Reverse Engineering on Drone

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Abstract— The increasing use of civil unmanned aerial vehicles (UAVs) has the potential to threaten public safety and privacy. Therefore, airspace administrators urgently need an effective method to regulate UAVs. Understanding the meaning and format of UAV flight control commands by automatic protocol reverse-engineering techniques is highly beneficial to UAV regulation. To improve our understanding of the meaning and format of UAV flight control commands, this paper proposes a method to automatically analyze the private flight control protocols of UAVs. First, we classify flight control commands collected from a binary network trace into clusters; then, we analyze the meaning of flight control commands by the accumulated error of each cluster; next, we extract the binary format of commands and infer field semantics in these commands; and finally, we infer the location of the check field in command and the generator polynomial matrix. The proposed approach is validated via experiments on a widely used consumer UAV.

Keywords: Drone, Pixhawk, Transmitter, Receiver, 3D Scanning

I. Introduction

1) Reverse engineering, sometimes called back engineering, is a process in which software, machines, aircraft, architectural structures and other products are deconstructed to extract design information from them.
2) Reverse engineering involves deconstructing individual components of larger products.
3) The reverse engineering process enables you to determine how a part was designed so that you can recreate it.
4) Companies often use this approach when purchasing a replacement part from an original equipment manufacturer (OEM) is not an option.
5) The reverse engineering process is named as such because it involves working challenge is to gain a working knowledge of the original design by disassembling the product piece-by-piece or layer-by-layer.

II. Literature Survey

- V.N. Chougule et al. developed an efficient algorithm for generation of free form surface from non-invasive CT scan images and to extract point cloud data from stalk of non-invasive CT scan images by using Image Processing techniques and Reverse Engineering approach. This point cloud data is processed for noise reduction, point cloud data segmentation and CAD model generation.
- Zhiliang Xia described the application of reverse engineering in product design and development; effectively solved the design and subsequent engineering design ,manufacturing link disjoint problems; put forward a kind of using computer software Pro/Designer, Pro/Engineer and Solid Works seamless connection method in the process of product design; industrial product modelling design and the engineering and manufacturing of coherence have opened up a new way; the design process will provide effective measures for the product design system, so as to shorten the product design and development cycle and realize the product design system.
- Ebhota Williams designed and developed permanent mould for the production of CY 80clutch basket using 7075 Aluminium alloy using Creo Element software and gravitational casting process using a crucible furnace respectively.
- Salmi et al. proposed a reverse engineering based procedure to obtain a three dimensional CAD model of a casting from its physical equipment by selecting an aeronautical part fabricated by sand casting as case study to verify the feasibility of this approach and proved that the Reverse engineering methodology is adequate to virtually reconstruct the geometry of each single part of the equipment as well as the whole geometry of the assembled mould.
- Istvan Kovacs et al. presented algorithms to eliminate the inaccuracies which may occur due to noise and the numerical nature of the algorithms, such as, aligning point clouds, mesh processing, created “perfected” B-rep models suitable for downstream CAD/CAM applications.
- Xue Ming He et al. developed a new method of adaptive measurement, real-time reconstruction, and online evaluation of free-form surface. He calculated the coordinates and vectors of the prediction points according to a Bezier curve which is fitted by measured points and showed that the measuring points are distributed over the surface according to curvature, and the reconstruction model can be completely expressed with micron level.

III. Objectives

1) The objectives of reverse engineering are then considered along with the major purposes that provide technical justification for performing reverse engineering: maintenance, reuse, and software quality assurance.
2) Literature Survey: Initially we started collecting data about the existing drone.
3) Scanning Existing Model: Then we scanned the existing model using sense 3D scanner.
4) Modification and 3D Printing the design: Then we 3D Printed The design After FEM Calculation.
5) Test Flight: After coding the program for flight controller, we did fight test.
6) In case anything goes wrong, we will re do the program and redesign the model as well.

