MALAVIYA NATIONAL INSTITUTE OF TECHNOLOYA JAIPUR

Report on Empowering India-2025 Exhibition
(12th to 14th September 2025 at Panjim Convention Centre, Goa)

Event Overview

The **Empowering India-2025 exhibition** was a landmark national initiative showcasing the achievements, welfare schemes, and developmental projects of central and state governments. Bringing together ministries, research institutes, universities, industries, and startups, it served as a dynamic platform for awareness, innovation, and collaboration. Science and Technology formed a central theme, highlighting India's progress in space, atomic energy, digital technologies, and applied sciences. Education was another key focus, with IITs, NITs, IISERs, IIMs, and national bodies showcasing reforms, skill development, and entrepreneurship pathways. The event fostered synergy between government, academia, and industry, promoting knowledge exchange and capacity building. Aligned with the vision of our Honorable Prime Minister of "Hamara Sankalp Viksit Bharat" and "Atmanirbhar Bharat", it celebrated India's journey toward self-reliance and sustainable development.

The **Empowering India-2025 Exhibition** was organized at the **Panjim Convention Centre, Goa**, from **12th to 14th September 2025**. This landmark national event, brought together **visionaries, innovators, entrepreneurs, researchers, and policy leaders** on a single platform. Over three days, the exhibition ran from **10:00 a.m. to 5:00 p.m. on the first two days and from 10:00 a.m. to 4:30 p.m. on the final day**, featuring a structured agenda that included the **inauguration ceremony, lamp lighting, keynote addresses, panel discussions, and concurrent exhibitions.**

Chief Guests & Dignitaries

12th September 2025

- **Chief Guests:**
  - Dr. Pramod Sawant – Hon'ble Chief Minister of Goa
  - Smt. Kamaljeet Sehrawat – Hon'ble Member of Parliament, Lok Sabha (West Delhi)
- **Guests of Honour:**
  - Shri Arun Kumar Mishra, IAS – Secretary, Health, Govt. of Goa
  - Shri Alok Kumar, IPS – Director General of Police, Govt. of Goa

13th September 2025

- **Guest of Honour:**
  - Prof. (Dr.) Tankeshwar Kumar – Vice Chancellor, Central University of Haryana, Mahendragarh
- **Special Guests:**
  - Shri Upendra Joshi – OSD to Chief Minister of Goa
  - Shri Agam Mittal – APS to Minister of State for Power & MNRE, Govt. of Goa
  - Dr. Muralidhar Nayak Bhukya – Director, Central University of Haryana
  - Mr. Basharat Khan – Film Producer, Mumbai

14th September 2025

- **Special Guests:**
  - Shri Sandeep B. Fol Dessai
  - Dr. Veena Kumar
  - Shri Shivendra Gaur
  - Dr. Rahul Ramteke – Senior Interventional Cardiologist

Audience Profile:

MNIT Jaipur Representation:

Official Representatives:

- Dr. Kuldeep Singh (Department of electronics and communication engineering)
- Dr. Swati Sharma (Department of metallurgical and materials engineering)
- Mrs. Simi Choudhary (Office of Dean Student Welfare)

MNIT Jaipur's representation at the Empowering India-2025 exhibition was truly commendable and left a lasting impression on all visitors. The institute's stall became a hub of innovation, where students enthusiastically presented their projects and ideas. Researchers showcased impactful studies, highlighting the strength of MNIT in advanced science and technology. The display reflected the institute's alignment with national missions like Atmanirbhar Bharat and Viksit Bharat. Faculty members engaged meaningfully with industry leaders, government officials, and academicians, creating valuable collaborations and most importantly, school students who are the budding future of India. Visitors appreciated the way technical knowledge was blended with practical applications, making the stall both informative and inspiring.

Students received praise for their confidence and creativity, which demonstrated the nurturing environment at MNIT Jaipur. The representation also highlighted the institute's focus on skill development, sustainability, and entrepreneurship. Dignitaries admired MNIT Jaipur's contribution to nation-building through quality education and impactful research. Overall, the institute's participation was widely appreciated, with students, researchers, and visitors all acknowledging MNIT Jaipur as a true center of excellence.

MNIT Jaipur – Exhibit Highlights

1. **Development of Plasma Sprayed High Temperature Oxidation Resistant Coating Materials for Satellite Thrusters**

- **Team:** Dr. Swati Sharma (Department of Metallurgical & Materials Engineering) MNIT Jaipur
  Ruchi Patak, Apoorva Vaishistha.
- **Overview:** Plasma-sprayed RHEA coatings (MoTaHfWV, MoTaNbWV, and MoTaHfWV/MoTaNbWV + Mxene) have been fabricated, showing high hardness, strong bonding, and oxidation resistance up to 2000ºC. These molybdenum-based HEA coatings improve high-temperature performance, corrosion resistance, and oxidation resistance.

