TRENDS IN UAV PLATFORMS AND TECHNOLOGIES

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Abstract

Unmanned Air Vehicles (UAVs) have developed into indispensable war fighting assets of modern battlefield. UAVs play a pivotal role in sharing and disseminating strategic information in a Network-centric war scenario. The fusion of the data obtained from different sensors/payloads further helps enhance situational awareness and enables quicker sensor-to-shooter reactions. There is a marked shift in the importance given to the Unmanned Air Systems development world-wide with significant increases in budget allocations. From Micro Air Vehicles (MAVs) to Unmanned Combat Aircraft, each type of UAV plays a distinct role at the same time presenting unique technological challenges. The paper discusses the present state of, and future trends in, various UAV platforms as well as sensor payloads carried by them and also highlights challenges in the related technologies. It also describes the ongoing UAV programs and technology competence built up by DRDO.

Introduction

The history of UAVs goes almost as far in the past as manned flights; however, until recently, they were thought to play only a support or peripheral role. Today UAVs are poised to take the centre stage with their increased capabilities and newer roles.

UAVs come in wide varieties for various applications. They can vary widely in size and weight from few centimeters and a few grams as in Micro Air Vehicles to few meters and 500kg as in small, short-range systems to big-as-manned aircraft and over 10 tons as in long endurance UAVs. They can be fixed-wing, rotor-borne or tilt-rotors. Power plant can vary from piston engines, gas turbines or electric motors. They can be hand-launched, catapulted from a launcher, or can take off in conventional manner. Small systems can fly for 4-6 hours whereas large endurance UAVs can have endurance time of over a day. Their ranges vary from few kilometers to few thousand kilometers and altitudes of a few hundred meters to above 20 kilometers.

The UAVs incorporate a variety of payloads that enable them to perform various operational missions. The payloads include imaging sensors such as Electro Optic (EO) and Infra Red (IR) and Synthetic Aperture Radar (SAR), non-imaging sensors such as ELINT and COMINT (Electronic and Communication Intelligence) as well as Chemical, Biological and Radiation sensors. The Sensors of High Altitude Long Endurance (HALE) UAVs have a global coverage whereas Medium Altitude Long Endurance (MALE) UAVs provide the regional coverage over the battlefield. Short range UAVs and Tactical UAVs provide closer look on demand; MAVs provide intimate look and advance warning on Chemical, Biological and Radiation hazards. Sensor data fusion and networking of the UAVs can further provide sustained and reliable situational awareness leading to Information Dominance.

Role of UAVs in the Changing Face of Warfare

There has been an increasing shift in the nature of warfare from symmetric to asymmetric and from conventional to proxy wars. Battles are won today by the side having the maximum information about the opposition. Such a scenario demands continuous gathering and exploitation of intelligence information. UAVs have a key role to play in this scenario.

The nature of warfare is also fast switching from platform-centric to network-centric operations. The essence of Network Centric Warfare (NCW) is speed of command, creation and sustaining shared awareness at all command levels and it offers a method to build information superiority, a key factor to success in the future battle space.
UAVs find application as drones or standoff weapons against radar stations, SAM (Surface to Air Missile) batteries, control stations and ships. They also can be used as decoys for bombers and fighters, to trigger AA (Anti Aircraft) guns and SAMs to be picked up by AEW (Airborne Early Warning) for further precision bombing. They also function as AEW assistance as bi-static radar for stealth aircraft detection and as AEW outreach in risky areas, EW missions, for triggering radar stations etc. They also help in detection and identification of targets by close reconnaissance at high risk areas.

UAVs have great role for reconnaissance with less risk over inaccessible or denied areas, Battle Field Surveillance, Sea Route Surveillance, Anti-smuggling Surveillance, Forest Fire or Flood Monitoring, Volcano Monitoring, Traffic Jam Monitoring, Mine Detection (MSS or LISS sensors), tectonic or geodesic surveying etc. In intelligence collection they are used for Signal Intelligence (SIGNIT), Communication intelligence (COMINT), Electronic Intelligence (ELINT) and Image Intelligence (IMINT).

