Multi-view Configuration of Flight Dynamic Playback

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Abstract

Unmanned Aerial Vehicles (UAVs) have proven to be highly capable in reconnaissance and intelligence gathering, as well as a possible future operation platform for weapons. Currently UAVs are supervised or piloted remotely, meaning that their behavior is not autonomous throughout the flight [1]. Consequently, instructions are being passed to the UAVs commanding the maneuvers to execute and perform to pursue their adversary or to evade being targeted. In recent years, the security level of these aircrafts has become a critical issue because these aircraft are used for combat missions and other secure operations. For this reason and many others, designing a dual display of the pursuer/evader of UAVs using a flight simulator and displaying in a singular window, appears to be a good idea. In this paper, we give a description of how the data is being collected and transformed into friendly data for viewing its actual maneuvers as a three dimension weapon using a flight simulator and why it is important and safe to do so.

I. INTRODUCTION

The arena of the Unmanned Aerial Vehicle (UAV) is an exceptionally interesting and important research topic. UAVs are remotely piloted or self-piloted aircraft that can carry cameras, sensors, communications equipment or other payloads. UAVs are able to be constructed much more cheaply than manned air vehicles because the lack of a human occupant decreases size, safety, and redundancy concerns [1]. UAVs also have the ability (range, persistence, survivability and altitude) to provide significant surveillance and observation data economically, compared with current manned aircraft approaches [2]. These factors therefore make them good ”defense aircrafts” used by the military.

Possibly, UAVs are used to pursue or evade an adversary because of the time lag and lack of pilot awareness. The safety and information of the UAVs therefore has become a vital issue. In recent years, vast amount of UAVs are been used for secure operations like border control protection, ground security and other missions [2]. However, there are certain tests and demonstrations or recorded data that cannot be viewed by the public because of the high security level of the sites or aircraft. To solve this problem, we have collectively decided to expand the accessibility of UAVs to the audience. In order for it to be viewed by people, certain things have to be done: Transferring the data being passed to the UAVs remotely, converting that data to an algorithm that a visualization tool would understand, and trying to see how information is passed from/to it, and finally displaying the actual data. This paper proposes a more efficient approach on how to configure these different maneuvers of UAVs using a flight simulator, and therefore gives a detailed view of how important the use of UAVs are and why it is important to isolate the information being passed to them.

II. BACKGROUND INFORMATION

The main tools used in this project are:

A. *Microsoft Visual Studio 6.0*

Microsoft Visual Studio 6.0 is our main tool of conversion. We implement C++ programming codes using Microsoft Developer, which then enables us to send our converted data to the AVDS system.

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Fig. 1. A Predator UAV

B. Aviator Visual Design Simulator (AVDS)

Aviator Visual Design Simulator (AVDS) has proven to be a promising flight simulator to be used for the multi-view configuration of the UAVs dynamic playback. It is a set of PC-based flight simulator and visualization tool designed to be used by students, educators, engineers and other researchers interested in aerospace research and development[3]. It is a real time interactive tool that can be used to simulate designs and animate the result of batch simulations, flight test data and motion-based simulator data, thereby adding to the knowledge of the design problem [3].

AVDS has highly detailed features such as user definable aircraft images, articulated surfaces, two-user definable interactive simulation models, and feedback of simulation parameters, such as pitch rate, altitude, airspeed, weight on main landing gear, etc [3]. Using this 3D modeling package, we could simulate the action, stop it and play it back. AVDS has proven to be very productive for this project; it provided a graphical environment for interactive simulation of user-defined vehicle models and animation of saved vehicle trajectory data. For instance, an F-15 like model response can be interfaced with the AVDS to produce real-time visualization of the aircraft.

C. Open Control Platform (OCP)

Open Control Platform, OCP is an open, middleware-based enabler for designing, testing, and transitioning embedded software to unmanned air vehicle platforms. The OCP provides a software infrastructure that will enhance the ability to analyze, develop, and test UAV control algorithms and embedded software [2]. It provides a middleware platform and run-time framework for UAV embedded flight software, integration with popular control design tools, and software components that enable the distributed simulation of one or more UAVs under control. The primary motivation for developing the Open Control Platform is to raise the conceptual level at which the controls engineer integrates components of complex, distributed, and reconfigurable control systems [2]. Hence, it supports development of the autonomous control of the take-off and landing of unmanned aerial vehicles (UAVs), as well as aerial maneuvers.

