A Proposal to Review the Propulsion System of an F-35 Class Racing Hovercraft

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Introduction

While hovercrafts are mostly in use today in military operations or for search and rescue operations, their popularity is growing among the general population. However, there is only a small amount of literature and guidance available as to how to design and build a hovercraft. This can be troublesome for those looking to purchase or build a craft of their own. The integration of several systems (lift, propulsion, controls) is necessary for the hovercraft to function properly. If someone is looking to buy/build a hovercraft and doesn't know how to properly choose/design a hovercraft for their specific needs, money will be wasted if the craft does not work properly or is not able to perform the tasks it was intended for. As a senior design project team in the department of aerospace engineering and mechanics, The University of Alabama Hoverteam is to design and build a hovercraft in a timeframe of approximately nine months. Since the team is composed of aerospace engineering undergraduate students, they possess the tools to perform some engineering analysis to aide in proper hovercraft design. This document proposes a review of one specific element of the hovercraft: the propulsion system. The proposed review will investigate the advantages and disadvantages of using a fan versus a propeller in the propulsion system of an F-35 class hovercraft. An optimal design of the propulsion system will also be discussed.

Motivation

As a member of The University of Alabama Hoverteam, I have a vested interest in the project's success. The culmination of the design project involves a hovercraft race against Auburn University. In order to win the race, a properly designed hovercraft is a necessity. In past years, only a small amount of analysis was performed to determine what the optimal propulsion system for the hovercraft might consist of. A lack of time also contributed to an inadequate propulsion system for the 2013-2014 hovercraft. An improperly designed propeller led to the use of a 45" diameter fan in a 48" duct. While the system worked, it was not optimal. There are several variables to consider such as fan vs. propeller, free vs. ducted, fan/propeller diameter, and weight. The proposed review will examine all of the aforementioned variables in an attempt to choose an optimal propulsion system for the Hoverteam F-35 racing hovercraft. In performing this analysis before the construction of the hovercraft is begun, I hope to have a propulsion system design ready to go when the time comes for it to be installed.

Deliverables

It is expected that this design process will include a final decision for each of the following variables:

- Fan or Propeller
- Free or ducted fan/propeller

- Diameter of fan/propeller

The engine for the propulsion system has already been chosen. All calculations will be done using the horsepower value for the chosen engine.

Literature Review

References for all literature listed in the section are located at the end of the proposal.

When presenting/writing about a topic such as a hovercraft, it is important that the audience has an understanding of how the object works before going into the details of a component of the object (in this case, the propulsion system). Since hovercrafts are not something that is widely used, an introduction on how a hovercraft works is necessary. A textbook from the The University of Alabama Department of Aerospace Engineering entitled Theory and Design of Air Cushion Craft contains some useful information. The Hoverclub of America (HCA) website will also be referred to when describing the classes of hovercraft (e.g. F-35) that can be built/raced.

In order to build a hovercraft that is to be raced in an HCA sanctioned event, many regulations must be adhered to. Relevant to this proposed review of the propulsion system are regulations relating to safety and noise. For these regulations, the HCA Racing Regulations for Light Hovercraft and HCA Construction Regulations for Light Hovercraft will be referred to.

To calculate the thrust produced by the different propulsion system configurations, three main sources will be used: A textbook entitled Mechanics and Thermodynamics of Propulsion, a webpage entitled Performance of Propellers and AEM 408 – Propulsion class notes. These materials discuss theories of calculating the propulsive force produced by a propeller/fan. The DiscoverHover Curriculum Guide website also includes an ideal estimate for the amount of thrust produced by a propeller.

After calculations are complete, analysis must be completed to choose the propulsion system configuration that is best suited for the hovercraft. A Pugh matrix will be employed to help with this decision, as many factors must be considered (thrust produced, weight, cost, etc.). For guidance on Pugh matrices, a webpage entitled Decision Matrix will be used.

