

# Concept and Construction of Cost Effective UAV Simulator Using Hardware in the Loop and Simulation-Based Training

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**Abstract**—Design concept and construction of UAV Simulator is presented in this paper. The simulator is designed as a training tool for external pilot, internal pilot, payload operator, and maintenance crews. The system architecture composes of hardware in the loop (HIL) subsystem and simulation subsystem. The actual UAV system is used as HIL, and virtual environment is created to provide necessary conditions for the systems. This configuration helps to reduce the cost associated with building replicas of UAVs and enable the trainees to train under the real equipment. A modular design will also make the system possible to be used as an engineering simulation.

**Keywords**—UAV Simulator; IP, EP, Payload Operator, HIL, Virtual Simulation, Engineering Simulation, X-plane, DTI, UAV School.

## I. INTRODUCTION

The aims of Defense Technology Institute (DTI) as a center of UAV technologies has encouraged research communities to design, develop, and build different types of UAV systems in recent years. These include handheld mini UAV, fixed-wing TigerShark II, vertical takeoff and landing UAV (VTOL), and etc. Some systems have been completed and are now in service. DTI also plans to upgrade the existing systems and invest in making a new class of UAV. If this plan is succeeded, then more of them will be in service in the near future.

The growth of UAV inventories raises a concern relating to the services required to support a variety of systems. In particular, to support an efficient use of UAVs, DTI must have sufficient training facilities and a regular course schedule to provide a year-round training. The courses should cover a full spectrum of training for different kind of military personnel including external pilot (IP), internal pilot (EP), payload operator, trainer, and maintenance crews.

In response to this demand, DTI UAV School has been opened in 2015 for EP training purpose. The course provides in-class training and field training. The class room equipped with EP Simulator can help trainees to be familiar with the equipment and acquire some basic skills. A more advance training is conducted in the airfield where each trainee can gain insight into the maneuvering of a drone in real situation.

However, a high cost of the training limits the number of trainees and increases a risk of damage to UAV itself.

The school will incorporate IP training course in its syllabus in the year 2017 as part of its capability improvement plan. The course will offer in-class training covering general level IP training as well as middle level training-e.g. emergency response. DTI has signed a contract to acquire IP/Commander UAV Simulator in early 2016. The system architecture of the simulator is designed so as to enable not only IP and commander trainings, but also EP and maintenance crews as well. It is also can be a great tool for engineering simulation as described below.

## II. REVIEW OF UAV SIMULATORS AVIABLE IN THE MARKETS

The demand for UAVs is expected to increase at a CAGR of 10.16% during the period 2016-2020. [1] The main driving force is the demand for small UAVs for both military and civilian applications as well as for MALE UAVs in military ISR missions [2]. It is difficult to say that the growth of UAVs relates directly to their costs when compared with manned aircrafts; however, it is considered that UAVs have operational advantages in certain areas [3].

The global UAV flight training and simulation has a similar growth at a CAGR of 7.5% from 2016-2022 [4]. A lack of certified pilots and maintenance crews are the key drivers fueling the market growth [4]. Today, pilots and operators are facing inadequate training despite the fact that modern autopilots have reduced operator's workload, e.g. auto take-off and landing. This is because pilots are assigned to fly more contingency missions such as to conduct "close air support, air interdiction, support of special forces, and killer scout missions." [5] Thus, R & D in UAV simulators will be a rising trend in the given research period as the need for both trainers and trainees is increasing.

CAE, Israel Aerospace Industries, L-3 Link Simulation and Training, Selex ES and Simlat are the main contributors for global UAV training and simulation. BAE Systems, Northrop Grumman, Textron Systems, and Thales are amongst the key players in this area [6]. As expected, North America and Europe who have the most UAV inventories are the prime