Enhanced exploitation of long endurance UAV's electro-optical payload for improved surveillance

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1. INTRODUCTION AND OBJECTIVE

The use of UAV across a wide spectrum of applications like military, traffic control, search and rescue operations, maritime patrolling etc. makes them a very interesting, potent and absorbing field for technical research. Apart from the obvious advantage of not putting a human life at risk, the advantages of low weight and cost, ease of access to extreme environments and getting higher endurance time [1].

The long endurance UAVs are co-located with existing airfields to facilitate their take-off and landing. These UAVs provide the sensor data to Ground Control Station (GCS) located at the airfield. In case of a real time scenario requiring flow of information to the team operating in a remote location, although the UAV is flying atop the team; the information flow and payload control of the UAV is reserved at the GCS, thereby denying the team on ground with critical real time information and control of operations. This work is an endeavour in this direction of enabling ground operational team with the payload control of the UAV.

The classical UAV scenario has had an inherent limitation to provide real time information to the Headquarters(HQs)/ teams operating on ground. The inability of these HQs/ teams to manoeuvre the UAV payload as per the situational requirement has still not been achieved. These limitations impede the success of ongoing operations, leaving a lot of scope for improvement in the way the payload is being handled by the end-user's perspective.

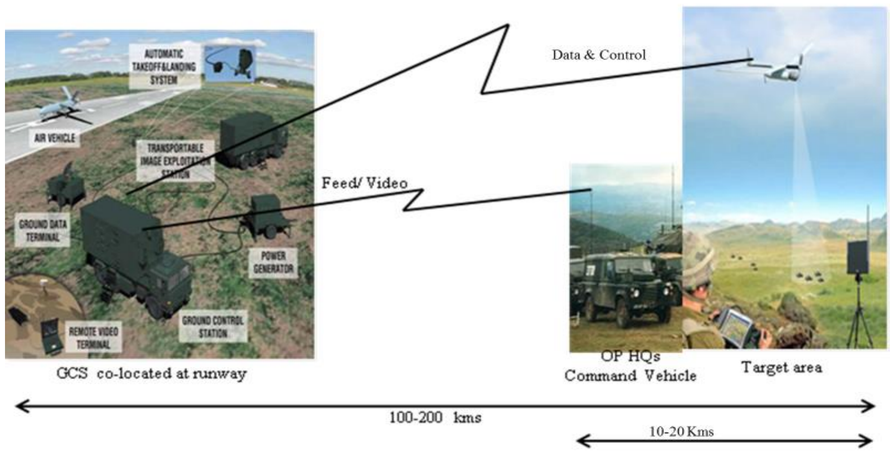

Figure 1: The UAV Scenario

The objective is to emulate and virtualize UAV payload control for enhanced exploitation and improved surveillance. The overall aim of the project has been divided into the following smaller objectives:

- Emulation of UAV payload control mechanism in lab.
- Enabling video streaming between two PCs/ laptops.
- Virtualization of payload control between PCs/laptops using GUI.

- Implementation and testing of the set-up in lab.
- Implementation, validation and testing in field.

2. KEY DESIGN CONSIDERATIONS

The key design considerations are minimum invasion of existing set-up, use of existing communication framework, user friendly installation and GUI operation, cross platform compatibility, efficient video reproduction and low latency and a low cost solution.

3. DESIGN AND DEVELOPMENT

3.1 Block Diagram

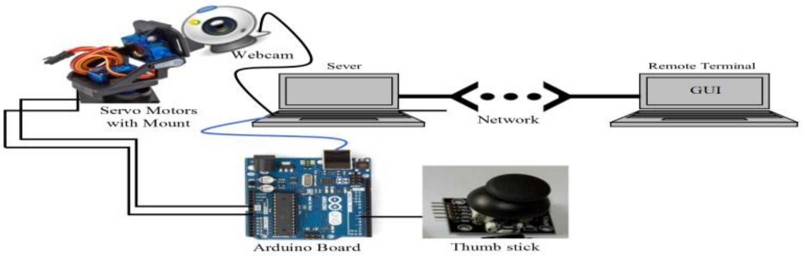

Figure 2: Block Diagram of Emulated Project Setup

3.2 Emulation of UAV Payload Control Mechanism

The UAV payload control mechanism was emulated in the lab using two SG-90 servo motors on a dual axis platform (refer Fig 3). The motors were interfaced with a Thumb Stick through an Arduino Uno board. The thumb stick works as a twin potentiometer, passing analog values to the Arduino board as per movement in XY-axis.