With regards to other papers published on propulsion of a hovercraft, there are almost none to be found. Hovercrafts used for activities such as racing are a fairly new concept. Much of what is learned about the field has come from amateur experimentation and experience. However, there are many published papers regarding propeller and fan propulsion. This propulsion system review should confirm what has been discovered through experimentation.

Management Plan

The following section includes my schedule and costs for the proposed propulsion system analysis. The analysis will culminate with a presentation on December 2nd and a formal technical paper due on December 12th. Most of my time will be spent obtaining the sources and information needed to prepare the data and preparing the presentation and report.

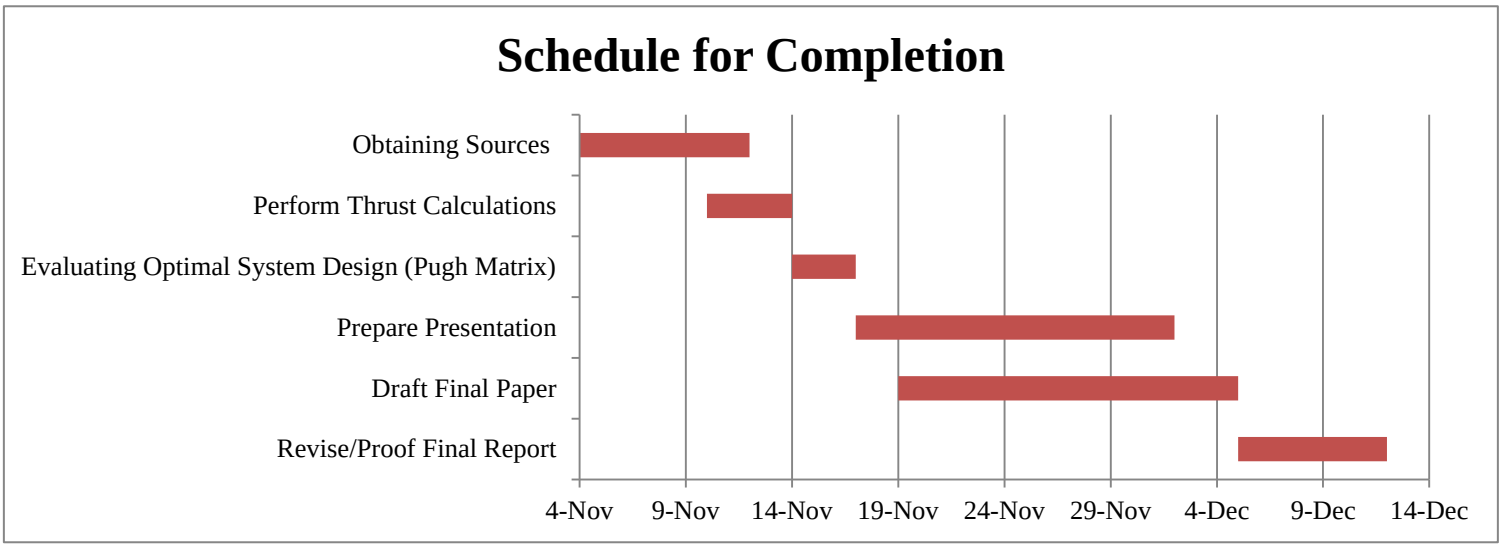

Figure 1. Schedule for completion of proposed hovercraft propulsion system review

There is no cost associated with performing this analysis. All sources will be obtained from my personal library of textbooks, the internet, or textbooks owned by The University of Alabama Department of Aerospace Engineering and Mechanics.

Team Members/Qualifications

This project has one member, Amber Deja. I am a senior in the Aerospace Engineering and Mechanics department at The University of Alabama. In my undergraduate curriculum I have completed classes in fluid mechanics, low and high speed aerodynamics, and am currently enrolled in propulsion class. My work with the Hoverteam this year has also provided some hands-on experience with the systems required to design and build a hovercraft. These courses and hands-on experience have provided me with the tools that I need to complete the proposed analysis.

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