UAVs also serve as communication nodes for military and civil applications. They can work as surrogate satellites or airborne platform (eg. Protius); pager services for fighting personnel, data communication to commander in chief as repeat station for encrypted GPS etc.

UAVs, especially micro UAVs are used in listening and seeing modes for detecting army or ship movements, listening to communications, looking into military establishments and multistory buildings etc. It has relevance in the proxy war environment and terrorist hideout penetration.

UAVs are also used for weapon delivery as stand off guided weapons against tanks, ships etc; bunker bursting, bombarding C3I control stations, delivering anti-radiation missiles, or high energy weapons.

Considering needs of the future it is prudent to examine and improve the technology areas of UAV Sensor platforms and the new sensor technologies followed by UAV engagement platforms.

**Taxonomy of UAVs**

As discussed earlier, UAVs are designed to have different sizes and shapes for different applications. The following paragraphs discuss the UAV types, their features and applications.

**Micro Air Vehicles (MAV)**

MAV are a revolutionary new concept that presents new opportunities and new challenges. MAVs have the potential to increase soldiers situational awareness and also to provide information dominance in urban warfare.

MAVs come in fixed wing, flapping wing (ornithopter) and rotary wing variations. Networking of MAVs for swarm operations controlled by higher echelon UAV with wider range and coverage can further enhance the utility. The possibility of microwave recharging of MAVs by HALE UAVs also exists for remote operations and extending range and endurance of MAVs.

Technology issues that need to be addressed are miniaturized sensors, miniature cameras, miniature radar (SAR), MEMS based micro-actuators, MAFC control of flows, micro-jets, pulsed blowing, Reciprocating Chemical Muscles (RCM), electrostrictive polymers and shape memory alloys to make wings flap, solar electric propulsion, low Reynold’s number flying and more. A typical MAV (Black kite initiated by NAL-ADE) having all up weight of less than 0.5 kg is shown in Fig 1.

**Short Range Tactical UAVs (SR-TUAV)**

Short Range Tactical UAVs (up to 200 kms range) are used for battlefield surveillance and targeting roles. They can fly up to 4 km altitude and with augmented power and wing area upto 10 kms altitudes. There are several UAVs of this class operational at present. Hunter and Searcher UAVs of IAI, Israel and the NISHANT UAV are of this class. Many of the European countries are having this class of UAVs and several Asian countries are developing Tactical UAVs.

**Medium Altitude and Long Endurance (MALE) UAVs**

MALE UAVs have range upto 800 kms or more and they can fly upto 20 hours or more duration and climb to altitudes of 10 to 12 kilometers. They will have satellite link facilities for communication at long ranges. They are used for round the clock surveillance of battlefield, shipping routes, intelligence gathering operations etc.
Predator UAV (General Atomic) is one of the most successful UAVs and thousands of the UAVs have been manufactured and nearly a thousand is operational over Iraq and Afghanistan. The later ones are augmented with weapons for selective killings ordered from afar. Predator command nearly 25 percent UAV market share.

**High Altitude Long Endurance (HALE) UAVs**

HALE UAVs can carry heavy pay loads (1000 kgs or more) and augment the reconnaissance and AEW aircrafts. They have substantially better range and endurance (48 hours and more) and can fly beyond the reach of many SAMS (20 kms). Because no pilot is involved, HALE UAVs can fly deep into enemy airspace for reconnaissance. They carry Synthetic Aperture Radar (SAR), satellite antenna (steerable or phased array) and EO/IR payloads. They can even carry offensive payloads for BPI/API missions (high energy laser) against Ballistic Missiles. HALE UAVs also make use of low observable (LO) characteristics for survivability and intrude into enemy airspace undetected by radar. They are also useful as long range battlefield surveillance platform and communication nodes. HALE UAVs can command lower echelons of UAVs for zoom in operations and swarm networks of micro UAVs. The Global Hawk (Northrop Grumman) is one of the most successful HALE UAV programmes with more than 40 percentage market share.

