV using piezosensor flight testings has been done on the basis of vibrations occurred on flight. The output will be collected and plotted in graph as take-off, steady flight, and landing as given in below graphs.

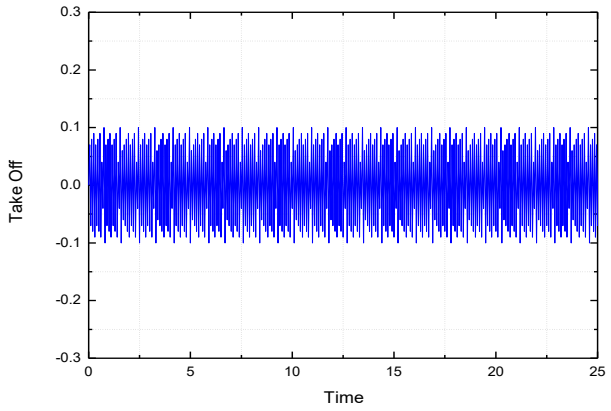

Fig : 3 Raw Measured data of test flight during take-off

The fig 3 and 4 shows the peak differences when the vibrations occurs while taking off their won't be any changes since there won't be any impact occurred at the peak level are equal.

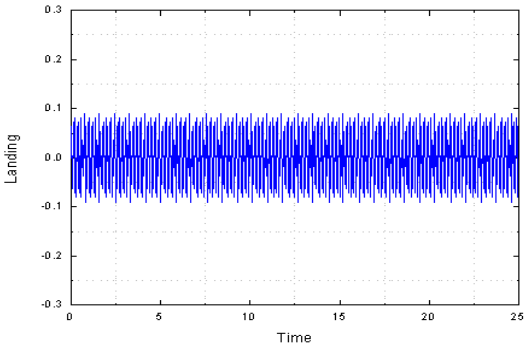

Fig : 4 Raw measurement data of test flight during landing

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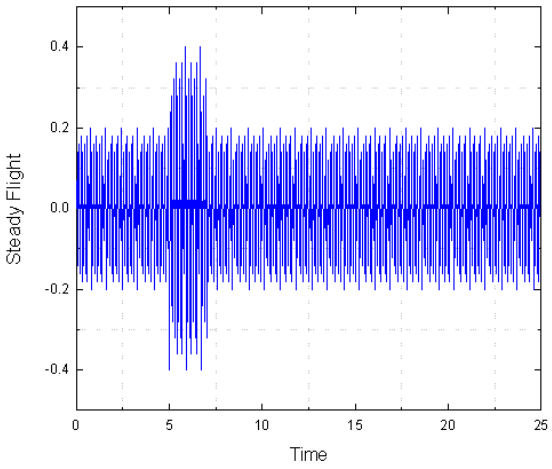

Fig 5 Raw Measured data of test flight during steady flight

The fig 5 will be showing the impact differences when the damage occurred the values are collected and converted into analogue to digital formats that will be plotted as graph the increase in peak level shows the impact of the damage with time difference.

Conclusion

Proposed system consists of hardware components for development of project "**Evaluation of Impact Effect on UAV using Piezosensor**`". The present research work can able to get reliable data as which will be result in feasible UAV system and the main objectives of the research work : To manufacture the low cost safety system for UAV using piezoelectric sensors.

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