Bridge Inspecting with Unmanned Aerial Vehicles R&D

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Project No. 17STLSU11

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Developing a system to assist engineers in the inspection of bridges, and bridge design itself using unmanned aerial vehicles (UAVs)

This project will commence with surveys, data gathering, and analysis to provide recommendations for two instrumented Unmanned Aerial Vehicle Systems (UAVs) for demonstration to determine their application, feasibility, suitability, practicality, and effectiveness according to a defined rubric centered around routine bridge inspection activities. The Research/Technical phase will finish with a report on the findings of the demonstration project, identifying the advantages, disadvantages, and limitations of the use of UAVs in routine bridge inspection work in Louisiana.

Problem Statement

When considering the practical application of Unmanned Aerial Vehicles (UAVs) to the task of bridge inspection, many factors maybe considered in the design of practical UAVs and associated instrumentation.The objective of this study is not to determine ways to replace the bridge engineers or inspectors fully, but instead to achieve a system design to assist and even augment those persons where possible. Therefore, the goal is to achieve a more practical and safe interim solution, which can evolve with technological improvements and changes in the case of UAVs, instrumentation, knowledge in the inspection of bridges, and bridge design itself.While UAV demos have not taken place as of yet, the research done thus far is revealing interesting opportunities for improvement of both commercial off the shelf (COTS) and custom UAVs and Instrumentation, to better meet the needs of bridge inspection and to better assist the needs of bridge inspection engineers in this process.

Summary

The method of initial investigative research within the project has followed four steps:

1. Gaining a useful knowledge of the conventional bridge inspection process, i.e. what human bridge inspectors look for and related ergonomics.
2. Gaining knowledge pertaining to projects similar to our UAV Bridge Inspection Project and pertinent FAA Rules and Regulations for the project at hand.
3. Survey of instrumentation functionality, suitable for use in bridge inspection using UAVs.
4. Survey of UAV functionality, suitable for use in bridge inspection

Figure 1. Draw Bridge, E. Broussard Rd., Lafayette.

Figure 2. Potential Economical Do-it-yourself UAV.

Findings

While the current state of Unmanned Aerial Vehicle (UAV) and Instrumentation technology is impressive, UAVs and the Instruments they can carry, are not naturally suited to bridge inspection. The team found that all "Off the Shelf" Commercial UAVs and Instruments must be adapted or modified in order to be suitable practically for bridge inspection. In some cases, especially with an economically restricted budget, it may be necessary to construct a do it yourself (DIY) UAV and even to construct instruments and fixtures with which to attach them to the UAV. A brief abridged summary of important decisions and findings pertaining to the appropriate design of the UAV bridge inspection system are included below:

1. The Design should be limited to Small Inexpensive UAVs, and to demonstrate that bridge inspections can be economically assisted through UAVs,
2. The Design should seek to use adaptable lightweight off the shelf or custom-built instruments, to maximize flight time and to adapt instruments to bridge inspection,
3. The design should plan to have separate inspection flights, each with a single instrument, so as to maximize flight time given to each bridge inspection pass, and to minimize the cost of a single mishap where instruments may be lost,
4. UAVs and gimbal arrangement will need to be adapted for inspecting beneath the bridge deck, i.e. to include top mounted and upward-looking camera gimbals, upward-looking spot lights to provide a visual light source, and visual location software to allow the UAV's self-location when GPS is lost beneath the bridge deck,
5. The UAV will require special modifications so as to allow it to survive the environment in and around the bridge, including a pressurized gas canister inflated parachute and floats to slow the UAV's fall and to stop it from sinking into the water beneath the bridge, should an emergency occur,
6. Since wind speed and turbulence near and around the bridge can be gusty and significantly greater than at ground level, the UAV flight controller should be equipped with high-speed orientation compensation to face the UAV into the wind, and an automatically adjusting gimbal, to ensure a low wind profile, while maintaining the gathering of visual data, among others.

From the findings herein, it can be inferred that a) commercial off-the-shelf UAVs and instruments require customization to be adequate to the task of bridge inspection. Hence, whether we pursue a do it yourself UAV, or utilize off-the-shelf components, a significant degree of customization will be required, b) a number of logistical difficulties, namely involving FAA regulations and the need for a UAV pilot's license, as well as weather and safety factors, make extensive proof testing in the actual environment slow going, however, the work herein provides a platform of practical improved UAV-Instrumentation design recommendations upon which theories can be tested through experimentation.

Impacts

The research is important in contributing primarily to potential enhancements to the practice of bridge inspection through UAV technology. The application of UAVs to assist in bridge inspection offers substantial economic and safety benefits, but to be accepted it must be seen by bridge inspectors, and the employing organizational entity as useful, practical and offering the aforementioned economic and safety benefits. The Implementation Phase of this project will utilize the informational and educational fruits of the technical research phase for Workforce Development, Outreach Activities, and Education. The Workforce Development activities will provide critical information to both students and practicing engineers pertaining to the deployment of UAVs in bridge inspection.

Tran-SET

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