- **Experimental Results:** These coatings effectively resist high-temperature oxidation of the substrate, and the established process and structure-property relationships pave the way for future development for use with convergent-divergent nozzles in satellites.

- **Industrial Significance**: Intricate and small parts can be coated using a plasma gun equipped with an extension for deposition inside internal diameters.

2. AI-Based Automated Microscopic Urinalysis System

- **Startup:** DeepLife Innovations Pvt. Ltd. (MIIC Startup)
- **Overview:** A diagnostic device has been developed that performs centrifugation, captures multiple microscopic images, and uses AI for urine sediment detection. It quantifies different sediments while also marking their exact locations, enabling both automated analysis and easy manual verification.
- **Experimental Results:** The device identifies more than eight categories of sediments in urine samples, achieving a sensitivity rate of 92.5% and a precision rate of 91%.
- **Importance:** The device is crucial for hospitals, especially in rural areas, offering an affordable indigenous solution. At one-fourth the cost of existing equipment and half the cost per test, it makes advanced diagnostics more accessible in India.

3. SILICO-AI: An AI-Based Portable Computer-Aided Diagnostic System for Silicosis Disease

- **Team:** Dr. Kuldeep Singh, Dr. Satyendra Singh Chauhan, Dr. Priyanka Harjule, Faisel Mushtaq, Rajesh Kumar,
- **Overview:** A deep-learning-powered device analyzes chest X-rays to detect early-stage silicosis caused by prolonged silica dust exposure. It not only confirms the disease but also highlights the exact affected lung regions. Designed for field use, it offers fast, accurate, and reliable screening.
- **Experimental Results:** Attained a **sensitivity** rate of **97.44%** and a **precision** rate of **99.07%** on a two-class dataset comprising Normal and Silicosis categories.
- **Importance:** The device is of great importance in any hospital or clinical settings, especially in rural regions where access to healthcare resources and technological infrastructure may be limited.

4. Advancements in Surface Protection: High Entropy Alloy-Based Robust Super hydrophobic Coating Fabricated with Plasma Spray

- **Researcher:** Dr. Swati Sharma (Department of Metallurgical and Materials Engineering) MNIT Jaipur.
- **Overview:** The research investigates plasma-sprayed High Entropy Alloy coatings, focusing on their wettability and mechanical properties. These coatings exhibit super hydrophobic behavior, causing water droplets to roll off the surface and enabling self-cleaning. The study also examines how surface energy affects interaction with substances, with low surface energy enhancing water repellency.
- **Experimental Results:** X-Ray Diffraction confirmed the peak and phase of plasma-sprayed High Entropy Alloy coatings on SS304L substrates. The coatings HEAC-1 and HEAC-2 showed super hydrophobicity with contact angles of 150.02° and 155.7°. Mechanical testing revealed high hardness values of 503.3±8.44 and 661.8±8.10, demonstrating robustness and elastic behavior.
- **Applications:** These coatings are used as anti-icing coatings on the front side of airplane wings and as anti-corrosion coatings for ship hulls and various machine parts.

5. Urban Fire Hazard Resilience Project

- **Researchers:** Dr. Yash Kumar Mittal, Dr. Niruti Gupta, and Dr. Himanshu Yogi and Team.
- **Overview:** The project studies urban fire hazards in Indian cities using GIS, planning, and data analytics. It maps fire risks, incident patterns, and emergency service coverage.
- **Experimental Results:** GIS analysis showed fire hotspots in Jaipur, especially in landfill and industrial areas. It revealed service gaps, highlighting the need for quicker responses.
- **Importance:** Urban areas face high fire vulnerability due to dense populations and infrastructure. The study stresses faster response, better planning, and stronger resilience.

6. MIIC, MNIT Jaipur

MIIC is the flagship incubation facility at MNIT Jaipur, dedicated to nurturing entrepreneurship and innovation. Spanning **70,000 sq. ft.**, the center has successfully incubated over **253 projects**, benefiting more than **2,400 ecosystem participants** and creating over **1,500 jobs** through **400+ new businesses**. The center has a dedicated fund of **₹11.00 crore** to support its initiatives.

MIIC provides extensive support and resources, including:

- **Infrastructure:** The center features **60 independent rooms** for startups, **134 start-up rooms**, and common equipment worth over **₹500,000**.
- **Strategic Support:** It offers mentorship, seed funding, and financial guidance, along with assistance in market research, prototype development, and IP protection.
- **Ecosystem Connections:** MIIC has strong ties with key government and industry bodies, including the **Department of Science & Technology (DST)**, **CII**, **FICCI**, and **TIE Rajasthan**.
- **Programs:** The center has successfully mentored over **2,400 students** through its internship program and supported **11 entrepreneurs-in-residence** under the NIDHI-EIR Program.

Notable success stories from MIIC include **Punto Corporation**, which was recognized among the top 75 startups in India, and **Svaargyom Medical Devices Pvt. Ltd.**, listed in DIPP's compendium of the top 50 women-led startups in the country.

