



# Technology

टैक्नोलॉजी फोकस



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## 2016 ANNIVERSARY ISSUE



## *From the Editor-in Chief*

### **Some reflections of the Year- 2016**



As we come to the end of 2016 and beginning of 2017, it is timely to reflect upon all that has happened over the past 12 months. Through this “Annual Issue”, our endeavour, firstly is to convey New Year’s Greetings to all our valued readers, dedicated and sincere contributors, and, to recapitulate the key events of DRDO through an assortment of images of the months gone by.

Let me start by reiterating that the DESIDOC team is focused on enhancing the status of the magazine. I take this opportunity to put on record my appreciation for the excellent team effort encompassing DRDO labs, editorial team and honest readership that has made TF a hugely popular technology magazine. To that extent our readers will note that the all processes have been put in place for the accelerated release of the magazine. The Magazine is punctual and now comes out on its pre-established date. The TF has also been made a fully digital magazine in line with the vision of ‘Digital India’. It is now available in e-book and flipbook forms besides regular pdf and print versions. However the challenge still remains to enhance the role of the magazine which is to be valued in terms of its efforts in reaching out to masses, stakeholders and in building brand DRDO.

I also like to reflect upon that 2016 has been a year of continued growth and continuing in our efforts to deal with difficulties such as short staffing and excessive workloads. To overcome this deficiency I depend upon the equity partnership of DRDO labs as success is possible only with the cooperation of our labs and valued readers. Through TF, it is our endeavour to highlight indigenously developed state-of-the-art and cutting-edge defence technologies by DRDO, and, to provide a forum for the presentation of outstanding science, technology and product development being done in our world class laboratories by our very own scientists.

TF has completed 24 years in 2016. In the year, six theme based special issues were published. These issues were, Detection, Protection and Decontamination of Chem-bio Agents; Military Aviation Tyres and Tubes; Optics Technology; Battlefield Protection System; DESIDOC: In Support of DRDO’S Academic Pursuit; Intelligent Mobile Robotics. 2017, is the “Silver Jubilee” year for the magazine and it would be very befitting that DRDO labs come forward to contribute in the special edition to commemorate its 25th anniversary of the TF. In this effort I invite DRDO community to try their hands at writing columns on the varied subjects covering topics from the fields of science, technology, global peace and security, proliferation of arms/disarmaments and likewise other topical subjects. The general coverage will give a different dimension to the magazine and help enhancing the interest of our readers.

We all approach the year’s end knowing that more, much more, needs to be done and as I look to the year ahead, I reiterate with confidence, the commitment that DESIDOC will continue with even greater enthusiasm and dedication.

For now, as the most special time of the year, I will end by wishing every one, their families and friends, a very happy New Year, and may you all enjoy good health, peace of mind and happiness in 2017.

**Gopal Bhushan**  
**Director, DESIDOC**



# TECHNOLOGY FOCUS

2016 ANNIVERSARY ISSUE

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- An Initiative by then SA to RM, Dr. APJ Abdul Kalam
- Covers products, processes, systems, and technologies developed by DRDO
- Completed 24 years of publication
- Circulation includes Ministry of Defence, Armed Forces, Academia, and Indian Missions in foreign countries

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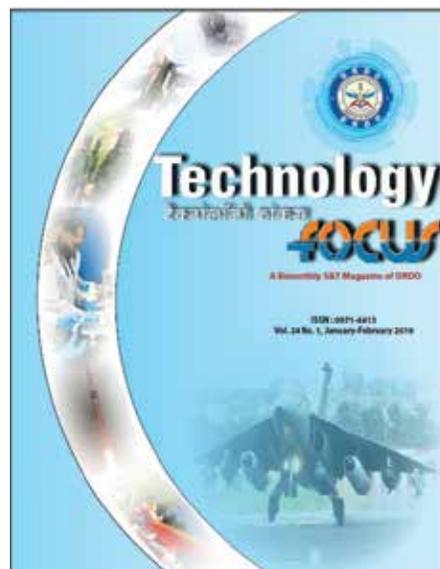


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# Detection, Protection and Decontamination of Chem-bio Agents

**D**RDO has designed and developed many state-of-the-art detection, protection and decontamination technologies against hazardous chemicals and microorganisms. Various disease detection and diagnostic kits have been developed for defence. These products have great potential for use in civil society too.