**Vertical Takeoff and Landing (VTOL) UAVs**

Unmanned helicopters have the VTOL capability; and their attrition rates are less compared to fixed wings UAVs. There are conventional no tail rotor (notor) and twin counter rotating rotor type. They are convenient for operation from ships and over uneven and hilly terrain. There are also tilt rotor (twin and quadra) and tilt body type UAVs under development. Stop rotor type of UAVs are where the wing rotates during takeoff and landing, augmented with circulation aerodynamics is also test flown.

The jet assisted takeoff with ring wing and vertical attitude takeoff aircrafts are also have been flight tested. Imagination is the limit in the area of unmanned air vehicles where the horizon is fast expanding.

**Strategic UAVs**

High altitude low observable UAVs are being developed for strategic applications. Many of the configurations are under wraps of Black programs. The low observability allows them to penetrate enemy airspace and do reconnaissance and limited offensive roles undetected (interdiction roles). For the first day of war application, the phased out manned aircrafts are converted as strategic unmanned aircrafts, to confuse the enemy and to expose SAM and Artillery locations, and force to switch on radars, making them vulnerable to next line of attack. Strategic UAVs also employ active RCS tailoring techniques to confuse enemy and avoid detection and continued tracking if detected.

**Unmanned Combat Air Vehicles (UCAVs)**

UCAVs have a role between Fighter Aircrafts and Cruise Missiles. They can strike against air defence systems and non-hardened high value targets in the pave way strike missions (first day strike enabler). The fire-bee drones of US, the harpy antiradar attack UAV of IAL, French fox-Tx, electronic warfare drone, Dornier Dar UAV, South African Lark UAV etc, are meant to attack targets from stand off distances.

The latest UAVs are multi-mission capable which is semi-autonomous weapons that would perform war fighting tasks. They perform the dull, dirty and dangerous (D3) tasks for Suppression of Enemy Air Defence (SEAD). They also perform long range reconnaissance for early warning of ballistic missiles in boost phase, jamming radars, target acquisition and laser designation and for weather assessment in long range missions.

The UCAV payloads upto (1000 kgs) include EO/IR sensors on turret, SAR with MTI, communication relay, ECM and ESM capabilities as well as precision guided weapons (laser guided bomb, satellite guided smart bombs, stand off hypersonic missiles etc). UCAV missions include destruction of SAM sites, radar antennae, mobile missiles, control vans, ballistic missile launchers etc. They can perform air to air combat with high maneuverability.

The success of predators in Iraq and Afghanistan spurt a lot of activities in development of UCAVs across the world and are in advanced stages of development. Stealth configuration for survival in deep enemy territory, internal weapon storage, satellite link and flying wing configuration with dorsal intake and 2D concealed nozzles, variable bypass turbo fan engines etc are some of the striking features. Fig.2 gives a typical UCAV configuration.
UAV Sensor Payloads

The current inventory of the world UAVs include systems widely varying in terms of role, size, endurance and range capabilities. The UAVs incorporate variety of Payloads that enable the UAVs to perform various operational missions. These payloads include imaging sensors such as Visible Light Electro Optic (EO) and Infra Red (IR) sensors housed in precision pointing systems, Synthetic Aperture Radar (SAR) and non imaging sensors such as Electronic Surveillance sensors (ELINT/COMINT system). The imaging sensors are operated under Wide area Search/Spot Light Imaging/Stereo Imaging modes.

EO Sensors have highest quality imagery in terms of resolution and ease of interpretation, but their operations are limited to day time clear weather operation. IR Sensors operate night and day and provide the capability to discriminate between operating and non-operating (decoys) systems. SARs can operate in any type of weather, day and night and at long range but need more effort for interpretation. In Multi Spectral Imaging (MSI), multiple images of a scene or object are created using light from different parts of the Spectrum.

SARs are available now in different frequencies and medium size UAVs use Ku-band and large size UAVs use X-Band for operation. The current version of SARs incorporate gimbaled antennae that provide imaging while turning and MTI capabilities. The non-imaging payloads include ELINT and COMINT systems which are carried in MALE and HALE UAVs. The ELINT system operates typically in 1 to 18 GHz whereas COMINT systems operate in 20-200 MHz ranges. The corresponding antennae are mounted on the UAV for lower hemisphere coverage.