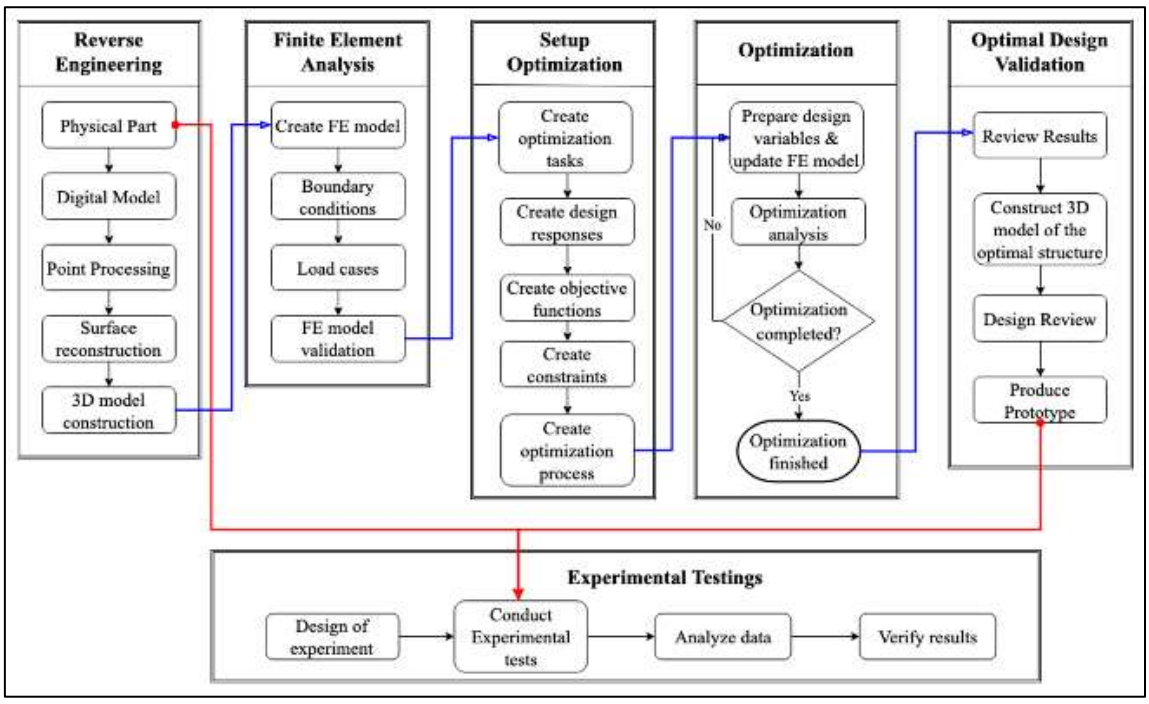
IV. MATERIALS AND METHODOLOGY

A. Materials Used

All the materials which are used in this project is listed below with specification and are supplied by rubo.in and flysky.com.

SL.NO	MATERIAL NAME	MODEL	SPECIFICATION	APPLICATION
1	Pixhawk 2.4.8	FR-02-804	PX4 32 bit	PX4 is an open-source flight control software.
2	propeller	FR-02-900	10in 10x4.5	Provides lift for the aircraft
3	Brushless motor	FR-02-403	1400KV	BL motors allow maximum integration with your assembly.
4	Electronic speed controllers	FR-02-500	30A	ESC adjust the speed of the aircraft motors.
5	Female jumper cable	FR-02-927	20cm	It is normally used to interconnect the components.
6	RC Transmitter	FRC-02-202	2.4G	RC provides control for your drone at greater distance.
7	Electronic compass	FR-02-604	Ublox neo-7M	It provides orientation.
8	Male jumper cable	FR-01-926	20cm	It is normally used to interconnect the components.
9	Accelerometer sensor	FR-01-662	6DOF	It is used to measure machine vibration.
10	Power module	XT60	5.3V/3A	It is a simple way of providing your APM with clean power from a Li battery.