## Chikungunya Detection Kit

**C**hikungunya fever is an acute arthropod-borne viral illness reported from Africa, Southeast Asia, Western Pacific and India. The causative agent is CHIK virus, and primarily transmitted by Aedes mosquitoes. Enzyme Linked Immunosorbent Assays (ELISAs) based diagnostic kits hold a great promise for economical and convenient diagnosis of viral infections. A highly sensitive and specific kit has been developed based

on IgM ELISA, Sandwich ELISA and RT LAMP Assay techniques for early detection of chikungunya. The kit has been validated with more than 100 clinical samples (serum and CSF), collected from chikungunya outbreaks in different parts of India. It is having 85 per cent concordance, 96 per cent sensitivity and 97 per cent specificity with commercially available ELISA kits. This technology has been transferred to private firms.

## Products for Vector and Insect Control

**S**cientists having expertise of different disciplines like entomology, synthetic chemistry and toxicology have been working for decades and have come out with formulations and products to control insects that are vectors of various diseases and biting nuisance, as well as a big problem for any household in the kitchen and stores.

## DEPA Spray and Cream

**M**osquitoes are well known carriers of malarial parasites; dengue, chikungunya, JE viruses; filarial worms and many other pathogens. Moreover, they are biting nuisance and different species affect human beings throughout the day at different times. Various products are available in the market to control mosquitoes either by killing or repelling. Physical protection is also a common practice toward off these insects but not being preferred by all sections of people. Though repellents are more preferred option but they lacks in efficacy. DEPA (N,N-Diethyl-2-Phenylacetamide) is a multi-insect repellent developed and has been extensively evaluated in laboratory as well as field conditions against several haematophagous organisms like mosquitoes, sandflies, black flies, mites, bed bugs, land leeches, etc. and found highly effective in protection over other commercially available repellents.





# Products for Environmental Hygiene and Waste Management

**H**uman waste management is a challenging task for thickly populated countries like India in spite of the well developed and accepted technologies at international level. The problem is further aggravated in low temperature areas like Siachen glacier and Ladakh region where ambient temperature remains subzero during most part of the year. The prevalent technologies for plains are cost and maintenance intensive besides being

inefficient. Even septic tank, the most popular technology, also has problems with respect to cost, evacuation, effluent quality and space requirement.

Biodigester technology developed by DRDO overcomes most of these problems and is affordable, environment friendly, maintenance free as well as efficient. The effluent is odourless and gets rid-off most of the pathogens. Biodigester technology has two main components:

one is biodigester tank (fermentation vessel) and the other microbial consortium which can degrade human excreta in wide range of geo-climatic conditions and temperature. Various models of biodigester cater to the requirement of common man in different set of conditions like for individual houses,

housing societies, multi-floor building and even for community use in villages and urban slums.

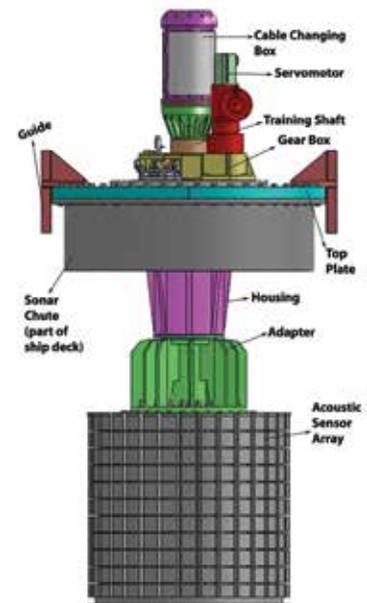
So far, technology has been transferred to 55 industries of national and international repute located in different states and more and more industries are approaching DRDO in view of the growing need of technology to accomplish the *Swachh Bharat Abhiyan* of Govt. of India.