Impact & Outcomes

- The **MIIC pavilion of MNIT Jaipur** emerged as a **center of attraction**, presenting research-driven and market-ready innovations addressing real-world challenges in **healthcare, aerospace, and urban resilience**.
- The **Department of Electronics & Communication Engineering (ECE)** showcased advancements in AI-based diagnostic systems, portable healthcare devices, and intelligent solutions, reflecting its strong focus on digital health, automation, and next-generation technologies.
- The **Department of Metallurgical & Materials Engineering** highlighted cutting-edge work in high-entropy alloys, plasma-sprayed coatings, and surface engineering, demonstrating MNIT's contributions to aerospace, defense, and industrial applications.
- **School and college students** engaged deeply, gaining exposure to research, technology, and the entrepreneurial mindset.
- **Delegates and dignitaries** interacted with MNIT researchers, opening avenues for **collaborative projects and technology transfer**.

- The institute reaffirmed its status as a **national leader in applied research and innovation** with strong societal impact.

Conclusion

The **Empowering India-2025 Exhibition** was a **resounding success**, reflecting India's spirit of innovation, academic excellence, and entrepreneurial energy. The distinguished presence of dignitaries, active participation of premier institutions, and enthusiastic involvement of students transformed the exhibition into a **true celebration of nation-building through science and technology**.

The exhibits from MNIT Jaipur at *Empowering India-2025* highlighted a strong synergy of innovation, research, and societal impact. From advanced plasma-sprayed coatings for satellite thrusters to AI-powered medical diagnostic systems, the projects showcased both technological depth and practical application. The urinalysis and silicosis detection devices proved how AI can make healthcare affordable and accessible, especially in rural India. High Entropy Alloy-based super hydrophobic coatings demonstrated immense potential in aerospace and marine industries with their strength and self-cleaning ability. The Urban Fire Hazard Resilience Project emphasized the importance of data-driven planning for safer cities. Together, these initiatives reflect MNIT's capability to bridge research with real-world challenges. They underline the institute's role in advancing national priorities in space, healthcare, and urban safety. Overall, MNIT Jaipur's contributions embody the spirit of innovation driving India's journey toward self-reliance and sustainable growth.

Development of Plasma Sprayed High Temperature Oxidation Resistant Coating Materials for Satellite Thrusters

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Jaipur(Rajasthan) 302017, India

Abstract
Oxidation resistant coatings are promising concept to improve the lifetime of propulsion systems. Thruster that provides passive atmospheric drag is one of the major components of this propulsion system. Conventionally, such components are protected using high temperature oxidation resistant coatings such as Refractory High entropy Alloys (RHEAs),Rare earth oxides, ceramic coatings etc. Among the oxidation resistance coatings, RHEAs have attracted a lot attention due to its thermal stability at high temperatures. These coatings have shown promising oxidation resistance behavior.

Introduction

Fabrication of plasma sprayed RHEAs (**MoTaHfWV, MoTaNbWV and MoTaHfWV/MoTaNbWV+Mxene**) coating, which is expected to show outstanding hardness, bond strength and oxidation resistance up to elevated temperature (2000ºC).

By improving high-temperature performance, corrosion resistance, oxidation resistance, the molybdenum-based HEA coating is able to effectively address the challenges presented by the severe space environment-

Fig. 1 Viking 5C rocket engine

- Exposed to high temp gas (≥ 2000ºC)
- High temperature Oxidation
- Nickel/cobalt-based nozzles of combustion chamber fail at the cooling channel, due to the large thermal stresses caused by the high inner surface temperature of the chamber.

Thermodynamic Parameters (criteria for formation of single-phase solid solution)

Thermodynamic Parameter	Equation	MoTaNbWV HEA	MoTaHfWV HEA
Mixing Enthalpy (ΔH_{mix}) ($-20 < \Delta H < 5$)	$\Delta H_{mix} = \sum_{i=1,i\neq j}^{n} (\Omega_{ij} C_i C_j)$	-0.432 KJ/mol	-0.39 KJ/mol
Mixing Entropy (ΔS_{mix}) ($\Delta S_{mix} \geq 12.471$)	$\Delta S_{conf} = -R \sum_{i=1}^{n} (X_i \ln X_i)$	13.38 J/molK	13.38 J/molK
Atomic-Size Mismatch (δ) ($\delta < 6.6\%$)	$\delta = 100 \sqrt{\sum_{i=1}^{n} c_i \left(1 - \frac{r_i}{\bar{r}}\right)^2}$	2.89	6.09
Ω (Mixing Parameter) ($\Omega \geq 1.1$)	$\Omega = \frac{T_m \Delta S_{mix}}{\lvert \Delta H_{mix} \rvert}$	0.917	0.988
Valence-Electron Concentration (VEC)	$VEC = \sum_{i=1}^{N} C_i (VEC)_i$	5.4	5.2

Conclusions

- ❑ The study successfully developed **plasma-sprayed RHEAs (Refractory Alloys)**, specifically **MoTaNbWV** and **MoTaHfWV**, for use as oxidation-resistant coatings (>2000˚C) on satellite hardware.
- ❑ The RHEAs coatings also can effectively **resist the high-temperature oxidation** of the substrate.
- ❑ The process and proposed structure-property relationships for the coating are now established, paving the way for the future development of these coatings for use with convergent-divergent nozzles in satellites.