The utility of UAV as a relay platform is to provide beyond Line Of Sight capabilities as well as to provide battlefield broadcast capability to field formations with less sophisticated equipments. The data link is an essential system required for disseminating the information obtained by the UAV payloads to the user. The need to operate at Beyond Line Of Sight ranges led to the development of SATCOM links for UAVs. The recent trend is to provide Common Data Link (CDL) operation in X/Ku-band between different platforms including satellite.

Chemical Sensors based on surface Acoustic Waves (MEMS Technology) are available for various chemical agents. Technology level in the design of precision stabilization platforms have matured to provide 15μ rad or better stabilization accuracy. Design of EO, IR and SAR/MTI Sensors as an Integrated Sensor Suit (ISS) that shares hardware and software elements and using common processor for processing information is the current trend.

Key UAV Technologies

Mission Payloads

The primary function assigned to UAVs has been the collection of intelligence using imaging and non-imaging sensors. Intelligence collection is becoming increasingly more sophisticated. Superior sensors, multi-spectral sensors, sophisticated image processing and data fusion are part of the intelligence collection process. Table-1 illustrates the roles and payloads for different UAVs and Fig 3 illustrates typical UAV payloads.

Power Plants

Different UAV types require different propulsion system depending on the mass and speed of UAV as well as maneuvering and endurance requirements, altitude of flight etc. Fig.4 illustrates Power Plants for different UAVs.

Different types of engines have been integrated i.e., turbojet and rotary engine on Lakshya and Nishant UAVs respectively. Integration of turbofan engine and different piston engines are also in progress.

Ground systems

Ground Control Station (GCS) is where information is received and exploited. GCS typically have the following capabilities. Fig. 5 illustrates a typical GCS console.

- Mission planning capability/ Electronic map display
- Display and record of all parameters essential for AV controller
- Man-machine interface and control for AV and Payload operators
- Payload operation with image exploitation facility, target acquisition, target co-ordinate computation, miss-distance computation etc.
Image Exploitation Station

Surveillance UAVs capture and transmit video and flight data in real-time to the GCS. GCS houses image exploitation station that provides enhanced images and ground truth information and additionally provides varying degrees of sophisticated operations for intelligence extraction.

Multi-sensor Data Fusion and Smart Map Generation

All practical sensor systems possess performance limitations, including most notably limited range, sensitivity and resolution. The use of multiple single source sensors provide at least three means for over coming individual sensor limitations. First, rather than attempting to employ a single sensor for collecting data against a particular region of interest, overall system performance can often be improved using multiple sensors, each with a correspondingly smaller field of regard. Second, collection system reliability can be enhanced by employing multiple sensors with overlapping coverage. Third, the use of multiple cooperating sensors can often extend the inherent capability of sensor classes. It is observed that no sensor class provide a complete target characterization and sensor classes tend to measure relatively independent attributes tend to be the most complimentary. For example, MTI radar measures features of objects, size and motion, SIG-NIT sensors provide information about onboard radar and/or radios and imagery characteristics. All these sensors provide information complementing to each other.

Targets may be moving at one instant of time and stationary at another, communicating during one interval and silent during another.

In general individual targets exhibit complex patterns of behaviour that can help discriminate object classes and identify activities of interest.

The ability to generate multiple levels of abstraction characteristics of the battle space and objects based on the sensor data and data fusion is a critical aspect of effective situation awareness development.

Data fusion automation requires two general classes of infrastructure support; data base management systems and generic functional software. Data base requirements include support algorithm development and efficient access and manipulation of potentially extensive non-sensor derived domain knowledge bases. At a minimum, fusion algorithms can require support for spatial, temporal and hierarchical reasoning. The database management system, in turn, must provide efficient support to these three rea-

