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Guest Editorial

OPTICAL AND ELECTRO-OPTICAL INSTRUMENTATION

Importance of Optical and Electro-Optical Instrumentation is growing by leaps and bounds in the modern day battlefield. Night vision devices both image intensifier (II) Tube based and thermal imagers (TIs) are true force multipliers as they allow weapons and equipments to be used during day and night in fair and bad weather conditions. Growing trends in the thermal imaging area are mega pixels arrays with smaller pixel size, active and passive imaging at the focal plane, new detector materials operating at elevated temperature, dual color detectors, advanced signal and image processing, sensor and image fusion and automatic target recognition capability. With sufficient exploitations of these devices on ground, worldwide focus is towards the militarization of space by deploying multi / hyper spectral imagers for better target discrimination. Low power non-lethal laser instrumentation is also emerging as another key area to fight a battle taking the shapes of Laser range finders, gap measuring devices, precision guided munitions, and laser proximity fuzes. The key trends in laser instrumentation area are eye-safe lasers, laser diodes arrays, diode pumped laser designators, high power lasers with adaptive beam-shaping, sensor fuzed seekers and 3-D laser imaging.

Defence Research and Development Organisation with one of its key system laboratories, Instruments Research and Development Establishment (IRDE), Dehradun has grown tremendously in the optical and electro-optical instrumentation area. With a challenging start around 1940 or so, when it developed moisture sealings for the tropical optical instruments, IRDE developed wide range of II tube based night vision devices which have undergone production by various PSUs and private industries generating a production business worth ₹ 400 crore during 1970-90s. As the TI technology was getting evolved worldwide, IRDE started working on the thermal imaging technologies during 1980s and developed various 1st and 2nd generation thermal imagers based on 60 element and 288 x 4 element linear focal plane arrays. With the availability of staring focal plane arrays i.e. (320 x 240/640 x 512 matrix), IRDE has developed various TI instrumentation, like integrated multi functional sight (IMFS), Helmet mounted TIs, TIs for AFVs, electro optical fire control Systems for MBTs and naval ships, which is likely to generate a business of approximately ₹ 5,000 crore to production agencies based on IRDE (DRDO) Transfer of Technology in near future. In parallel, diode pumped laser designators were also developed for services for designating the targets of interest for precision guided munitions. R&D in low power laser area also kept on growing from gas lasers to eye–safe solid state and diode lasers. IRDE has developed light-weight laser target designators (LLTD) for services for accurately guiding bombs and PGMs. For significant contributions in the area of electro-optics, IRDE has been awarded DRDO Silicon Trophy in 2012.

IRDE also undertook significant steps in technology development areas. With a far sighted vision, IRDE launched a photonics programme in 1990s which was an applied R&D programme but started delivering useful products from first stage itself. A gun mounted holographic sight developed by IRDE has been an enormous success with the Indian Army. Integrated optics chips and tunable frequency converters have been developed which will find application for fiber optic gyros (FOGs) and infrared counter measures (IRCMs). Other DRDO labs like Solid State Physics Laboratory (SSPL), Delhi and Laser Science & Technology Centre (LASTEC), Delhi have been sincere partners in the photonics programme and Research Centre Imarat (RCI), Hyderabad has been instrumental in taking IRDE's photonic products to actual uses. Encouraged with this success, IRDE has now initiated an ambitious programme on 'Micro-Optics and Nanophotonics' which is going to get the cutting edge high technology research happening in Indian academia applied in defence domain. As a spin off technology provider also, IRDE has delivered low cost high magnification plastic aspheric lenses to visually handicapped which have won a national award.

In thermal imaging area, detector is the key technology. So, a lot of importance has been given to this one in this special issue of *Defence Science Journal*. Tissot and co-authors has presented the status of uncooled detector technology at ULIS, France. Their paper describes uncooled microbolometers made from amorphous silicon enabling the development of small weight and small power (SWaP) high performance IR systems. Latest developments of cooled detectors at Sofradir France have been presented by Vuillermet. His paper presents new products based on MCT detector technology like Scorpio LW, Jupiter MW detectors. Klipsten and co-authors from SCD, Israel in their long paper titled 'Status of Cooled and Uncooled IR detector at SCD, Israel' have discussed in detail the newly matured InSb planar technology especially SCD's new epi-InSb detectors and also the new HOT XBn-InAsSb detectors enabling faster cool down time and mission readiness, longer mission times and higher cooler reliability and enhanced S/N ratio due to reduce dark current. Gupta and co-authors at

SSPL, Delhi, India has presented coventorware software based simulation results on design optimization of pixel structure for α-Si based uncooled IR detector in which they have concluded that pixel membrane structures of grid and serpentine types are more appropriate for achieving high performance IR detector arrays. Developments in cryocooler technology for IRFPA in India has been presented in detail by Singh and co-authors at SSPL, India.

Kumar in his paper titled 'sensor uniformity correction algorithms and its real time implementation for infrared focal plane array based thermal imaging system' has presented the two types of sensor non-uniformity correction algorithms developed at IRDE–one correction of sensor non-uniformities based on calibration method and the other one based on scene information and the results of their implementation on FPGA based embedded system hardware. The paper titled 'Infrared Background and missile signature survey' by Renuka and Reddy from Defence Avionics Research Establishment (DARE), Bangalore has presented the building of tactical missile IR signatures and background data bank.

Laser and adaptive optics technology is another key area in electro-optics instrumentation domain. Design of a large aperture, tip tilt mirror for beam jitter correction in high power lasers at LASTEC, Delhi has been presented by Ghai and co-authors. The performance of TTM in both static and dynamic conditions and test set-ups have been well discussed in this paper. Bhardwaj and co-authors has reported the design and development of intra-cavity Optical Parametric Oscillator-based Eye safe laser at LASTEC, Delhi.

As a guest editor, I am grateful to all the expert reviewers for their time and efforts in providing valuable comments. I am very grateful to all the authors. I convey my sincere thanks to DG R&D (ECS) for encouraging me to take up this task. Dr AK Gupta, OS and Director IRDE has been a continuous source of guidance and motivation for me. I also convey my special thanks to Mr J.P. Singh, Scientist 'F', IRDE for making all the arrangements required for this special issue.

I am thankful to the Editorial Team of *Defence Science Journal* for devoting the issue to this vital defence technology Optical and Electro-Optical Instrumentation and inviting me as a Guest Editor. I hope this issue of DSJ will be highly useful for all the concerned persons in this area.

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