## Indigenous Training Gear for Ship Borne Hull Mounted Sonar System

**I**n a ship borne hull mounted sonar system, the cylindrical acoustic sensor array is usually fitted to the ship deck through a training gear. The training gear, also known as Directing Gear (DG) is an electrically driven rotating mechanism that supports the 4 Ton sensor array and acts as an interface to the ship's deck structure. The main purpose of the DG is to rotate the sensor array at a controlled slow speed and index to a specified angle for

*in-situ* calibration and health monitoring using a near-field acoustic projector array. Till recently, the DG for all Indian naval ships were imported from UK and Germany. In the year 2014, an indigenous DG was successfully developed through a collaborative effort between NPOL, Kochi, BEL, Bengaluru and HMT Kalamassery. NPOL provided the design support, HMT was the DG manufacturer and BEL was the sonar system integrator and supplier.





# Military Aviation Tyres and Tubes

In order to achieve self-reliance and sufficiency in Indian defence requirements there is a need to adapt modern technology and master the process of indigenisation. India needs to change from being the biggest recipient, to highest level of self-sufficiency before joining the list of highest suppliers. The Indian government reinforced a policy of self-reliance in defence and is advancing the concept of *Make in India*. A fruitful realisation of this goal will also free the country from dependency on foreign supplies.

India is a leading manufacturer of tyres and tubes in the automobile industry. However, for military aviation tyres, the defence services are dependent on foreign countries. In order to achieve self-reliance in military aviation tyres in the country, CEMILAC, one of the establishments of DRDO, initiated

development plan with users and manufacturers and has successfully developed requisite technology, methodology of testing, ground and flight evaluation criteria right from the raw materials preparation to the finished product. CEMILAC helped in identifying vendor/s, the requisite test facility for static tests and for conducting 'Dynamometer Test' in-house.

As a first step, development of main wheel tyres of Su-30MKI was initiated keeping in mind that this aircraft will form the backbone of the Indian Air Force and will be operated for the next two decades. DRDO in consultation with HAL, IAF and private industries like MRF evolved the process for material selection, tyre build up and manufacture. DRDO initiated the process of manufacture of main wheel tyres of Su-30 based on study carried out on samples of Russian



tyres from the IAF. Details such as type of construction, dimensions, materials,



# THE BEST ON LAND NOW CONQUERS THE AIR.

MRF, India's leading tyre manufacturer, adds another first. MRF's **Aero Muscle**, the only Indian tyre approved by CEMILAC, has been chosen for the main wheels of the legendary fighter jet - **Sukhoi 30 MKI**. And it's this same commitment to excellence that also empowers you on the road.

**Adding Muscle to the Nation's Security.**

speeds and loads are not available in the country. Aviation tyres are usually tested using ground test facilities due to the expense and hazards associated with testing on aircraft. The facilities for testing and validation are not available in the country. Aircraft tyre test facility are available with developed countries such as US, France, Germany, Japan, Russia, etc., As most of these countries possessing the testing technology, are also large scale manufactures of aviation tyres, they do not want competition from the Indian market and thereby refuse testing of tyres on dynamometers.

## Retreading of Tyres

Civil and commercial airliners having bogie type tyres all over the world use retreaded tyres. Some of the tyre retreaders, carry out 12 retreads on each tyre. Hence, an effort was initiated to retread tyres of IL-76/78 aircraft. A private automobile tyre industry and DRDO carried out extensive studies for retreading followed by stringent qualification ground testing, taxi/flight trials to prove the tyre in the field conditions. The retreaded tyres gave