Table-1 : Roles and Payloads for different UAV

<table>
<thead>
<tr>
<th>UAV</th>
<th>Primary Role</th>
<th>Payloads (Sensors)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close Range &lt; 50 kms</td>
<td>Surveillance, Reconnaissance, Target Location, Damage Assessment</td>
<td>EO, Thermal, NBC Sensors</td>
</tr>
<tr>
<td>Altitude 2000 ft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endurance 1-5 hrs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tactical Short Range - 200 km</td>
<td>Surveillance, Reconnaissance, Target Acquisition, Target Location, Damage Assessment, NBC</td>
<td>EO, Thermal, LRD, SAR, CRP, NBC Sensors</td>
</tr>
<tr>
<td>Altitude 15000 ft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endurance 4-10 hrs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MALE Range - 1000 km</td>
<td>Surveillance, Reconnaissance, Target Acquisition, Target Location, Laser Designation EW, Communication Relay, Weapon</td>
<td>EO, Thermal LRD, SAR EW-ESM, ECM, CRP, MPR Weapon</td>
</tr>
<tr>
<td>Altitude &lt; 30000 ft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endurance 15-20 hrs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HALE &gt; 50000 ft</td>
<td>Surveillance, Reconnaissance, Target Acquisition, EW Communication Relay, Weapon</td>
<td>EO, Thermal LR, LRD, SAR, EW, ESM, ECM, MPR Weapon</td>
</tr>
<tr>
<td>Endurance &gt; 24 hrs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combat UAV</td>
<td>Surveillance, Reconnaissance, Target Acquisition, EW, Weapon</td>
<td>EO, Therma, LRD, Radar, SAR, EW, ESM, ECM, Weapon</td>
</tr>
<tr>
<td>High Sped, Maneuverable, Low Observable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Micro Air Vehicle</td>
<td>Reconnaissance</td>
<td>EO, IR, NBC Sensor</td>
</tr>
</tbody>
</table>
soning classes. The primary fusion system requirements include

- Effective utilization of multiple similar source sensors
- Effective use of dissimilar source sensors to measure a wider range of target attributes
- High performance computational hardware
- Wide bandwidth communications
- Effective sensor management.

The information is finally displayed in a user friendly manner and smart map incorporating the enemy and friendly assets in terrain scenario and colour coding them (friend and foe) and indicating motion by pointing arrow (vectors) etc.

UAV play a vital and effective role in Sensor Management and UAV platform development is projected as a priority sensor management initiative, in conjunction with other robot systems (Unmanned Under Water Vehicles (UUVs), Unmanned Ground Vehicles (UGVs)) and Battlefield Robots.

Core Competence Building Efforts at DRDO

DRDO initiated development of UAVs in late 1970s, spearheaded by Aeronautical Development Establishment (ADE). The initial development of Aeronautical System and Technologies for unmanned aircrafts aimed to meet the requirements of aerial targets for training of artillery crews in weapon engagement. This led to development and production of Aerial Target system LAKSHYA and surveillance and Reconnaissance UAV NISHANT.

LAKSHYA- Pilotless Target Aircraft

LAKSHYA is a surface/ship launched high subsonic reusable aerial target system, which provides a realistic simulation of enemy aircraft threat to artillery crews, for training in firing of air to air and surface to air weapons. It is boosted from a simple zero length launcher by a solid propellant rocket motor, and sustained by a turbojet engine in flight. It carries two expendable tow bodies of tow lengths 1.5 km each; having radar, IR and visual signature augmentation. These tow bodies are used as targets for training land or ship based missiles or gun crews in weapon engagement. The LAKSHYA is recovered by a parachute system either over sea or land. LAKSHYA completed more than 100 successful launches and are in limited series production and delivered to Army, Navy and Air Force.

NISHANT- Battle Field Surveillance UAV

NISHANT is an all composite, low speed battle field Surveillance UAV designed to meet the needs of the Indian Army. Target Acquisition and tracking is done by electro optic payloads, mounted on a stabilized steerable platform. A sophisticated image processing system is used for analyzing the images obtained by the electro-optic image sensors. An onboard, integrated digital flight management system is used for flight control and autonomous navigation of the UAV. NISHANT user trials have been successfully completed and UAV is in production. Payloads like CCD cameras, Low Light Level TV Camera, ELINT, COMINT, FLIR, LD and LRF can also be fitted on this UAV platform.

