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SMALL- SCALE AEROSTATIC CRAFT PERFORMANCE TEST

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ABSTRACT

This study aims to determine the performance of a lightweight small scale Aerostatic craft. A lightweight material such as plastic or high-density foam might be able to reduce the weight of the craft. The minimum weight of the craft was set at 800gram and a maximum is 1.4kg with a 200gram increment. The lifting performance was determined at 7.5m/s and 15m/s while for the thrust performance at 5m/s and 10m/s. The optimum height and speed for the Aerostatic craft to operate were determined. The result showed that the height and speed of the craft changed based on the weight added. For the lifting performance, the height of the craft reduced approximately 22.5% and for thrust performance, the speed reduced by 33% when 200g weight is added.

Keyword. Aerostatic craft, propeller, lifting motor, thrust motor

1. INTRODUCTION

Air cushion vehicle (ACV), hovercraft of aerostatic craft referred to the same objects. This object was designed and used to travel on land, water and even on mud and ice at alternative speed and stationary speed. The aerostatic craft or hovercraft or air cushion vehicles float on the water and land even over a small depression such as a bump, ditch or over waves. It is suspended between above the water on a cushion of air [1]. An aerostatic craft designed with a powerful fan as part of the air cushion to hover. Modern aerostatic craft is used for many applications where people and equipment need to travel at speed over water and capable of climbing the slope up to 20% depending on surface characteristics [2]. A large volume of air below the planform is higher than atmospheric pressure to produces lift that causes the planform to float above the ground. The holes or slots on the rounded-rectangular shape planform blown by the air to create stability and giving moist aerostatic craft characteristics [3]. The skirt located at the edge of Aerostatic craft used a flexible curtain of materials, made from rubber and light to reduce the damage over a small obstruction. The entire skirt will be replaced if the skirt was torn out [4]. The back pressure of the propeller was used to move the aerostatic craft forward and turning using the rudder located at the edge of the planform. The air force down under the aerostatic craft vehicles create lift force usually supported by fan and the forward propulsion supported by propeller [5].
In this study, a small-scale aerostatic craft is fabricated using lightweight materials such as plastic and composite to create a small craft that gains lift and thrust force

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[6]. The performance of the speed, lifting and thrust was investigated based on weight provided.

2. SMALL SCALE AEROSTATIC CRAFT FABRICATION TESTING PROCEDURE

The small scale aerostatic craft was designed and illustrated in CATIA V5R19 software. All the components were assembling as shown in Figure 1. The planform, the lifting motor, thrust motor, propellers, skirt and batteries were also illustrated in Figure 2. The Fly Sky FST6 transmitter was used to control the small-scale aerostatic craft movement. Using the ECS (Electronic Speed Controller) to the receiver of the controller, the movement of the rudder, lifting and thrust can be controlled as shown in Figure 3. The Fly Sky FST6 transmitter has 6 channels but only 3 channels are used to control the movement. Channel 1 for rudder movement, Channel 2 for lifting motor and Channel 3 for thrust motor.

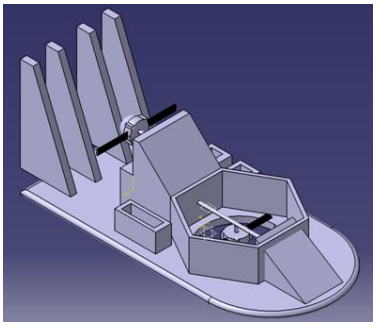

Figure 1: CATIA V5R19 drawing of the isometric view of small scale aerostatic craft[6]

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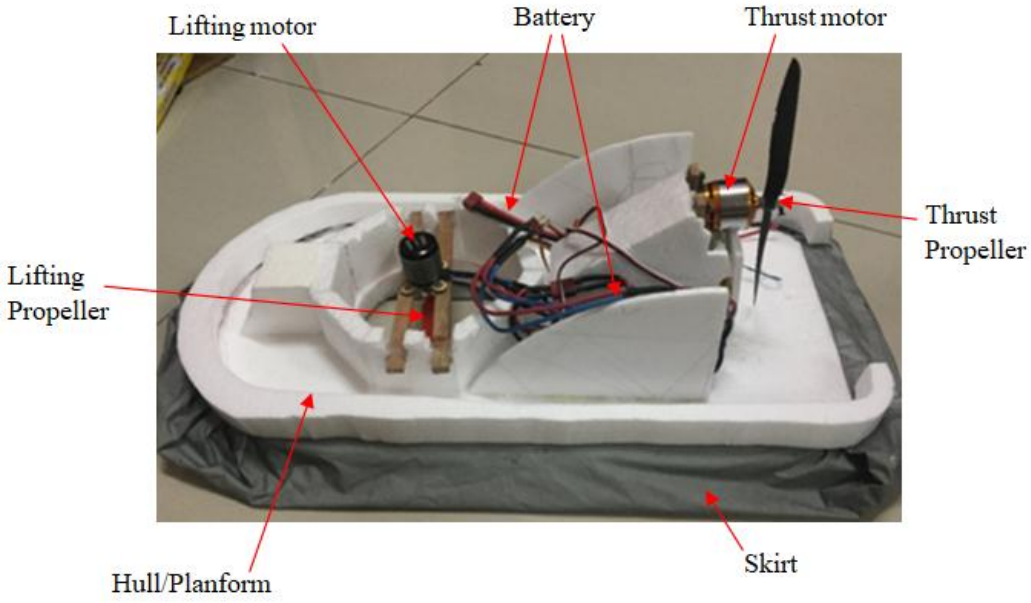

