TUAS-12- D25 UAS
Technical Proposal

This advanced UAS is specifically designed for simple and straight forward operation by field operators with minimal training, and utilizes AI for navigation in a GPS denied environment. In this document, you will find technical information about the TUAS-D50 system along side a detailed budgetary proposal.

1. TUAS-25 system

General Description

The TUAS-D25 UAV system is a low-cost, payload carrying aerial system with autonomous navigation and guidance system. The system can use either GPS navigation to the target using its dual on board GNSS receivers, OR, for a GPS denied environment, use a pre-programmed photo route of the path to the target and the target itself, and visually navigate to the target using a nose mounted IR sensor, and special software that follows the imagery data by comparing the real time video from the camera and the preprogrammed data.

Because it is necessary to have most recent imagery of both the path to the target and the target itself, taken from a similar angle at which the payload AV will approach the target, it is necessary to send a first AV with a radio modem which allows sending commands to the AV and receive the real time imagery.

Therefore, each AV is designed to accept an ADT unit which allows real time, high speed communication between a ground control station and the AV.

After the first AV performs the mission, the collected imagery data is then processed in the rendering computer, the targets are marked, the mission imagery is saved on a sd card and the sd card is inserted into the AV, and the AV is then launched to the target.

Included in each device:
-composite platform
- Flight control servos
- Battery
- Motor and ESC
- Flight controller with IMU and dual GNSS
- Thermal sensor
- image processor for visual based navigation and final stage guidance.
- Wiring harness

***Ground equipment can be reused for every system*:**
- Computer for flight plan and target imagery programming
- rail Launcher if necessaries
- Field repair tools

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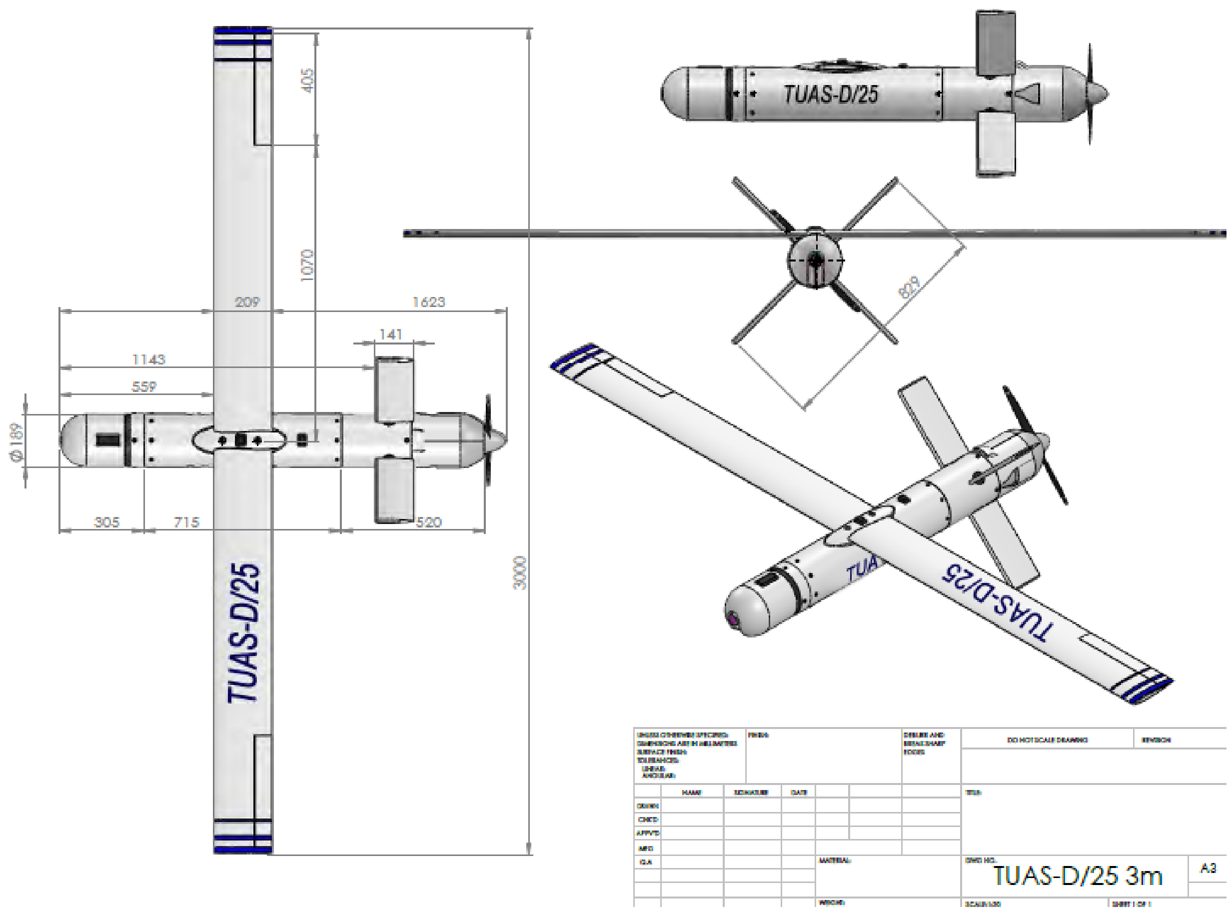
<u>As per initial requirements, the unit must be able to navigate without GPS. The system has a dual GNSS receiver on board so it will be able to navigate alternatively using GNSS/GPS</u>
<u>The requirements were also for a futuristic autonomous system, optionally a radio modem can be installed in the platform with a control station for real time control, telemetry and video</u>