III. Motivation

There are various purposes behind designing a dual display of the pursuer/evader of UAVs. The foremost reason is for security reasons. The military uses UAVs as their chief target for combat missions and other payloads. In order to keep their information restricted but informative to the public, configuring the multi-view of the aircraft used during these combat missions, would be very helpful, and can also be used for future plans and would save time and a lot of money. In recent years, UAVs have become more of a ”must-have” combat tool. However, they can be tremendously flexible devices, and can be used to provide entertaining videotaped scenes to movie-makers, news reporters and tourism industry [2]. Thus, by configuring these data, we are also making UAVs somewhat more open to people in general for viewing and demonstration purposes, using AVDS.

The International traffic in Arms regulations, ITAR, which is the U.S. law governing munitions export and defense technology, restricts the export and import of arms goods in general, therefore limiting the accessibility of UAVs [4]. By making these data more useful and less harmful to the community, these laws would be kept. Controlling the export and temporary import of defense articles and defense services covered by the United States Munitions List, will consequently become easier.

The sensitive part of the data is not the actual maneuvers of the aircraft, but the location, and other secret sites, where it is maneuvered over. Our motivation therefore lies in the fact that configuring the actual movements of the UAVs using a flight simulator makes it handier to researchers and regular everyday people that are interested in the dynamics of the UAVs and its uses, but also protecting its primary duty as a defense and safety aircraft. UAVs can now be viewed with a 3D tool and used for actual visualization purposes. This tool can also be used to test the actual maneuvers of planes and for learning purposes without endangering its main role of battle operations. Our incentive of constituting recorded various flight test simulations to a file and playing them back through AVDS makes this all promising and extremely safe.

IV. Contribution

The main idea of our project is to keep our defense aircraft’s zone, safe and secure, by restricting part, but not all, of the information the public can have access to. Our goal is to be able to show the public the movements and maneuvers of the aircraft without giving out confidential information about the missions or location. Working with the AVDS system and seeing how information is being passed to it, was the initial part of this project. Using AVDS, we could demonstrate phenomena such as flight path, velocities, roll, pitch and yaw. AVDS has highly sophisticated features and provides interactive simulations.

In addition to animating the data in forward motion, AVDS lets you stop the action, slow the action down, and reverse directions. Our main role is to look for a way for AVDS to accept data being passed to the UAV from our control platform, OCP, by converting it to friendly data it would understand and displaying its actual maneuvers without the secret information.

A. Method

As data is being sent to the UAVs from the Open Control Platform, the data are collected, saved and then converted to AVDS “friendly data” format for actual demonstration. The data contains different information about the maneuvers the UAV should perform. For this project, we use two main tools: Aviator Visual Design Simulator, AVDS, and Microsoft Visual Studio 6.0. Our main tool of conversion is Microsoft Developer Studio 6.0., which supports C++. The idea of this project is to allow designers and people in general, to view UAVs as a three-dimensional object and test the actual maneuvers of the planes without putting their major role as “defense aircraft” at risk.

To reach our goal, we first collect and save the data from the OCP to a file. We then implement C++ programming codes in Microsoft Developer Studio 6.0 to send I/O stream data such as time-stamp, latitude, altitude, velocity, pitch, roll, true air speed, yaw, etc. to the AVDS system specifically. Since AVDS accepts data in a different way, we convert the data being passed to AVDS “friendly” data and then send that converted data to the AVDS network system. Depending on the data being sent and received by the network, the UAVs would perform different maneuvers being ordered, using the AVDS flight simulator. In order for the AVDS system to respond to the retrieved data from the OCP, the configuration of the playback have been defined in order to allow designers to pass their data/ algorithm on the AVDS flight simulator aircraft for possible 3D multi-viewing and visual demonstration.

V. Result

The C++ conversion programming codes has been implemented and debugged. Therefore, we are able to send data such as latitude, longitude, altitude, pitch degree, etc. from the control platform to the flight simulator after going through the conversion implementations using Microsoft Developer.

Currently, we can load saved data that is collected from the Open Control Platform, convert the retrieved data into I/O stream format and run it using the flight simulator system, in a three-dimensional playback mode. These converted data are saved into specific files according to the aircraft they belongs to. We can now configure the flight simulator system to retrieve the converted data and display the actual maneuvers of each flight. The final stage is testing various data and making sure it implements the right maneuvers of the aircraft or even accepts the data at all.

