The Micro Air Vehicle (MAV) Unit is a newly formed unit of CSIR-NAL with the mandate to carry out focused research and development of mini & micro air vehicles. A small group of scientists working in the unit are involved in airframe design, aero propulsion system selection and characterization using wind tunnel studies, prototype fabrication, integration of autopilot and payload and flight testing in semi and fully autonomous modes.

Some of the advanced areas of research carried out in the unit include low Reynolds number aerodynamics, smart material based active flow control, flapping wing MAV development from unsteady aerodynamic studies, application of alternate power sources like fuel cells and solar films for increased endurance, real time flight data logging for design validation, formation flying for extended missions etc.

The unit also has taken the responsibility of conducting user demonstrations, workshops and lectures.

It is a highly multidisciplinary field requiring multi-faceted talent and domain expertise and provides unique opportunities and challenges in many disciplines of aeronautical engineering. The small size and weight of the airborne system and relatively high level of atmospheric gusts under which the vehicle needs to fly in fully autonomous mode make the development of MAVs a technological challenge.

The development of MAV is a highly multi disciplinary and a highly technology driven activity.
DESIGN CENTER
A fully functional facility to design and prototype Fixed and Flapping wing Micro Air Vehicles.

- Conceptual design using Open Source and highly reliable aerodynamic analysis software packages.
- Multi-Disciplinary Design Optimization for highly efficient airfoil and planforms design.
- Conversion of design concept to 3D CAD model
- Prototyping using automated hot wire foam cutting
- Fusion Deposition technique for Rapid Prototyping
- Faster turnaround time for wind tunnel models using RPT
- Digital assembly of components.

MICRO AIR VEHICLE RESEARCH TUNNEL (MART)
A special purpose wind tunnel for the Aerodynamics, Propulsion and Aero-elastic characterization of Fixed, Flapping and Rotary Wing MAVs. The open jet test section for wall interference free measurements for flapping and rotary wings. A gust generation mechanism to simulate atmospheric gusts. Study of stability and aero-elastic issues in MAVs.

- Test Section: 0.8m x 1.2m x 2.5m
- Automated Pitching and Yawing Mechanism
- Open Jet with Betz chamber, Gust generation
- Velocity Range 1-45m/sec for Closed Test section and 1-20m/sec for Open Jet Test section

POWER & PROPULSION
The electric motor propulsion system characterization involves thrust and power measurements using Medusa system. Static and dynamic characterization of BLDC motor and propellers. Study of drain rates of Lithium Polymer Battery for various atmospheric conditions.

AVIONICS & INTEGRATION
Commercially off the Shelf components like Motor, Propeller, ESC, Servo motor, Battery, Autopilot, Data Modem, Camera (payload), Video Transmitter are tested and qualified for performance and then integrated with the Micro Air Vehicle for Autonomous flight operations.
LOW REYNOLDS NUMBER AERODYNAMICS
- Efficient airfoil design using inverse methods.
- PIV / LDV experiments on 2D and 3D platforms.
- Active flow control deploying smart materials.
- Embedded sensors and closed loop control
- Propelled model tests.

FLAPPING WING STUDIES
Unsteady Aerodynamic Characterizes from force measurements and Flow field measurements in wind tunnel. Planform geometries, wing material properties, flexural stiffness on the Aerodynamic performance of flapping wing MAV. Design of gear and transmission systems.

FLIGHT DATA LOGGING
Data logger for real time record of the flight parameters like: power, attitude, payload sensor data, actuator position, motor RPM etc. This system will help designers and programmers alike to improve the MAV in all respects.

ANTENNA TRACKING SYSTEM
Tracks MAV to receive video signal without any interruption based on the GPS data. The GPS location of the MAV is transmitted to the tracker and the servo system position the antenna thereby ensuring a high signal strength. The system is under field trails and will soon be available to the users.

INDIGENOUS PROPELLER & FUEL CELL
Indigenous propeller development for the improved efficiency. Fuel Cells and solar films as augmented power sources to increase the endurance.

PRODUCT ENGINEERING
Product engineering concept has been brought into the design of the MAVs for easy assembly, testing, transportation and crash resistant proof and robustness and reliability. Light weight high strength materials, multi functional connectors and components are used in this design.
Exhibitions, Flight Demonstrations and User Trials

MAV unit has constantly been interacting with the user community and showcasing the CSIR-NAL unmanned system capabilities.

Industrial partners
Defense: ADE, HAL
Sister labs: CECRI, CEERI, CMERI, CSMCRI (CSIR)

Academic Partners
IITs, IISc, Engineering Institutes around India

Training and Industry Collaborations
- MoUs have been signed between CSIR-NAL and private industries for joint development.
- Field trials and product demonstrations for Army, Paramilitary forces (ITBP, CRPF) and State Police.
- Students from different disciplinary are being trained in various domains (computational and experimental aerodynamics, propulsion system testing and avionics development).

**300mm SPAN VEHICLES**

| Payload: | Downward looking camera |
| Range: | 2 km |
| Endurance: | 30 mins (approx) |
| Speed: | 13-15 m/s |
| Operational altitude: | 0-100m AGL |
| Weight: | 300 g (approx) |
| GCS: | Rugged, waterproof, user friendly |

**FIXED WING MINI UAV**

| Payload: | Forward looking pan-tilt camera/IR camera |
| Range: | 10km |
| Endurance: | 60 mins |
| Speed: | 10-30 m/s |
| Operational altitude: | 30-300m AGL & 15000 ft ASL |
| Weight: | 2.6 kg |
| GCS: | Rugged, waterproof, user friendly |

For more information please contact:
Director, CSIR-National Aerospace Laboratories, PB 1779, HAL Airport Road, Bangalore-560017, India.
Tel: +91-80-25086000, 25270584; Fax: +91-80-25260862; E-mail: director@nal.res.in; www.nal.res.in