Industrial Significance

- ❑ Intricate shapes and small size parts will be coated using plasma gun having an extension for deposition in internal diameter.

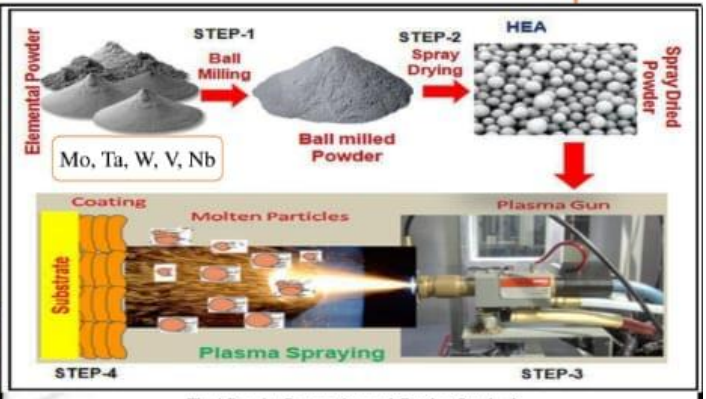
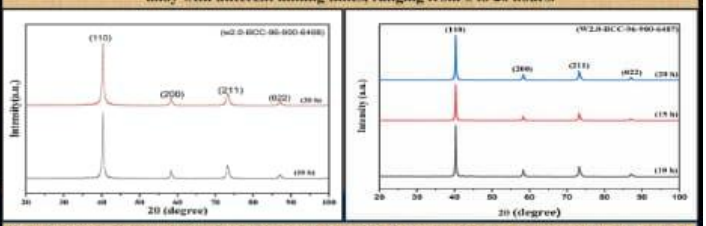


Fig.4 Powder Preparation and Coating Synthesis

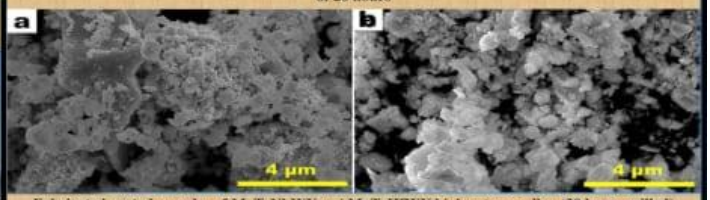
Three different compositions of the coatings will be prepared, which are as follows

1. MoTaHfWV RHEA coating
2. MoTaNbWV RHEA coating
3. MoTaHfWV/MoTaNbWV+ Mxene

X-ray diffraction patterns of powdered samples of the MoTaNbWV and MoTaHfWV high entropy alloy with different milling times, ranging from 0 to 20 hours.



Morphological analysis of MoTaNbWV and MoTaHfWV high entropy alloy powders with milling time of 20 hours



Fabricated coated samples of MoTaNbWV and MoTaHfWV high entropy alloy (20 hours milled) powders using Atmospheric plasma spray technique

References

1) Xiao, L., Zhou, X., Wang, Y., Pu, R., Zhao, G., Shen, Z., Huang, Y., Liu, S., Cai, Z., Zhao, X.: Formation and oxidation behavior of Ce-modified MoSi2-NbSi2 coating on niobium alloy. Corros. Sci. 173, (2020). https://doi.org/10.1016/j.corsci.2020.108751
2) Shuai, K., Zhang, Y., Fu, Y., Guo, X., Li, T., Li, J.: MoSi2-HfC/TaC-HfC multi-phase coatings synthesized by supersonic atmospheric plasma spraying for C/C composites against ablation. Corros. Sci. 193, 109884 (2021).https://doi.org/10.1016/j.corsci.2021.109884
3) Lu, J., Chen, Y., Sun, Z., Li, L., Liu, X., Huang, A., Zhang, H., Guo, F., Zhang, X., Zhao, X.: Air plasma sprayed high-entropy AlCoCrFeNiY coating with excellent oxidation and spallation resistance under cyclic oxidation at 1050–1150 °C. Corros. Sci. 198, 110151 (2022). https://doi.org/10.1016/j.corsci.2022.110151

Acknowledgement

Principal Investigator, Swati Sharma wish to acknowledge the financial support from Indian Space Research Organization for executing this work. Also PI wish to acknowledge MNIT Jaipur for giving all the laboratory facilities for carrying out this work.