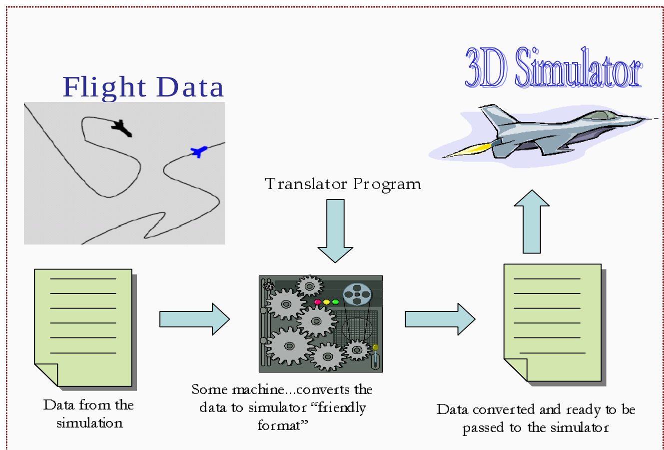

Fig. 2. Diagram showing the method used in converting the data to simulator "friendly" format

VI. Future

In this current state, the issue of the security and accessibility of the UAV has been solved. Through this project, the confidentiality of the missions of the UAVs has been protected by configuring different views of the aircraft's playback using the flight simulator, AVDS. The future of this project lies in the hand of the designers and military groups in charge of the safety of their areas, on how safe they want their data implemented and the risk they are willing to take, involving the public. The increased use of UAVs for various reasons other than battle missions may also be an issue on the rise. For now, AVDS is suitable for viewing UAVs in three dimensions and also for testing its actual maneuvers, while keeping the secret information secure.

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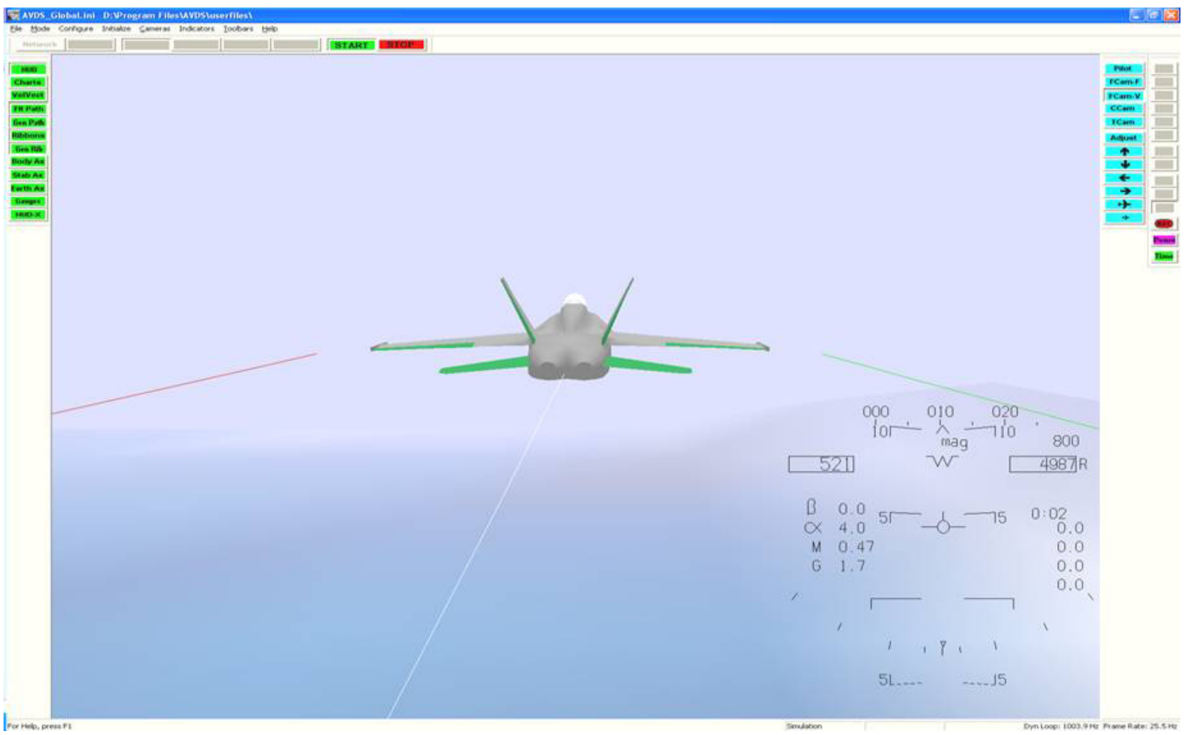

Fig. 3. A Screen shot of a flight simulator running in playback mode