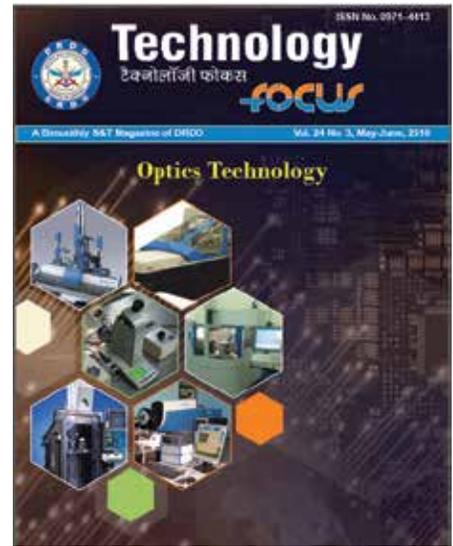
higher number of landings as compared to the new foreign tyre (132 landings compared to 80 landings). This significant achievement has translated in to supply of retreaded tyres to the IAF. Process of flight trials after second retread is already in progress at an IAF base. Aviation

Research Centre (ARC) has been apprised of the success of retreaded tyres, so that the same can be used on IL-76 operated by them. The proven technology is now being used to retread main and nose wheel tyres of other transport fleets like An-32 aircraft.

# Optics Technology

**I**nstruments Research and Development Establishment (IRDE), one of the constituent establishments of Defence Research and Development Organisation (DRDO) is devoted to research, design, development, and technology transfer in the field of sophisticated optical and electro-optical instrumentation. IRDE has designed and produced a large number of products to meet various system requirements

of vital interest to the Defence Services. IRDE has in-house capability for the design, fabrication, assembly and testing of optical systems for visible as well as infrared region of spectrum. Precision optical components in diverse materials like glass, silicon, germanium, ZnS, ZnSe, and various shapes and sizes are realised using state-of-the-art fabrication and testing facilities and decades of experience.



## Conventional Optics Fabrication

**C**onventional optics fabrication techniques rely heavily on the skills of optical technician. These fabrication techniques require a high level of expertise that takes years to develop. In this technique, surfaces are generated on machines and then smoothing is done on cast iron tools. For polishing, pitch polisher with metal oxide polishing compounds are used. The use of pitch polishers gives very smooth surfaces and surface roughness of the order of 1 nm is routinely achieved. Using optical contacting techniques, angles are made with in  $\pm 5''$  accuracy. This fabrication method is most suitable for spherical and flat optics. Ultra precise prisms such as TIR prisms, roof prisms, Z-prisms, etc. where angular tolerances are of the order of few arc seconds are required, are fabricated only by this method.



## Modern Optics Fabrication

**C**onventional optics fabrication technique is very useful for fabrication of flat and spherical optics. Using suitable blocking schemes, batches of optical components can be rapidly produced in a cost-effective way. But this fabrication technique is of very little use for aspheric surfaces. Aspheric lenses are being increasingly used to realise high performance optical systems. Aspherical surfaces are used in optical design to control aberrations, to reduce weight, to make optical systems more compact. Fewer elements are needed, making systems smaller, lighter and shorter. With ever increasing constraints on size and weight of optical systems, aspherical surfaces are becoming a common place in optical systems. Manufacturing of precision aspheric surfaces poses significant challenge as limited recourses are available to grind, polish and test aspheric surfaces.



# Infrastructure Facilities for Optics Fabrication and Testing

## CNC Centering and Edging Machine

**S**ix axes CNC centering and edging machine is used to align optical axis of lens with its mechanical axis and for edging of lens. The machine has provision for automatic centering, manual centering, and optical centering. Centering accuracies of less than 30 arc sec are easily achieved and optical component can be edged in circular, rectangular or even free form shapes.



# Centeration Measurement and Assembly

**P**C controlled test station is used for measurement of centering error in reflection mode, decentre investigation of multi-lens systems, alignment of optics inside housing, cementing of doublets, assembly of optics.



# Battlefield Protection System



**H**igh Energy Materials (HEMs) exhibit high rate of release of energy, which is used for destructive purposes in battlefields, but the energy released can be tamed to develop protection capabilities, against destructive forces. High Energy Materials Research Laboratory (HEMRL), Pune, one of the establishment of Defence Research & Development Organisation (DRDO) has developed many systems for the protection of tanks and aircrafts.