Department of Metallurgical and Materials Engineering, MNIT Jaipur

Advancements in Surface Protection: High Entropy Alloy-Based Robust Superhydrophobic Coating Fabricated with Plasma Spray

Swati Sharma[1*]

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Objective

- Study of wettability behaviour of plasma sprayed High Entropy Alloy Coatings.
- Analysis of the mechanical Properties.

Introduction

- These coatings cause water to form spherical droplets that easily roll off the surface, carrying away dirt and contaminants.
- Due to the water-repellent nature, superhydrophobic surfaces are often self-cleaning as dirt and particles are carried away by water droplets.
- High surface energy indicates (low contact angle <90°) that a material's surface tends to attract and interact strongly with other substances.
- Low surface energy (High contact angle > 90°) suggests that a material's surface has reduced affinity for other substances.
- Applications: These coatings find applications in various industries, including self-cleaning surfaces, anti-icing coatings, corrosion protection, and medical devices.

Methodology

Deposition of High Entropy Alloy Powders for fabrication of coatings by Plasma Spray Technique.

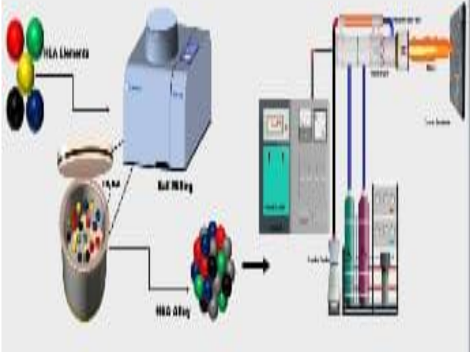


Figure 1 : Fabrication of HEA coatings with Atmospheric Plasma Spray Route

Results and Discussion

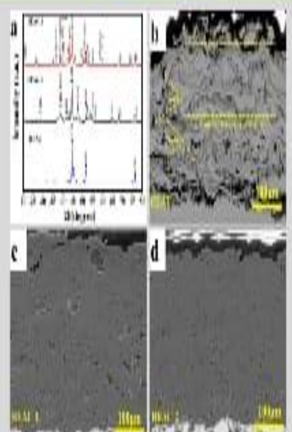


Figure 2 (a)Shows the XRD patterns of fabricated coatings along with the morphological images (b,c,d)

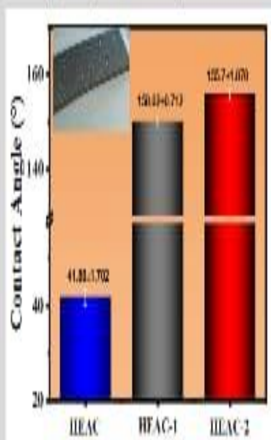


Figure 3 : Shows the Contact Angles of fabricated coatings

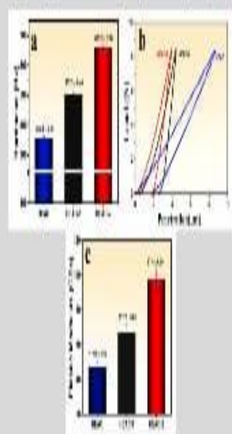


Figure 4 (a) Shows the Hardness of fabricated coatings along with load vs peneration graph and elastic modulus(b,c)

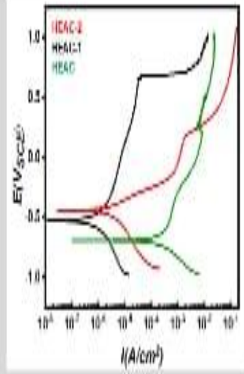


Figure 5 : Shows the Potentiodynamic Polarization Curve for corrosion analysis fabricated coatings

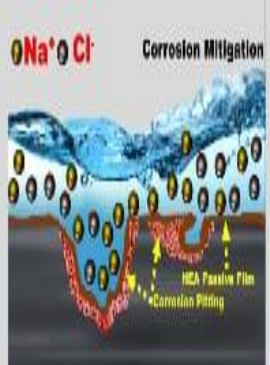


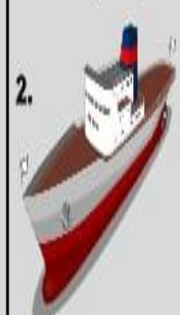
Figure 6 : Shows the Corrosion Mechanism of fabricated coatings

Application

1.

Anti Icing Coating of front side of wings of airplane

2.



3.

Super hydrophobic Coatings

Anti corrosion Coating for ship hull

4.

Anti corrosion Coating for Machine Parts

Conclusions

- X-Ray Diffraction shows the peak and phase of the fabricated coatings.
- Plasma sprayed high entropy alloy coating was successfully fabricated on SS304l substrate.
- The advancing contact angle for the fabricated coating HEAC-1 and HEAC-2 was found of 150.02° and 155.7°.
- Mechanical properties like hardness of the fabricated coatings was found 503.2±8.44 and 661.8±8.10 which shows the mechanical robustness along with load vs penetration and elastic modulus.

