ME476C: Senior Design Project

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Status Report: October 18, 2004

Top Issues:

- State of the Art search: As an initial step in the proposal process, research is to be done looking into current PWB mounting methods, analysis, and other related subjects. Attached are some initial search results for journals, patents, websites, and standards research. This is meant to provide an initial idea of the research being done by the design team. Much more research will be performed before completion of the proposal phase
- Proposal Outline: A proposal outline, into which the design team can start putting the proposal body and basing its research around, should be completed this week. It will include input from the Orbital proposal suggestions and requirements document, and the course instructor/text.
- Orbital Visit: The design team will visit Orbital on Friday, October 22, 2004 to get a better experience with some of the equipment/methods related to the project. A meeting will take place from 10:30-11:30 a.m., with the possibility for a plant tour. All team members are United States citizens, and are willing to sign Non-Disclosure Agreements. The extent of the visit is still somewhat dependent on feedback from Orbital security.

Decisions Pending: None

State of the Art Search: Standards

1. A-A-55563, "Holders, Electrical Card, Metal Card Guide, General Requirements for," Defense Supply Center Columbus.

   This standard talks about requirements for a specific type of metal card guide. In the search for new mounting configurations/methods, requirements for new card guide designs are important to look at.

2. A-A-59590, "Holder, Electrical Card, Wedge Retainers, 3 Piece, Screw Actuated Drive, General Requirements for," Defense Supply Center Columbus.

   This standard sets out requirements for a line of wedge retainers. This is another possibility for board mounting, which could be looked into.

3. ASTM E1530-04, "Standard Test Method for Evaluating the Resistance to Thermal Transmission of Materials by the Guarded Heat Flow Meter Technique," ASTM International.

   In our thermal analysis, the thermal resistance values from the center of the board will be used as a measure of the thermal properties of the design. Knowledge of this test method may give insight into important thermal relationships and calculations to be used in analysis.

4. MIL-HDBK-1861, **"**Selection and Use of Electrical and Electronic Assemblies, Boards, Cards, and Associated Har," Defense Supply Center Columbus.

   This handbook examines some possible considerations in the design of PWB and PWB mounting. As such, it could provide some valuable information relating to design of PWB mounting systems.

5. MIL-STD-275, "Printed Wiring for Electronic Equipment," Defense Suppl y Center Columbus.

   This MIL standard gives a general overview of requirements related to PWB construction, parts mounting, and other important aspects. It could be useful in understanding stresses, deflections, and vibration response of the PWB.

State of the Art Search: Website Results

1. http://www.enre.umd.edu/stein.htm

   This is a table of contents for a book on vibration analysis for electronics equipment.

2. http://www.extron.com/product/listbytype.asp?subtype=11

   Here, there are many different designs of mounting plates for electronics. By looking at these designs, we can get an idea of the best types of designs.

3. http://www.nasatech.com/Briefs/Jan99/NPO19972.html

   This web-site provides a briefing on the Multi-Board Module (MBM) scheme and also provides link for detailed technical support for the briefing.

4. http://www.tomshardware.com/howto/20010810/

   This web-site provides a variety of information on printed circuit boards, including different types of PCB's, technologies for component packaging, design and manufacturing processes, and issues to pay attention to in order to save money.

5. http://www.winonics.com/about.html

   Winonics is a pre-manufacturing company for printed wiring boards. The majority of their manufactured products is for the telecommunications and instrumentation segments, but they also manufacture boards for the aerospace industry as well as industrial and computer controls.

State of the Art Search: Patents/Web Results

1. Patent # 6083032 http://patft.uspto.gov/netacgi/nph-Parser?Sect1=PTO2&Sect2=HITOFF&p=1&u=/netahtml/search-bool.html&r=2&f=G&l=50&co1=AND&d=ptxt&s1=PWB.TTL.&s2=mounting&OS=TTL/PWB+AND+mounting&RS=TTL/PWB+AND+mounting

   This patent outlines a mounting method using "combs" that provides multiple mounting locations for the PWB's. The combs attach to the output/inputs of the PWB and facilitate mounting and conduction. This may not be feasible for our design. But it is still an option. The connectors could be integrated into the mount instead of running around them.

2. http://www.samtec.com/flex_circuitry/standard_products.asp

   Here are flex cables similar to those that Orbital uses. This will be helpful for getting some dimensions and specifications for the required size and type of connectors.

3. http://www.regalusa.com/d-subs_-_right_angle_.html

   Here are some subminiature right angle 'D' connectors. It would be helpful to know the number of pins that Orbital requires, but this site should be good for general specifications.

State of the Art Search: Journals

1. Assadian, N., Pourtakdoust, S.H. "Investigation *of thrust effect on the vibrational characteristics of flexible guided missiles*". Journal of Sound and Vibration: Volume 272, Issues 1-2 , 22 April 2004, Pages 287-299.