Explosive reactive armour (ERA) has capability to significantly reduce the penetration of shaped charge warheads and Kinetic Energy (KE) projectiles,

thereby ensuring the non-perforation of tank armour and protection of crew.

## ERA Mk-I

In 1980s, the concept of reactive armour was reported in literature and patents were obtained by some researchers. Being the lab working with explosives, studies were initiated at HEMRL on reactive armour. Different explosives as well as sandwich materials were studied and effect of various parameters like charge to mass ratio, explosive properties, sandwich plate material, angle of attack, etc.

on performance were studied. After generating data on various aspects, HEMRL in association with Combat Vehicles Research & Development Establishment (CVRDE) and Defence Metallurgical Research Laboratory (DMRL) undertook the developed ERA Mk-I for adaptation to tank T-72. The development was completed and user trials were successfully carried out in 1996. The technology for production of different components has been transferred to ordnance factories in the year 2002 and till date more than 1000 numbers of T-72 tanks of Indian Army has been equipped with ERA Mk- I. There are three types of panels on tank, namely standard, tapered and top panels as per design constraints and protection requirement.



## ERA Mk-II

ERA Mk-I was developed for protection of tanks against shaped charge warheads as per users requirement. However, with enhanced penetration capability of KE projectiles, there is a requirement to provide additional protection from KE projectile in addition to shaped charges. Accordingly, the development of ERA Mk-II was undertaken by DRDO in 2011 with HEMRL as nodal lab and CVRDE, DMRL



and PXE as project partners. HEMRL has developed the reactive elements, DMRL carried out development of armour materials for panels and CVRDE has finalised the layout and fitment of panels on tank T-72 and Arjun Mk-II. PXE provided the experimental facilities for dynamic evaluation of ERA Mk-II panels against 125 mm FSAPDS ammunition.

## Anti-thermal Anti-laser Smoke Grenade

For survivability of tanks in the battlefield from enemy fire, creation of aerosol smoke screen for short-duration obscuration has been the last line of defence. The present inventory, in use for last 25 years by Indian Air Force have 81 mm burning type smoke grenade (3D6) based on Hexachloroethane (HCE). The grenade after launching from the smoke grenade discharger functions on the ground at a distance of approx. 300 m from the AFVs. HEMRL has designed and developed bursting and burning type of 81 mm Anti-thermal, Anti laser smoke grenade Mk-I which bursts in mid air/ground at a distance of 50-70 m from firer

tank and produce a dense white smoke screen. This smoke screen is capable to obscure the visual and all bands of infrared regions (0.4 to 14 microns) and also confuse laser range finders.