References

1. Meghwal, A.; Singh, S.; Anupam, A.; King, H.J.; Schulz, E.; Hall, C.; Munroe, P.; Berndt, C.C.; Ang, A.S.M. Nano- and micro-mechanical properties and corrosion performance of a HVOF sprayed AlCoCrFeNi high-entropy alloy coating. J. Alloys Compd. 2022
2. Li, N.; Tao, Y.; Yang, R.; Zhang, H.J.; Li, H.; Chen, X.Y. Superhydrophobic surface on arc-sprayed aluminum coating via fluorinated polyurethane modification: Preparation and application in corrosion protection. J. Therm. Spray Technol. 2022
3. Kumar, A.; Nayak, S.K.; Laha, T. Comparative study on wear and corrosion behavior of plasma sprayed Fe73Cr2Si11B11C3 and Fe63Cr9P5B16C7 metallic glass composite coatings. J. Therm. Spray Technol. 2022

SILICO-AI: An AI-Based Portable Computer-Aided Diagnostic System for Silicosis Disease

Faisel Mushtaq, Kuldeep Singh,
Satyendra Singh Chauhan, Rajesh Kumar, Priyanka Harjule
Malaviya National Institute of Technology Jaipur, Rajasthan

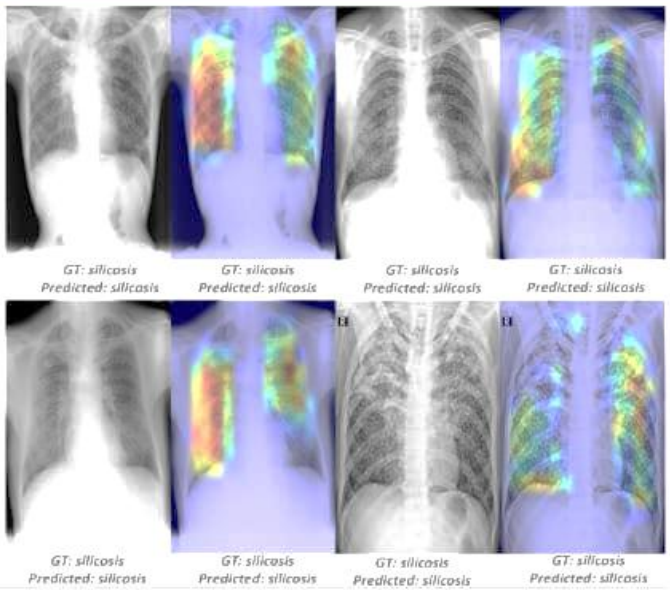
Introduction

- **Silicosis** is a progressive and incurable lung disease caused by long-term inhalation of crystalline silica dust.
- In **India**, about 10 million workers are exposed to inorganic dust with majority of them are from the Indian states of Rajasthan, Gujarat, Madhya Pradesh and Andhra Pradesh.
- Diagnosis is often made through a combination of medical history, physical examination, **chest X-rays**, and pulmonary function tests.
- According to **I**nternational **L**abor **O**rganization, chest radiography is the most affordable and accessible radiological test available for physical examination of workers exposed to dust.
- Diagnosing pulmonary conditions demands **skilled radiologists** who visually interpret X-ray images, leading to **time-consuming** processes and subjective assessments.

Challenges

- In early stages, the radiographic changes associated with silicosis may be **subtle** and **easily missed**, especially by less experienced radiologists.
- Diagnosis exhibits **variability** among the radiological observers.
- Silicosis often coexists with other lung diseases, such as tuberculosis or emphysema, which can further complicate interpretation of X-ray findings.

Visualization



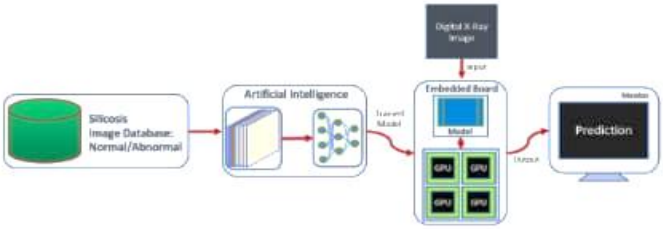
Solution: An AI Powered Device

- We've engineered a **portable** diagnostic device tailored for early detection of silicosis from chest X-rays.
- The device not only confirms the presence or absence of silicosis but also identifies the specific lung areas affected by silicosis disease.

A portable silicosis diagnosis device

Overall Working Scenario

- The device comprises a specialized hardware paired with a user-friendly interactive software.
- The diagnostic software utilizes sophisticated artificial intelligence based algorithm for efficient diagnosis.



Experimental Results

- We've attained a **sensitivity** rate of **97.44%** and a **precision** rate of **99.07%** on a two-class dataset comprising Normal and Silicosis categories.
- Additionally, in a multiclass pulmonary condition settings, we've reached a sensitivity rate of 85%.

Importance

- The device is of great importance in any hospital or clinical settings, especially in rural regions where access to healthcare resources and technological infrastructure may be limited.