   In this paper the effect of thrust on the bending behavior of flexible missiles is investigated. For this purpose, the governing equations of motion of a flexible guided missile are derived following the Lagrangian approach. The missile is idealized as a non-uniform beam where the bending elastic deflections are modeled using the method of modal substitution. The vehicle (time varying) bending mode shapes and natural frequencies are determined by modeling variable mass and stiffness distributions with thrust and mass burning effects accounted for. To solve this problem the missile is divided into several segments of uniform stiffness, density and axial force distribution. This approach produces a non-linear transcendental equation, which requires an iterative scheme to numerically determine the magnitude of the eigenvalues. Since inertial measuring units (IMU) also sense the local body vibrations, the mass and stiffness non-uniformities plus the thrust action on elastic missiles can potentially influence their measurements and thus must be properly accounted for in an aero elastic simulation. It is noted that the thrust force reduces the vehicle natural frequency while mass consumption increases it. Thus the modal natural frequencies can either decrease or increase in time. Also the critical buckling thrust, which dynamically causes a zero natural frequency, is obtained and therefore the thrust instability limitations are determined through simulation. With proper modeling of the IMU vibrations effects and engine/thrust fluctuations, the influence of body vibrations on the missile dynamics and controls are investigated with axial thrust effect.

2. De Baetselier E., Goedertier, W. and De Mey, G. "*A survey of the thermal stability of an active heat sink*". Microelectronics and Reliability: Volume 37, Issue 12, December 1997, Pages 1805-1812.

   In cases where forced convective cooling alone is inadequate, or where the size of the housing limits the heat sink' s dimensions, ICs can be cooled using an active heat sink. Compared to a classical finned heat sink, it can benefit from a substantial size reduction or from an important enhancement of the heat transport from the IC to its surroundings. The active heat sink' s function is based upon a Peltier-effect cooling system. The active heat sink controls the IC' s thermal resistance to its surroundings. The Peltier-effect heat pump is a non-linear system. Therefore, surveys of the system' s stability are far from evident. Thermo-electric models for both the Peltier-effect heat pump and a NTCR (Negative Temperature Coefficient Resistance) temperature sensor are presented. These are linked to thermal models for the IC packaging and a finned heat sink on one hand and to electronic models for the controlling circuit on the other hand. Simulation show non-linear thermal behavior and system instabilities according to the power load on the IC, to the forward amplification of the circuit, but also to the ambient temperature change. The latter phenomenon occurs after power-on of the whole device of which the IC is a part. The theoretical results were confirmed by infrared thermo graphic measurements on a self constructed active heat sink.

3. Brönnimann, R. and Hack, E. "*Electronic speckle pattern interferometry deformation measurement on lightweight structures under thermal load*". Optics and Lasers in Engineering: Volume 31, Issue 3 , March 1999, Pages 213-222.

We report on the application of ESPI to measure deformations induced by thermal load on lightweight honeycomb panels for space applications. The panel was mounted isostatically onto a **vibration** isolated table. A **housing** for temperature stabilization was constructed enclosing the panel, heating elements, fans and the ESPI-head made of Invar. Emphasis is put on the quantitative analysis of the deformation of this large object ($0.8\times0.8\ m^2$) viewed from a relatively short distance of 1.1 m and illuminated sequentially from three non-orthogonal directions. Influences of laser stability, rigid body displacements, temperature in homogeneities as well as possible deformations of the measurement head are discussed in order to derive the measurement uncertainty and to estimate corrections. Beside the sensitivity vector analysis it is important to take into account the optical light path changes due to temperature changes. Out-of-plane deformation fields of the panel are presented.

4. Moon, Y., Kim, B., Ko, M., Lee, I. "*Modified modal methods for calculating eigenpair sensitivity of asymmetric damped system*". International Journal for Numerical Methods in Engineering: Volume 60, Issue 11 , Pages 1847 – 1860.

   Many real systems such as moving vehicles on roads, missiles following trajectories and ships in sea water have asymmetric mass, damping and stiffness matrices. Eigen-sensitivity analysis methods for the symmetric damped system cannot be used in the asymmetric damped case. Therefore, a method for calculating eigenpair sensitivity of the asymmetric damped system is needed. To do this, a modal method employing a modal superposition idea was recently developed. Since the accuracy of the modal method is dependent on the number of modes used in calculation, the modal method needs higher eigenvectors to guarantee the accuracy. In large-scale systems, however, only a few lower modes are generally considered for the dynamic analysis. Hence, if the modal method is used to obtain the eigen-sensitivity of the large-scale system, the significant errors could not be avoided due to the lack of the information of higher modes. In this paper, the modified modal methods for computing the sensitivities of the eigenpairs of asymmetric damped system using a few lowest sets of modes are proposed. Numerical example shows that the proposed methods achieve better calculating efficiency than the previous modal method.