The initial development efforts have helped DRDO to build up UAV related technology base in the areas of propulsion system integration, launch and recovery, flight control and navigation, communication, payload development and operation, ground control station, image processing and UAV simulation.

Ongoing UAV Programs

The ongoing UAV Programs are summarized in Table-2. Fig. 6 illustrates the UAV configurations of Lakshya-II, Rustom-I (demonstrator) and Rustom-H LER UAV.

Technology Needs and Upgrades

- Aerodynamics: The new frontiers of aerodynamics lie in for UAV domain development. The UAV development has pushed the boundaries of aerodynamic research into new realms. The flying wing aerodynamics, low radar cross section (RCS) configurations, internal weapon storage and deployment, automatic takeoff and landing etc., need to be developed. The low Reynolds number operations, flapping wing aerodynamics, vortex lift, circulation aerodynamics and control and a myriad of associated devices and technologies are being researched and experimented for micro air vehicle development.

- Structures and Materials: The composite materials with high stiffness and strength and low weight (high specific properties) and light weight cellular materials are being used in UAV frame. Smart structures and
materials, smart actuators, morphing and variable geometry wing, distributed and conformal antennae integrated with aircraft structure, variable camber aerofoil etc., are being investigated to improve efficiency and sustain efficiency in different speed regimes. Low observability (stealth) requires radar absorbing materials and structures in addition to geometric tuning. Development and production of these materials without depending on foreign sources is necessary to contain cost escalations and delays.

- **Propulsion**: Advanced and efficient propulsion is required for long endurance flights. Dorsal intakes and 2D nozzles are required for RCS and IR Signature Management. Variable bypass turbofan engine is required for combat vehicles for efficient performance at Subsonic and Supersonic flight regimes. UAV propulsion requirements also encompass electric propulsion, fuel cell technology and flapping wings and associated technologies for smaller UAVs.

- **Sensors**: The field of sensors is ever advancing and more powerful and capable imaging and non imaging sensors are being developed with relatively smaller size and weight for UAV payloads. Miniature sensors are needed for micro air vehicles including miniature SAR. Improved sensors with electronic scanning array and conformal electronic packaging are also being developed. The inertial sensors and other navigation and control sensors are being made more rugged and compact.

- **Control, Communication and Simulation**: The necessity for adaptive control, UAV & battle field simulation, image processing, advanced ground control station, jam resistant links, satellite communication, GPS based autonomous navigation etc are available, but need upgradation. Need for high degree of autonomy and multiple UAV scenario is gathering importance, along with weaponization and innovative CONOPS.

- **Facilities**: Facilities need to be set up for large scale test and evaluation of UAVs (Aerodynamics, Structures and Propulsion Signature Evaluation), production and integration of UAVs in large numbers require extensive facilities and the existing facilities need to be Upgraded and Augmented. Simulation as well as test flight and certification facilities are needed. UAV test range is being developed by DRDO to meet some of these requirements but need augmentation.