Figure 2: The fabrication of small scale aerostatic craft[6]

(a) (b)

Figure 3: (a) Fly Sky FS T6 Transmitter; (b) Receiver

Before the actual testing is carried out, the mock-up test is randomly tested to check any defect to ensure small scale aerostatic craft in good condition. The testing of the craft will be done on a flat surface. During the testing, the model will be exposed to different propeller speed and different weight was recorded. The speed of the propeller is measured by using the Anemometer. The craft weighs around 800 grams and the motor was capable to lift the weight with a maximum of 1400g. The test will be added 200gram from 800gram, 1.0 kg, 1.2kg and 1.4kg.

3. RESULT AND DISCUSSION

Lifting motor performance

The height of the aerostatic craft from the lifting force was determined with different weights from 800gram to 1.4kg. The propeller speed was tested with 7.5m/s and 15m/s. The height was measure from the ground until the motor lifting. At 800gram, the craft itself is very light for the motor to operate. At 7.5m/s the craft lift 14cm

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height and 1.65cm height for 15m/s. From the observation, the craft is not stable and not efficient in lifting the craft.

To balance the weight of the craft, the clay was used. 200gram was added and the craft weighed 1.0kg. The clay was added at the front part of the planform to balance the craft. At 7.5m/s, the craft lift 11.4cm height, and at 15m/s the craft lift 15.2cm height reduces by 18.5% and 7.8% from 800 gram respectively. From the observation, the 1.0kg craft is very stable and easy to operate.

Then, 400gram more of clay was added to the front and the middle part of the craft to balance the craft operation. At 7.5m/s, the craft lift 10.2cm height reduced by 27% and 15m/s craft lift at 13.5 height reduced up to 18% from the 800gram weight. The craft with 1.2kg has a stable operation but needs extra power to lift and operate.

The 600gram was added to the craft. At 7.5m/s, the craft lift at 9.9cm height reduced by 29% and 11.9cm height for 15m/s reduced approximately 28% from the 800gram craft. The craft needs extra power and time to lift due to the weight is quite heavy. The motor setup is not suitable to support the weight of the craft. For 7.5m/s, the maximum lift height is 14cm and the minimum is 9.9cm from 800gram to 1.4kg craft. Meanwhile, for 15m/s, the maximum lift height is at 16.5cm for 800gram and the minimum is 11.9cm for 1.4kg. The less power used to operate and create a higher lift at 800gram. But, only 1kg craft is the most stable and balanced compared to other craft weight. The lift for the craft reduces approximately by 25% as the weight added by 200gram for 7.5m/s and approximately 20% for 15m/s.