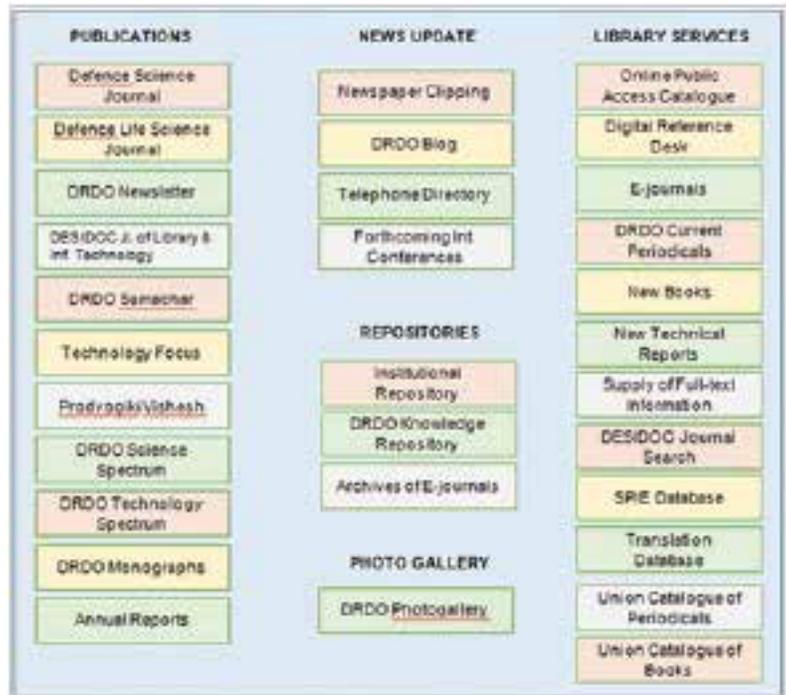
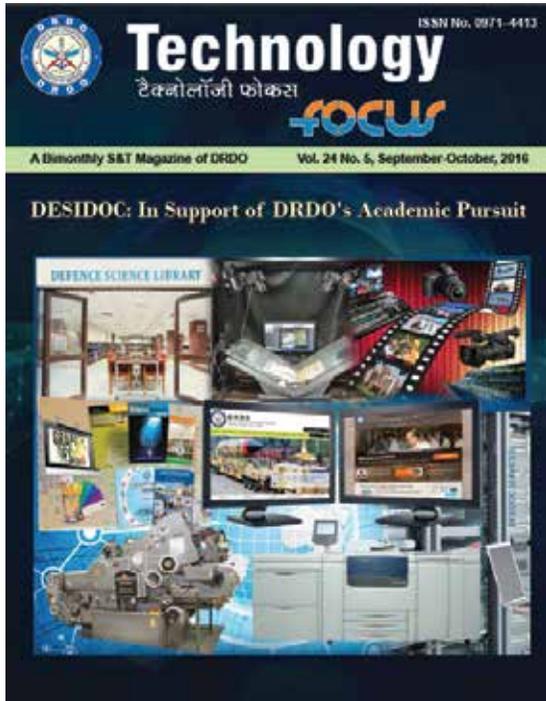
## Chaff Cartridges

Chaff cartridge 118 forms part of a CMDS to protect the host aircraft from radar guided missile threats by providing a suitable alternative and preferred target or 'decoy' (as chaff cloud). The function of the decoy is to lure the radar guided

missile away from the intended target such that it passes the target aircraft at an effective miss distance. Ejection of the chaff payload is triggered either manually by the pilot or automatically by the CMDS. There was a requirement from IAF for the indigenous development of chaff cartridges for IAF. Defence Laboratory Jodhpur (DLJ) and HEMRL has taken joint efforts to develop chaff cartridge 118. DLJ has been developing indigenous chaff payload, while HEMRL is developing impulse cartridges, containers and safe dispensing mechanisms.



# DESIDOC: In Support of DRDO'S Academic Pursuit

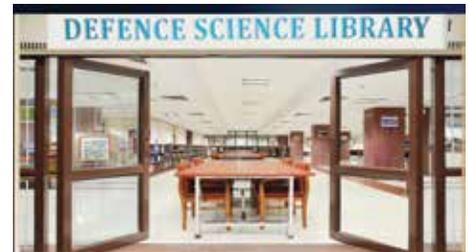


In pursuit and promotion of science, DESIDOC acts as a science and society interface of DRDO and plays a very important role in promoting S&T, and bringing public awareness and understanding of science in the scientific and civil society. DESIDOC has the vision, “to provide essential science and technical research, development information rapidly, accurately and reliably to support DRDO’s scientists’ needs”. The academic pursuit of DESIDOC’s through its in-house publications is a step towards contributing in the knowledge economy of the country and improving DRDO’s connectivity with the outside world and the common man. DESIDOC collaborates with librarians, academicians, researchers and scholars to popularise science and technology and bringing knowledge to life

in meeting with the needs of varied user communities. DESIDOC disseminate knowledge through online platforms with intuitive user interface and works for enhanced discoverability for journals and reference work.