** Funded by: Directorate of Specially-Abled People, Govt. of Rajasthan, India (Project ID.: 1000113529)*

** Indian Patent Granted (Patent No. 570357)*

AI-based Automated Microscopic Urinalysis System

*DeepLife Innovations Pvt. Ltd.
MNIT Innovation and Incubation Center (MIIC)
MNIT Campus, JLN Marg, Jaipur

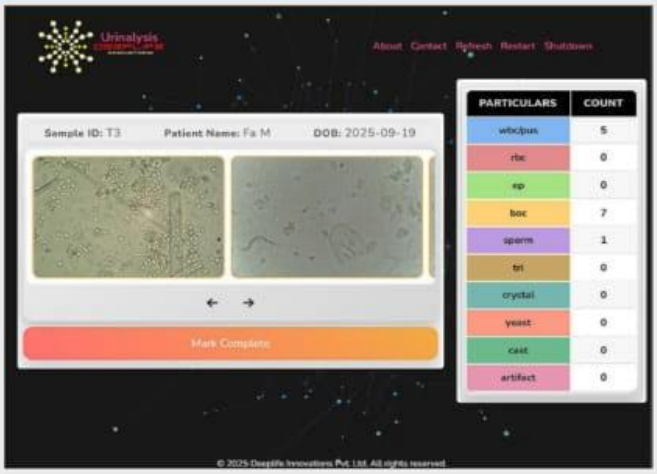
Introduction

- Urine analysis is used to diagnose a wide range of health conditions, including kidney disorders, urinary tract infections, and metabolic diseases.
- In India, millions of patients undergo routine urine examinations each year, forming a crucial component of preventive and diagnostic healthcare.
- Conventional urine tests are slow, error-prone, and heavily reliant on scarce skilled manpower, with no guarantee of standardized results.
- Automation of this process through advanced imaging and AI-based object detection enables faster, more accurate, and standardized diagnosis.

Overall Working Scenario

- The device comprises a specialized hardware paired with a user-friendly interactive software.
- The diagnostic software utilizes sophisticated artificial intelligence based algorithm for efficient diagnosis.

Preview



Problem statement

Current situation of Manual Microscopic urinalysis in India :

- Multiple steps: centrifugation, particle counting, and reporting
- Time-consuming and labor-intensive: Low efficiency and increasing workloads in high-volume clinical settings
- Further exacerbated in rural settings and II-tier cities where clinical diagnostic facilities are limited

Solution: An AI Powered Device

- We've engineered a diagnostic device capable of centrifugation, capturing multiple microscopic images of a urine sample, and AI-based urine sedimentation detection.
- The device not only quantifies the presence of various sediments but also provides their location on the image for manual verification.

Experimental Results

- The device identifies more than 8 categories of sediments in the urine samples.
- We've attained a **sensitivity** rate of **92.5%** and a **precision** rate of **91%** on the urine samples.

Importance

The device is of great importance in hospitals and clinical settings, especially in rural regions with limited healthcare resources, as it provides an indigenous solution at nearly one-fourth the cost of existing equipment and almost half the cost per test, making advanced diagnostics more accessible and affordable for the Indian market.

शिक्षा मंत्रालय
MINISTRY OF
EDUCATION
सत्यमेव जयते

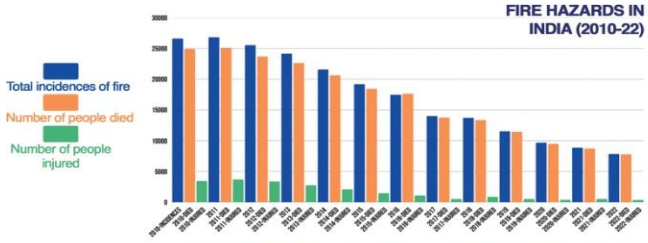
SPARC
Scheme for Promotion of Academic and Research Collaboration

Department of Architecture & Planning
Malaviya National Institute of Technology Jaipur

Title of Project: Building Urban Resilience to Fire Hazards through Planning and Design Optimization using Data Analytics

Objectives:

1. To profile fire incidents and evaluate the level of emergency responses for urban fire in dense historical cores and informal settlements of Indian cities.
2. To develop and validate vulnerability assessment framework for the analysis of fire risk at building and neighbourhood level based on land-use, urban form and density.
3. To conduct -a) fire-risk assessment at the building level and b) spatial optimization of fire service coverage at the metropolitan level to enhance emergency response, improve preparedness and to reduce fire risk.
4. To develop an optimization model through simulation for improving urban fire resilience based on components of urban design and building regulations.