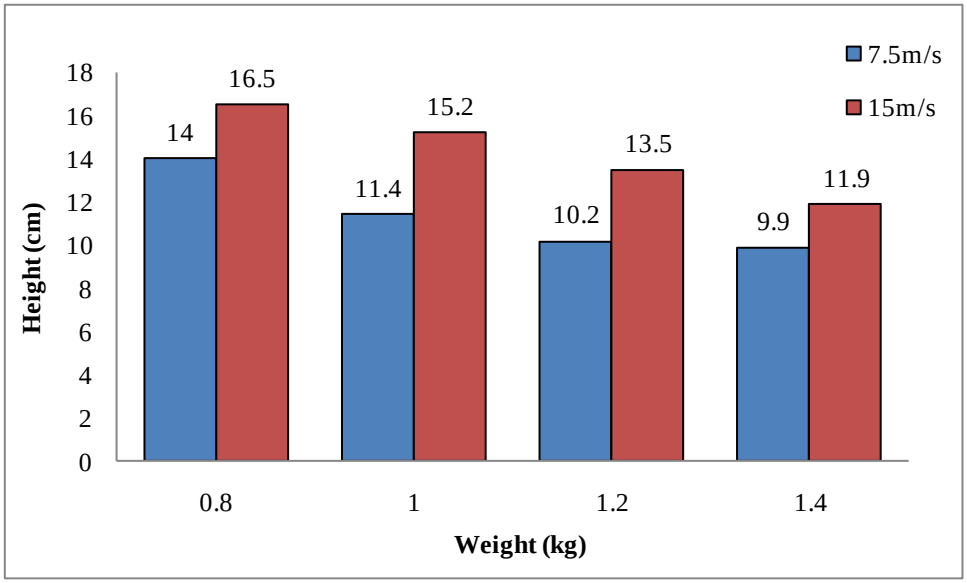

Figure 4: Performance of lifting motor with different weight over height at 7.5m/s and 15m/s propeller speed

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Thrust motor performance

For the thrust motor performance, the propeller speed was tested at 5m/s and 10m/s with 800gram weight till 1.4kg as shown in Figure 5. The craft was tested on a 1-meter distance on a flat surface. For 800gram, 5m/s propeller speed completed the 1-meter distance in 6 seconds, thus the speed of the craft is 0.15m/s. Meanwhile, for propeller speed 10m/s, 3 seconds in 1 meter was completed created 0.3m/s.

200gram was added on the craft weight created 0.12m/s for 5m/s propeller speed and 0.25m/s for propeller speed 10m/s. The propeller speed of 1.0kg craft reduced at 20% from 800gram craft.

At 1.2kg, 0.1m/s was obtained from 5m/s propeller speed and 0.2m/s for 10m/s propeller speed. It shows 33.4% reduction speed with 400gram additional weight. The 1.4kg craft weight with 5m/s propeller speed created 0.08m/s and 0.16m/s for propeller speed 10m/s. The weight decreases the distance travel of the craft and reduces as much as 46% compared to 800gram craft weight. It is shown that 800gram craft travels faster compared to 1.4kg craft. The 800 gram might be fasters, but it is not well balanced and tends to go sideways when cruising. The 1kg most stable and balance compared to other weight. The craft used less power to operate and have a high thrust. The speed of the craft reduces approximately by 33% when 200gram is added to the craft.

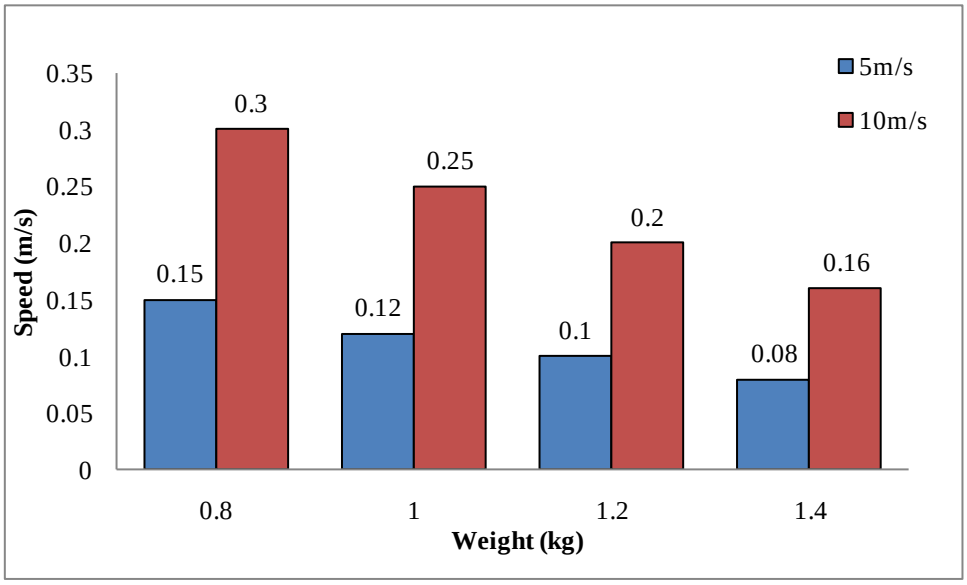

Figure 5: Performance of thrust motor with different weight over speed for 5m/s and 10m/s propeller speed

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4. CONCLUSION

The performance of the lifting motor and thrust motor was investigated using different weights. The height of the lighting force and the speed from the thrust force determined from 1-meter distance per time taken were identified. The maximum height lift was obtained from the 800gram craft and the minimum from the 1.4kg craft. The speed of the thrust motor performance also shows 800gram craft is better compared to 1.4kg craft. It shows that the heavier craft creates less lift force and less thrust. However, the 1.0kg craft is more stable and balanced compared to other weight. The improvement needs to be done on the type of materials and weight with a different type of motor that can support the performance in lifting and thrust of the craft.

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