## Defence Science Library

Defence Science Library (DSL) is a fully automated nerve centre to provide information on defence, science, technology to the research community of DRDO. Library has a very rich collection of books in physics, chemistry, materials, electronics, aerospace, life sciences, computer science, mathematics, remote sensing, and defence science technology,



etc. DSL subscribes scientific and technical journals, print and e-journals, reports, conference proceedings, books and CD-ROM databases. It has a special collection on Jane’s publication, SPIE Proceedings, IEE/IEEE publication and databases on specialised subjects. DSL also supports other labs of DRDO. DSL is fully automated and use integrated library management system to cater administrative and management of library functions.



## Publications

DESIDOC is the central publishing agency of DRDO. It brings out number of regular and ad-hoc/special publications to disseminate information on research and development activities carried out by various DRDO labs/estts. DESIDOC is involved in editing, designing, press work and digital printing of publications. Many ad-hoc publications/books/proceedings of the DRDO HQrs and other DRDO laboratories/establishments are brought out by DESIDOC from time to time besides DESIDOC's regular publications. In a year DESIDOC publishes about 200 documents.

## Network Services

DESIDOC is Sub-Main Routing Centre of DRONA and is responsible for taking care of Intranet network for all DRDO



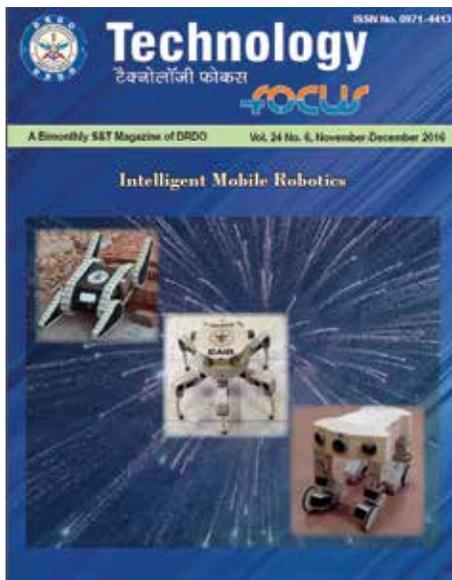
labs in Metcalfe House complex. It is also responsible for live webcasting of all major events taking place in DRDO. DESIDOC is responsible for design, development, hosting, and maintaining DRDO website on Internet.

DESIDOC has taken a new initiative for the promotion and sale of its publications and to increase visibility and credibility of DRDO. A new promotion and exhibition hall, 'Gyan Sanchar', was established at DESIDOC which was inaugurated by Secretary DDR&D and DG DRDO.

To reach globally to readers and to make publications ready for mobile devices, an e-publishing activity has been initiated at DESIDOC. Since January 2016, most of the publications have been converted into e-pub, HTML5 and in flipbook forms. The e-pub format is downloadable and ready to use on kindle and other e-readers. HTML5 is device independent reflowable format and flipbook is ready to read book format for desktop and mobile devices.



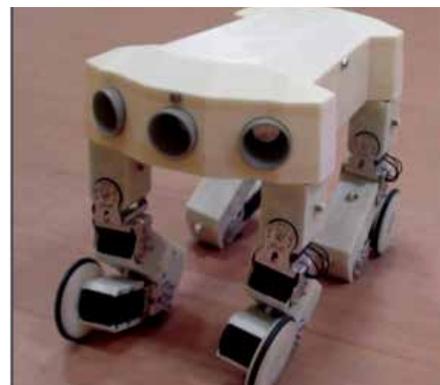
# Intelligent Mobile Robotics



## Tracked Miniature Unmanned Ground Vehicle



The Miniature Unmanned Ground Vehicle (MINIUGV) uses tracked locomotion to negotiate rough terrain and features found in a typical urban terrain including steps and staircases. It is a remotely-controlled man-portable robot which can be used for surveillance and reconnaissance in low intensity conflict operations.



hexapod, six-legged robot, has reptilian leg configuration while the quadruped, four legged robot, has mammalian leg configuration. The quadruped has additionally been provided actuated wheels to enable hybrid locomotion capability. These platforms have given an insight into the implementation of stable gaits for legged locomotion.