FIRE INCIDENCES, DEATHS & INJURIES DUE TO FIRE (2010-22)

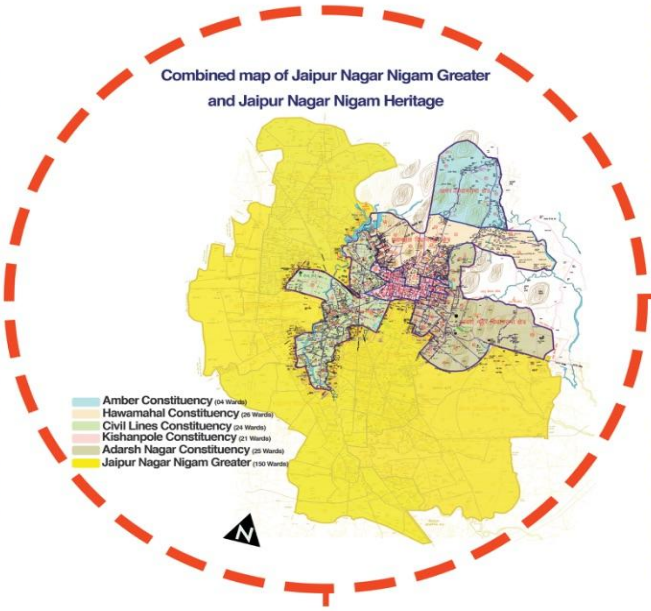
Selection of Case Study Area: Jaipur Nagar Nigam Heritage

1. The urban growth dynamics in Jaipur have evolved considerably in recent years, driven by a combination of population increase, economic development, and spatial expansion. The city has experienced substantial urban sprawl, with its built-up area expanding by more than 50% over the past two decades *(Priti Deo, et al., 2024)*.

2. This growth has led to increased population density and the expansion of city limits, further straining the existing infrastructure and emergency services. Studies have documented the impact of urban sprawl on the availability and accessibility of essential services, including firefighting, making it imperative to assess the adequacy of service coverage in this context *(G. K. &. G. V. V. Sharma, 2024)*.

3. Fire hazards in Jaipur are particularly pronounced during certain seasons, such as summer and festivals, when the risk of fire incidents tends to increase due to higher temperatures, the use of firecrackers, and other cultural practices. The traditional residential buildings in the walled city of Jaipur are especially vulnerable to fire hazards, given their dense construction and the use of flammable materials *(S. K. A. &. P. S. Goswami, 2024)*.

4. These factors necessitate a focused study on the spatial distribution of firefighting services in Jaipur to identify gaps in coverage and ensure that all areas of the city are adequately protected against fire hazards.



Remarks on NCRB Data:

1. Fire accidents have been a cause of concern in India, leading to substantial loss of life and property. However, since 2014, a significant decline has been observed in number of fire accidents.

2. Despite the decrease in incidents, fire-related fatalities remain at high levels. On average, women comprised 60% of total fatalities, significantly higher than their share in other types of accidental deaths.

3. The steep decline raises questions about dataaccuracy and reporting methodologies. Experts suggest cross verifying with alternative sources such as hotspital records, fire department call logs and burn registries to ensure the reliability of the reported data.

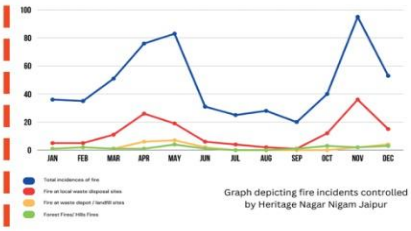
Conclusion:

1. The GIS-based analysis of fire incidents within the Jaipur Municipal Corporation Heritage boundary for the year 2023 reveals critical insights into the spatial distribution of fire risks.

2. The identification of risk hotspots, such as landfill sites and forested areas, underscores the need for targeted firefighting strategies and the strategic placement of new fire stations in underserved regions.

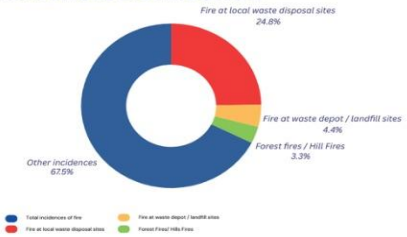
3. The current gaps in service coverage highlight the importance of augmenting firefighting resources to improve response times and mitigate the impact of fires.

2023_FIRE INCIDENCES REPORT

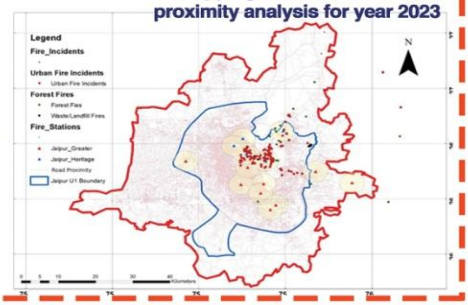


Graph depicting fire incidents controlled by Heritage Nagar Nigam Jaipur

2023_FIRE INCIDENCES DISTRIBUTION



Mapping of fire incidents and proximity analysis for year 2023



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EVENT HIGHLIGHTS:


MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY
JAIPUR, RAJASTHAN
NATIONAL INSTITUTE OF TECHNOLOGY
JAMSHEDPUR


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