### Table-2 : On going UAV Programs

<table>
<thead>
<tr>
<th>Project</th>
<th>MAV</th>
<th>Lakshya Mk-2</th>
<th>Rustom-H; LER-UAV</th>
</tr>
</thead>
<tbody>
<tr>
<td>UAV Type</td>
<td>Fixed Wing</td>
<td>Upgrade of Lakshya-1 High Speed Target Drone</td>
<td>Conventional Take-off and Landing</td>
</tr>
<tr>
<td>All up Weight (Kg)</td>
<td>&lt; 0.5 Kg</td>
<td>700</td>
<td>1800</td>
</tr>
<tr>
<td>Endurance</td>
<td>1 HR</td>
<td>&gt; 25 HRS</td>
<td></td>
</tr>
<tr>
<td>Operational Altitude</td>
<td>30 - 100 meters</td>
<td>6 - 9 Km</td>
<td>10 Kms</td>
</tr>
<tr>
<td>Max Speed</td>
<td>20 Knots</td>
<td>0.7 M</td>
<td></td>
</tr>
<tr>
<td>Pay Loads</td>
<td>2 Tow Bodies 45 Kg Each</td>
<td>300 Kg GPA, CCD Camera, FLIR, LRD, SIGINT, SAR, MPR, COMINT, ELINT</td>
<td></td>
</tr>
<tr>
<td>Propulsion</td>
<td>Electric motor</td>
<td>Turbojet Engine (Indigenous HAL, PTAE)</td>
<td>Piston Engine Rotax - 914</td>
</tr>
<tr>
<td>Launch</td>
<td>Hand Launched</td>
<td>Zero Length</td>
<td>Take-off and Landing</td>
</tr>
<tr>
<td>Range</td>
<td>2-3 Km</td>
<td>200 Km</td>
<td>350 Km</td>
</tr>
<tr>
<td>Recovery</td>
<td>Soft Landing</td>
<td>Parachute assisted Land/Sea</td>
<td>Wheeled Landing</td>
</tr>
<tr>
<td>Technology</td>
<td>Auto Pilot for Stability</td>
<td>Full authority Digital FCS Autonomous Flight with GPS Update</td>
<td>Automatic Take-off and Landing, Payload Integration Interoperable GCS</td>
</tr>
</tbody>
</table>
Training: The crew for UAV operations and maintenance need to be trained. Necessary training facilities include simulation of battlefield and network centric operation that needs to be set up.

Discussion and Conclusion

Information dominance is going to be the key factor in the 3D battle space of the future and unmanned systems are going to play key roles in future conflicts. UAVs are emerging as the most effective sensor platform considering its versatility, flexibility of operation and quick access to territories.

DRDO has entered the UAV race with its products LAKSHYA Target Aircraft and NISHANT Tactical UAV. However, there is urgent need to develop MALE and HALE UAVs and UCAV. Hence new programs and concepts studies were initiated towards development of MALE and HALE UAVs and UCAV as well as Short range UAV and MAVs etc. The MALE UAV Rustom-H and its Demonstrator Rustom-1 (based on LCRA variant) as well as LAKSHYA-2 design and development activities are progressing.

The efficient uses of UAV assets are possible in a conflict only if significant numbers of UAVs are available in the inventory for operation, since UAV attrition rates are larger compared to manned aircrafts. This suggests indigenous production of UAVs and subsystems by the industry rather than depending on foreign sources, especially for propulsion system and sensors.

Training of UAV Pilots and system operators in network centric environment emphasizes simulation requirements. Training in virtual battle space incorporating real world scenarios is necessary. Upgradation and Augmentation of Simulation facilities are needed to meet these requirements.

The technology needs of the hour points to ATOL (Automatic Take Off and Landing) system, Payload sensors, and small turbofan engines, SATCOM Links, Low observable technologies, Secure communication links etc.

DRDO has built core competence in development and operation of UAV platforms for target practices for artillery and missile as well as for carrying Electro Optic sensor payloads with stabilized platform and pointing capability. The associated systems such as control and navigation, communication, ground control station etc are also totally indigenous. The UAV platforms are built from light-weight composite materials and design expertise to configure, build and operate UAV platforms is available.

There is expertise in integration of rotary engine, piston engine, small turbojet and turbofan engine etc. Zero-length launch using solid propellant boosters, as well as rail launch using hydro-pneumatic launcher have been perfected. Recovery using parachute and landing gas bag and other energy dissipating systems are also available. The indigenous turbojet engine is produced by industry and rotary engine and piston engines are under development. There are also programs to develop small turbofan engines. Certain payloads like CCD Camera, FLIR etc are imported at present and indigenous development is progressing. The SAR, ELINT and COMINT systems are also under development. SATCOM antenna is designed and its production is progressed by industry.

The UAV test range being set up in Karnataka will provide facility for integration and testing of various types of UAVs including Long Endurance UAVs and for training of crew on UAV operations including extensive use of ATOL for wheeled UAVs.

The industry participation in design, development and production is imperative to large volume production of UAV platforms and associated systems and thus make the core competence built up at DRDO into fruitful products and curb the need for sourcing UAVs from abroad.

References


11. DRDO/ADE Reports on UAV programs.
Fig. 5 Typical ground control station

Fig. 6 UAV platforms under development