SMART INDIA HACKATHON 2025

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ALGO TRONICS

TITLE PAGE

- MINISTRY : Ministry of Earth Sciences (MoES)
- PS NUMBER : SIH25036
- PS TITLE: Development of Sensor for Detection of Microplastics
- TEAM NAME : Algo Tronics
- THEME : Miscellaneous
- PS CATEGORY : Hardware

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DEVELOPMENT OF SENSOR FOR DETECTION OF MICROPLASTICS

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PROPOSED SOLUTION

We're looking for a solution by creating a sensor that will help us to get rid of microplastics from our life through 1-5mm plastic detection so that it don't effect any human nor marine live . By integrating it through software we can detect with-in real time

- Doing Automated detection of microplastics in water samples using images or sensor data. Then we Classifies particle types: polyethylene, polypropylene, PET, etc.
- It Detects particle size, shape, and count for detailed analysis.
- Uses ML (SVM, Random Forest) and DL (CNNs, YOLO, U-Net) for accurate detection.
- We Train our model on public and lab-collected labeled datasets that will evaluated with metrics: accuracy, precision, recall, F1-score, IoU, mAP.
- We also designed it as Real-time predictions via mobile or web interface for field and lab use.
- Dashboard displays particle highlights, concentrations, trends, and alerts.
- Also it is a Scalable solution as it supports batch processing for multiple samples simultaneously.
- Cost-effective and easy to deploy with lightweight models for edge/mobile applications.
- Enables fast, large-scale environmental monitoring and preventive action.

WORKING OF MODEL

User presses **"START"** on the Dashboard

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Command sent to **MICROCONTROLLER** -> activates sensors & pumps

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Laser interacts with microplastics in water sample

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Camera captures signals/images data sent to microcontroller

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Microcontroller transmits raw data → **software processes it** with ML models

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Software analyzes and classifies → **dashboard show results**

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Dashboard gives user real-time feedback ,while commands can be sent back to hardware for next actions

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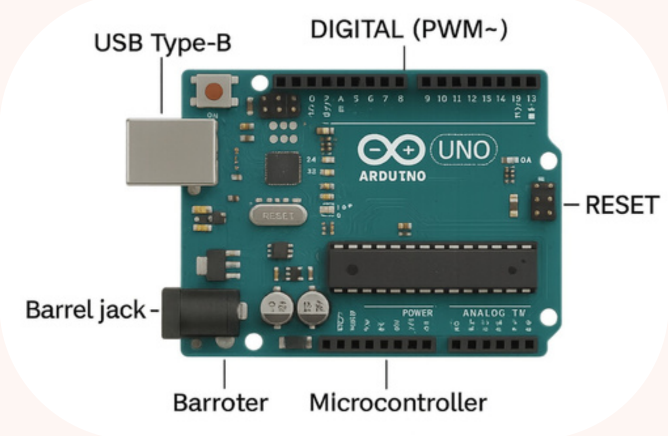
TECHNICAL APPROACH

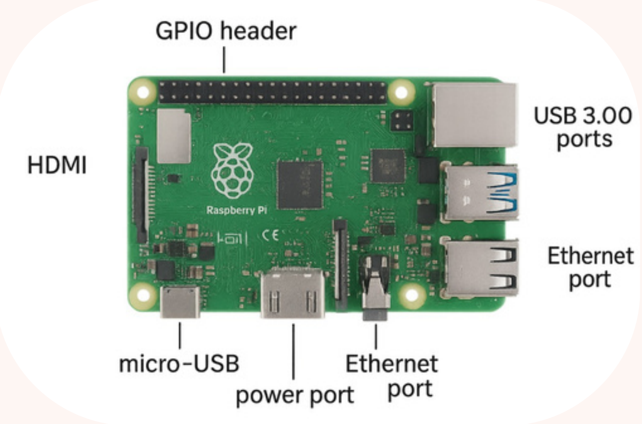
HARDWARE COMPONENTS

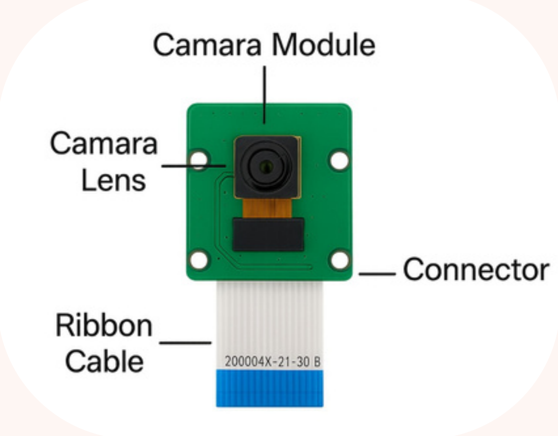
- Laser Diode
- Camera Module
- Optical Filters
- Flow Cell
- Raspberry Pi 4
- Pump
- Battery

Technology Stack :