## Smart Autonomous Tracked Vehicle

The Smart Autonomous Tracked Vehicle (SATV) employs intelligent algorithms for navigation, path planning, localisation and mapping. It



processes the sensor data to perceive its environment and react accordingly. Since it is a BMP-II vehicle with armor and tracked locomotion capability, it is the most suitable unmanned robot to carry out surveillance and reconnaissance in battlefields. The user can command it to continuously patrol or reach a spot on a map, and the vehicle can autonomously navigate, avoiding obstacles on its path, until it reaches its goal.

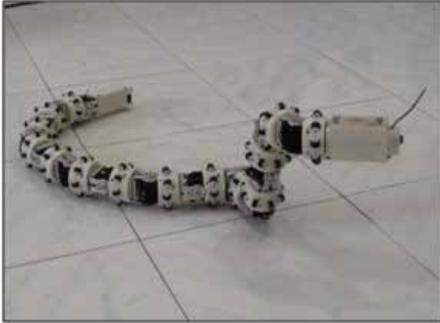
Robotics for defence has constantly progressed through indigenous synergies in diverse multi-disciplinary technologies. Extrinsicly, it has been driven by the current military scenario which demands unmanned systems with the ability to operate in an autonomous or semi-autonomous mode, under varied environmental conditions and terrain. Intelligence and mobility are critical enablers for unmanned systems targeted for military operations. Terrain structures vary throughout the Indian landscape. Mountainous, desert, rural, urban, outdoor and indoor, each present a unique locomotion challenge to a robotic platform. Extensive research in locomotion technologies has been underway to cater to specific needs of these terrain types. Robots navigating on their own and performing even the most basic tasks require a multitude of algorithms running continuously and concurrently to make decisions towards achieving the end goal. These algorithms together constitute the intelligence exhibited by a robotic platform. These technologies have been evolving through advances in Artificial Intelligence (AI).

## Legged Robots

CAIR has developed six and four legged robots. These robots have three degrees of freedom legs giving them omnidirectional motion capability. The robots have been equipped with ultrasonic sensors for obstacle detection and avoidance. The



## Snake Robot



This robot demonstrates concepts of whole body locomotion. The snake robot has 14 active joints. Lateral undulation, side winding, and rolling gaits have been implemented on this robot. A colour camera mounted in the hood of this robot provides video feedback.

## Wall Climbing Robot



The wall climbing robot is a miniature tracked robot capable of climbing vertical walls. It uses an impeller to

generate suction to adhere to walls. It has an onboard colour camera for video feedback. The camera is mounted on pan-tilt unit.



## Robot Sentry

Robot Sentry (RoboSen) is a mobile robot targeted at patrolling and surveillance applications in urban campuses. The system comprises an intelligent mobile robot and an Operator Control Unit (OCU), both communicating via a wireless link. Using the OCU the robot can be commanded to move autonomously along a predefined path or controlled by a joystick while providing a continuous video feedback. The RoboSen senses its environment using GPS, stabilised digital compass, and laser rangefinders which help the navigation and path planning algorithms in avoiding obstacles as it patrols a campus.

## Autonomous Search Robot

The autonomous search robot can perform 3D mapping of an indoor area on its own. In addition to localisation, mapping, and path planning, it employs an exploration algorithm which searches for all unknown areas until they have been mapped. Apart from a LiDAR, it uses a RGBD sensor for 3D depth data capture. With the help of these sensors, this robot can identify 3D obstacles and avoid them during navigation. It can continuously create a 3D map of the



indoor scene, which is displayed on a remote user device. The user can select an object to be searched, which are then marked by the robot when they are found in the scene. It uses algorithms for object detection to perform the search. The user can fly through the map and interactively locate searched objects in the map. The autonomous search robot is useful for indoor counter insurgency operations, search and rescue operations, and remote mapping of indoor environments with NBC hazard, when mounted with a NBC sensor.

# Correspondents for Technology Focus

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