B. Methodology



V. RESULTS AND DISCUSSIONS

- Initially we started our work with existing model of Mavic pro quadcopter drone.
- We scanned the 3D Model using Sense 3D scanner, followed by cleaning the unwanted surface and obtained the CAD file using sense software.
- We carried on with all required FEM and other mathematical calculation and 3D printed the model using FDM 3D printer.
- While 3D printing, we found that few parts were not able to get printed properly then we rectified our mistake, but it was not matching with the expected outcome.
- So, we redesigned the whole model and carried with the fresh calculation.
- Finally, we designed a Hexacopter Drone and carried with the necessary calculation.
- Then we 3D printed the Drone and did flight test and is flying successfully.

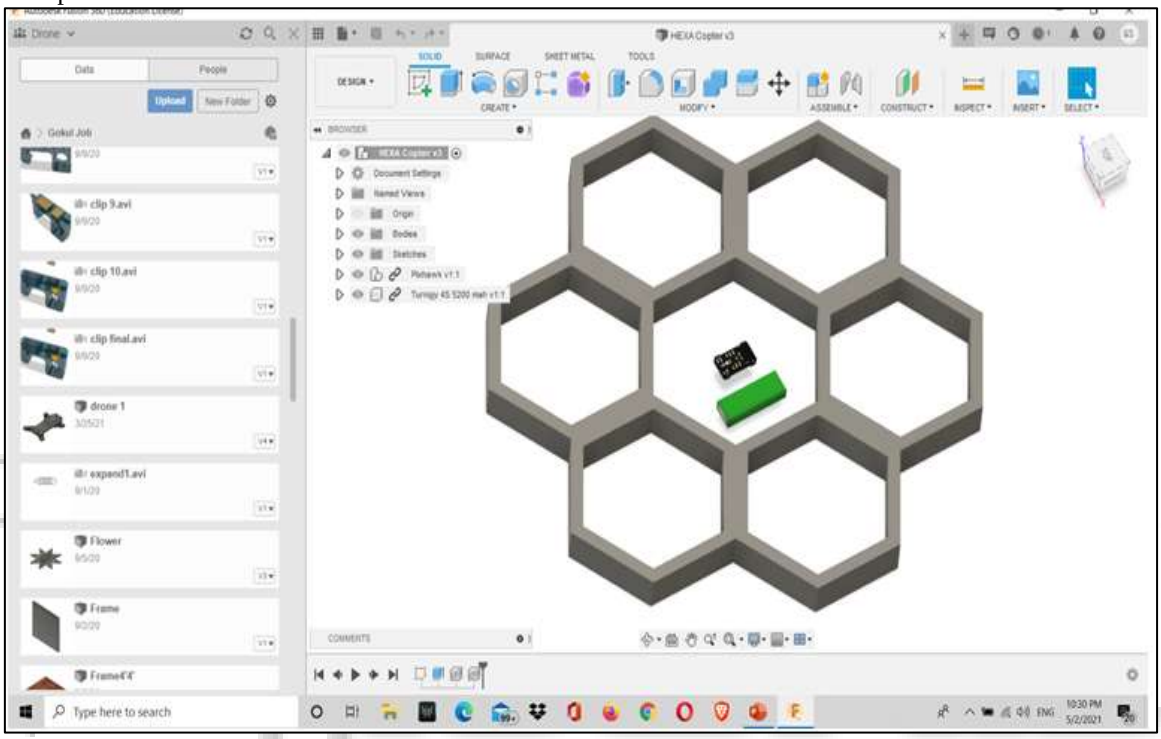


Fig. 1: Hexacopter Design

Fig. 2: Final 3D Output

VI. CONCLUSION

Understanding the meaning and format of UAV flight control commands by automatic protocol reverse-engineering techniques is highly beneficial to UAV regulation. This paper proposed a method to analyze the private flight control protocols of UAVs. First, we classify flight control commands collected from a binary network trace into clusters; then, we analyze the meaning of the flight control commands by the accumulated error of each cluster; next, we extract the format of the commands and infer the field semantics in these commands; and finally, we infer the location of the check field and the generator polynomial matrix that generates the check field. In experiments, we reconstructed the flight control command successfully. Future work will aim to leverage computer vision technology to improve the method of mining the meaning of flight control commands.

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