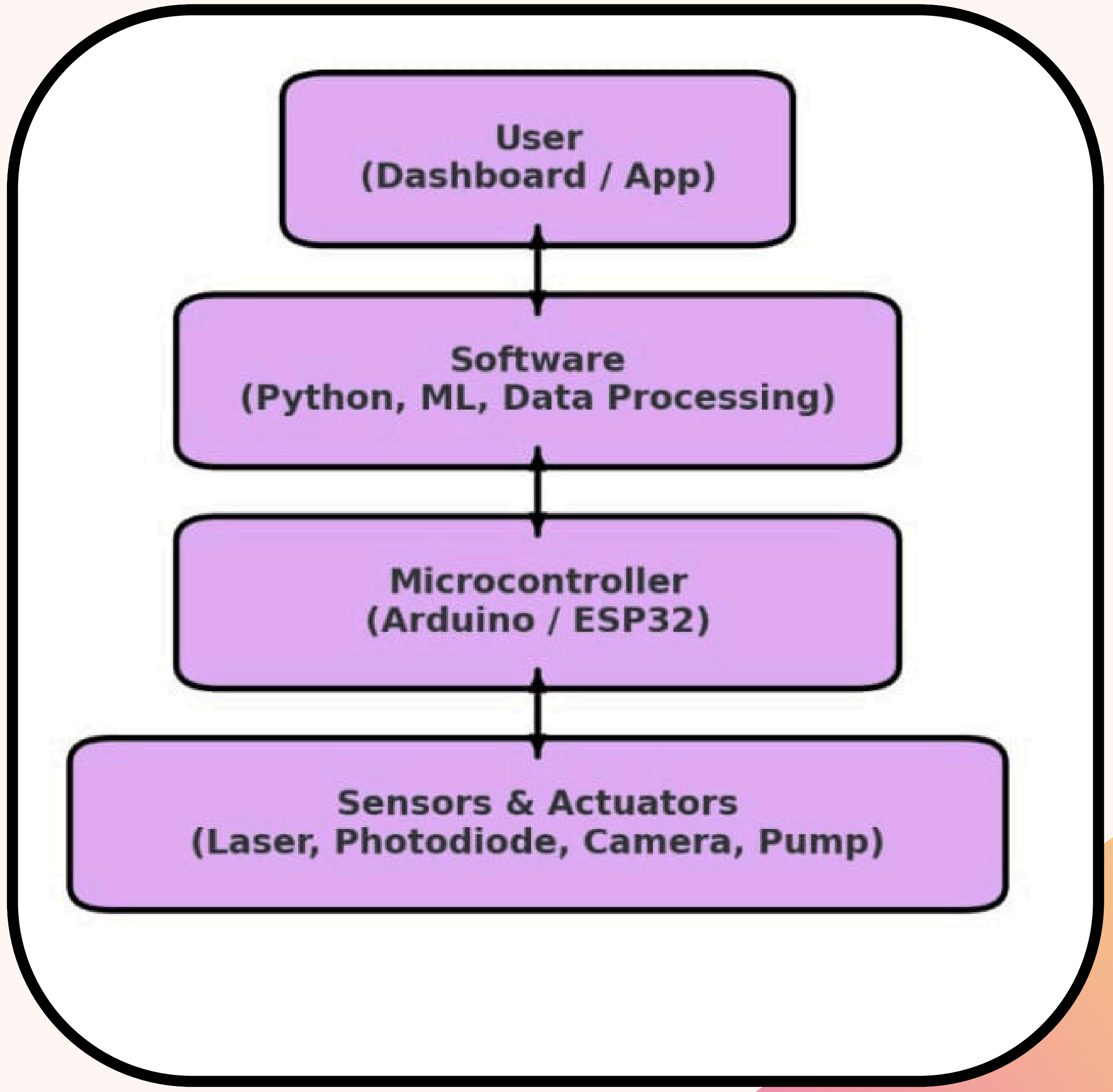
LightGBM, PYTORCH, NumPy, dask, TensorFlow, NLTK, pandas, Keras, BeautifulSoup, matplotlib, GENSIM, Scrapy, XGBoost, CatBoost, plotly, scikit learn, spaCy