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System configuration

The TUAS-D25 UAS is comprised of the following components:

● Batch of AVs
● GCS - typically a single portable ground control station
● Rendering computer
● GDT – up to 100 km portable ground data terminal with auto tracking feature for ALPHA AV
● Catapult system
● Hard case box for transportation
● Field tools to assemble and disassemble the system
● GSE - ground support equipment including battery charger and maintenance tools
● ILS package:
1. Spare parts, including one field repair kit
2. Operational and O level training and all O level Documentation - manuals, checklist, logbook

2 System operation

There are two sorts of missions, GPS based and image based guidance.

AI image guidance based mission:

Step 1: Mission Planning and Preparations
Mission objectives are defined, including the path to the targets and the specific targets of interest.
This is done on the GCS computer.

Step 2: AV with ADT Deployment
AV with ADT is prepared and launched, while flying to the target the operator changes the flight path according to mission requirements. The video is sent back to GCS in real time. Operator identifies targets and guides the AV to one of them.

Step 3: Data Processing at Rendering Station
The video is uploaded to the Rendering station where the operator marks various targets for the following AVs. the mission is saved on a SD card and the card is loaded into each AV

Step 4: AV deployment
AVs are launched one at a time to the target.

GPS guidance based mission:

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Step 1: Mission Planning and Preparations
Target coordinate and flight paths are programmed in the rendering computer, loaded on the SD card, and then the SD card is loaded into the mission computers of the Avs.

Step 2: AV with ADT Deployment
AVs are launched one at a time to the target.

3 System performance

Speed	70 Kt cruise
Operational altitude	500 m AGL
Range	100 km
Wind	40 km/h (for takeoff, flight, and landing)
Temperature	-30 +60 C
Rain	<2.5 mm/hr
Time to deploy	under 15 minutes.