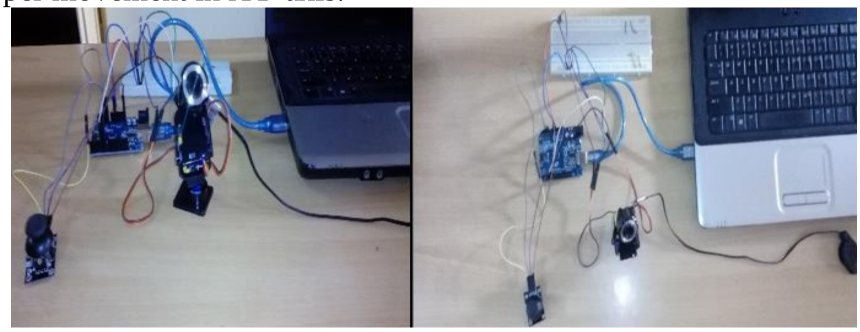

Figure 3: Emulation of UAV Payload Control

3.3 Video Streaming Between Two Terminals

The video capture at host terminal was achieved using Computer Vision through Python. The image frames were captured and compressed for transmission to the remote terminal using TCP IP. The image frames received at remote terminal were resized again to display the video received from host terminal. The video was displayed in GUI constructed using Tkinter library.

3.4 Virtualization of Payload Control Using GUI

The payload control was enabled on GUI by using rate control signals by varying voltages to facilitate motion of the payload by desired degree of angles (refer Fig 4). The values of voltages were transmitted through same TCP IP link which was used for video streaming. At the host terminal the Arduino board was configured to accept the incoming serial control data, which was further processed to provide the required signals to the servo motor platform.

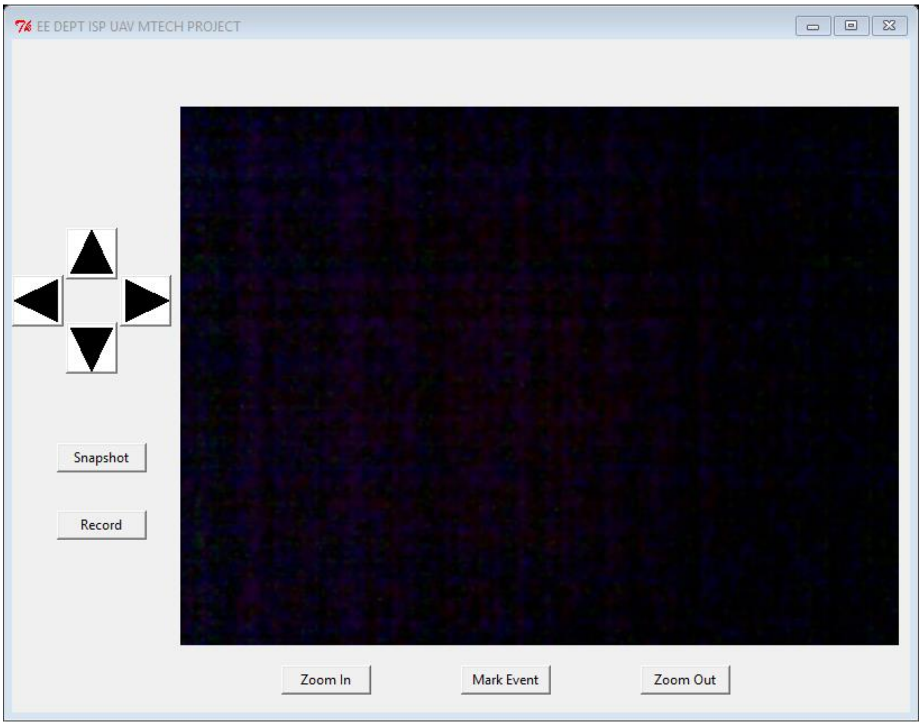

Figure 4: GUI available at Remote Terminal

4. FIELD WORK

After having tested the complete set up at the lab level the field visit to a UAV facility was conducted to carry out the trials and check for the variations if any in the actual setup. The actual system setup was studied. The set of control signals generated from external setup were supplied to the GCS and the desired motion of the payload has been obtained.

5. RESULTS AND DISCUSSIONS

The most important aspect affecting the real-time utility of this project was the latency that would have been achieved during its implementation. The higher the latency, the more would have been the delay in decision making at user end and thereby jeopardizing the entire advantage achieved by the video streaming. This aspect of latency was also studied in two different contexts for quantifying video latency and control latency. It's an integration of both software and hardware that aided in enhancing exploitation of long endurance UAV's electro-optical payload for improved surveillance.

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