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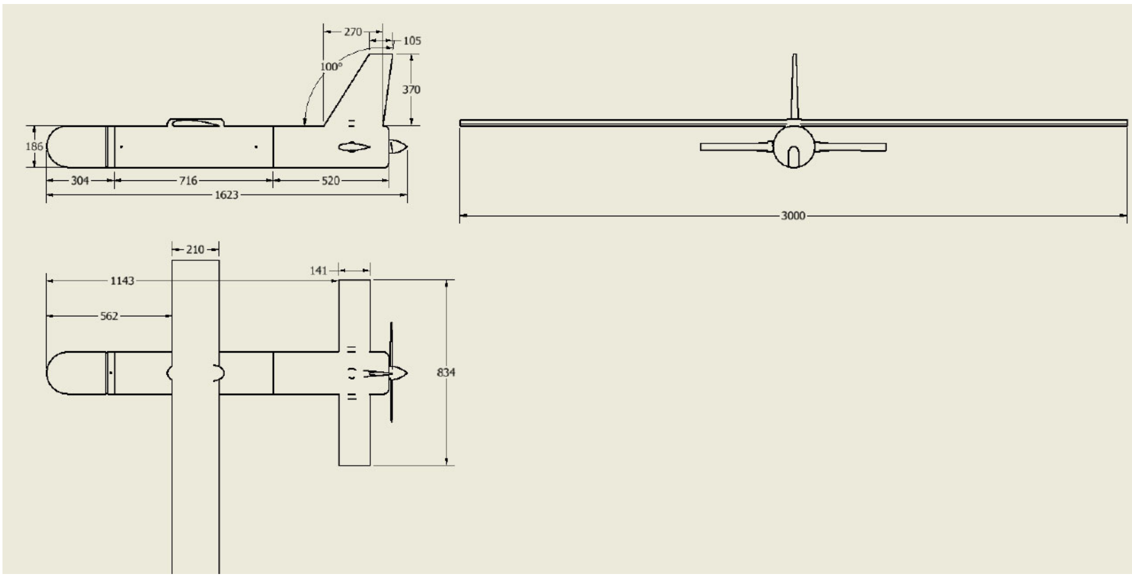
MODEL T25 UAV



Airframe specification:
Flight range – 100 km
Cruise speed – 120 km/h
Take of weight – up to 25 kg
Wings span – 3 m
Flight altitude – 500 m
Payload – 10 kg (payload does not include PC and video adapter weight)
Airframe material: carbon/glass fiber composite, plastic.

Power plant and propulsion:
Electric propulsion system with motor and battery pack
2-blade propeller
Gasoline engine with alternator can be implemented optionally.

Equipment:
Flight controller (Pixhawk / The CubePilot) with ailerons, rudder and elevator servo actuators.
Camera 8.3 MP, RGB, 45 fps, USB 3.0 (preliminary Basler brand, Germany)

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Proposed Technological Solution

1. For drifting, the proposed solution is based on innovative Machine Learning (ML) techniques such as Transformers, a class of artificial neural network models developed in the field of natural language processing (NLP) that, due to its flexibility, is also used in other fields. Machine learning models are known to demonstrate superior performance in minimizing error in navigation, enabling accurate estimation of UAV position and orientation even in GPS/Comms denied areas.

2. For 'target identification and classification, on the other hand, AI solutions rely on advanced algorithms to analyze images and visual data captured by UAVs. Convolutional neural networks (CNNs) and variants optimized for object recognition, such as YOLO (You Only Look Once) and Faster R-CNN can detect objects in real time, classifying them and tracking their movement. These are essential elements for the success of ISTAR and SAR operations, both from the point of view of accuracy and from the point of view of safety and effectiveness.

Technical and innovative aspects of the proposed technology

- The synergy between Transformer-type networks for inertial navigation and advanced algorithms such as YOLO represents a significant innovation in the approach to military and rescue missions by enabling more precise and reliable navigation and ensuring that UAVs reach their designated targets accurately, safely, and effectively.

- Innovative neural network architectures (Transformers), have appeared in research on inertial navigation in land or sea drones, without exploring the use of these approaches on UAVs

- Transformers are innovative neural network architectures, originally developed for natural language, demonstrating their adaptability in other fields and are an effective solution to address the drifting problem in inertial systems used aboard UAVs in military contexts by showing advantages such as the ability to process contextual and multimodal information by simultaneously considering inertial data and data from auxiliary sensors.

- What distinguishes these networks is their use of so-called attention mechanisms, which enable the analysis of complex relationships between input elements; in practice, they excel at handling data sequences of varying lengths, which is critical for inertial data, reducing in practice the accumulation of errors over time.

- In addition, another extremely important element is their unsupervised learning ability that reduces dependence on precise reference data, a valuable feature in military contexts where scarcity or obsolescence of data updated even at the last second can preclude accurate information.

- In the area of object detection, advanced algorithms (such as YOLO) have proven to be efficient in identifying targets in real time. These algorithms enable the detection, localization, and tracking of objects of interest (defined in the training phase on dedicated libraries) quickly with high accuracy (even segmenting the target accurately), enabling UAVs to react promptly to critical situations autonomously. The use of YOLO and similar algorithms is particularly valuable in military operations or rescue missions.

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