PROTOTYPE MODEL CONNECTION BETWEEN HARDWARE & SOFTWARE



FEASIBILITY AND VIABILITY

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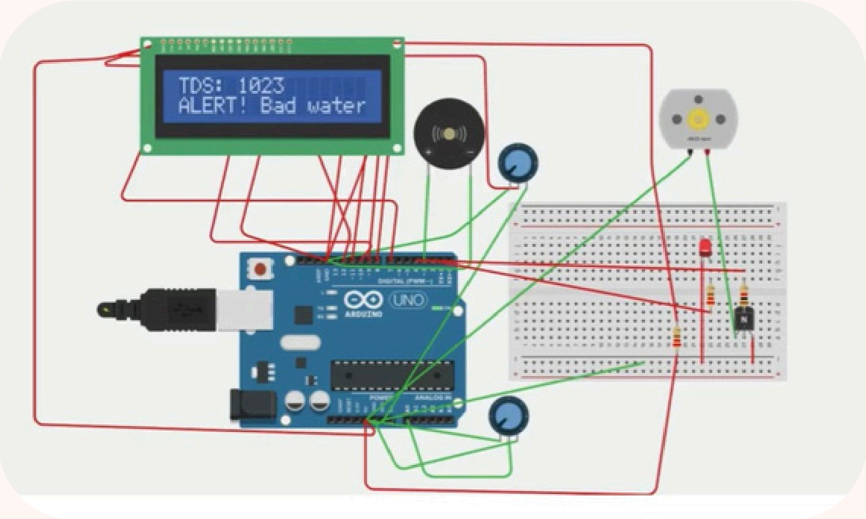
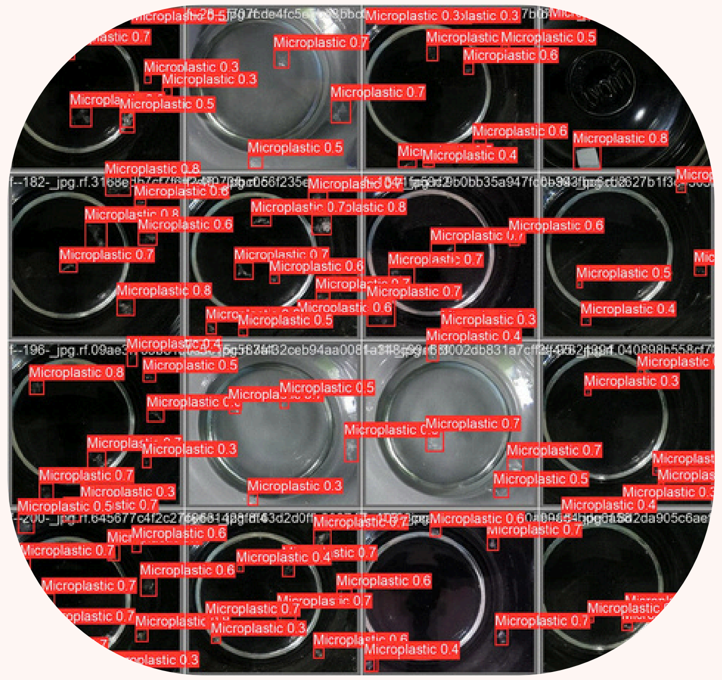
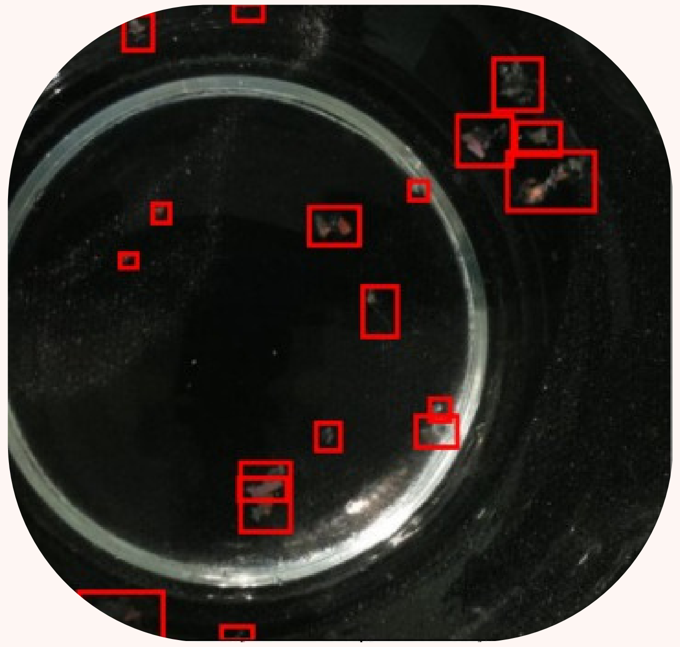
FEASIBILITY

- **Technical**: We uses existing low-cost optics (camera + LEDs) + ML → feasible to prototype.
- **Resource**: Raspberry Pi, open-source ML models, and basic lab plastics are accessible.
- **Time**: Simplified prototype (count + size detection) possible in SIH timeline.
- **Challenge**: Dataset preparation, precise optical chamber design but still we will complete our project .



HARDWARE PROTOTYPE MODEL





SOFTWARE PROTOTYPE MODEL

VIABILITY

- **Practical Need** – Rising global concern about microplastics in drinking water and ecosystems creates urgent demand.
- **Affordability** – Current solutions (FTIR, Raman) are expensive and lab-based; there's a clear gap for portable, low-cost devices. But we are using Sensor + ML approach reduces dependency on costly lab infrastructure, making it deployable in field conditions.
- **Adoption Potential** – Governments, environmental agencies, and water utilities actively seek real-time monitoring tools for compliance and safety.
- **Integration Feasibility** – Compatible with IoT platforms for remote monitoring and reporting, increasing long-term usability.
- **Funding** – Opens doors for CSR funding, government environmental schemes, and collaborations with water-purification companies.
- **Sustainability Factor** – Battery/solar-powered design makes it viable for deployment in rural and resource-limited regions.

IMPACT AND BENEFITS

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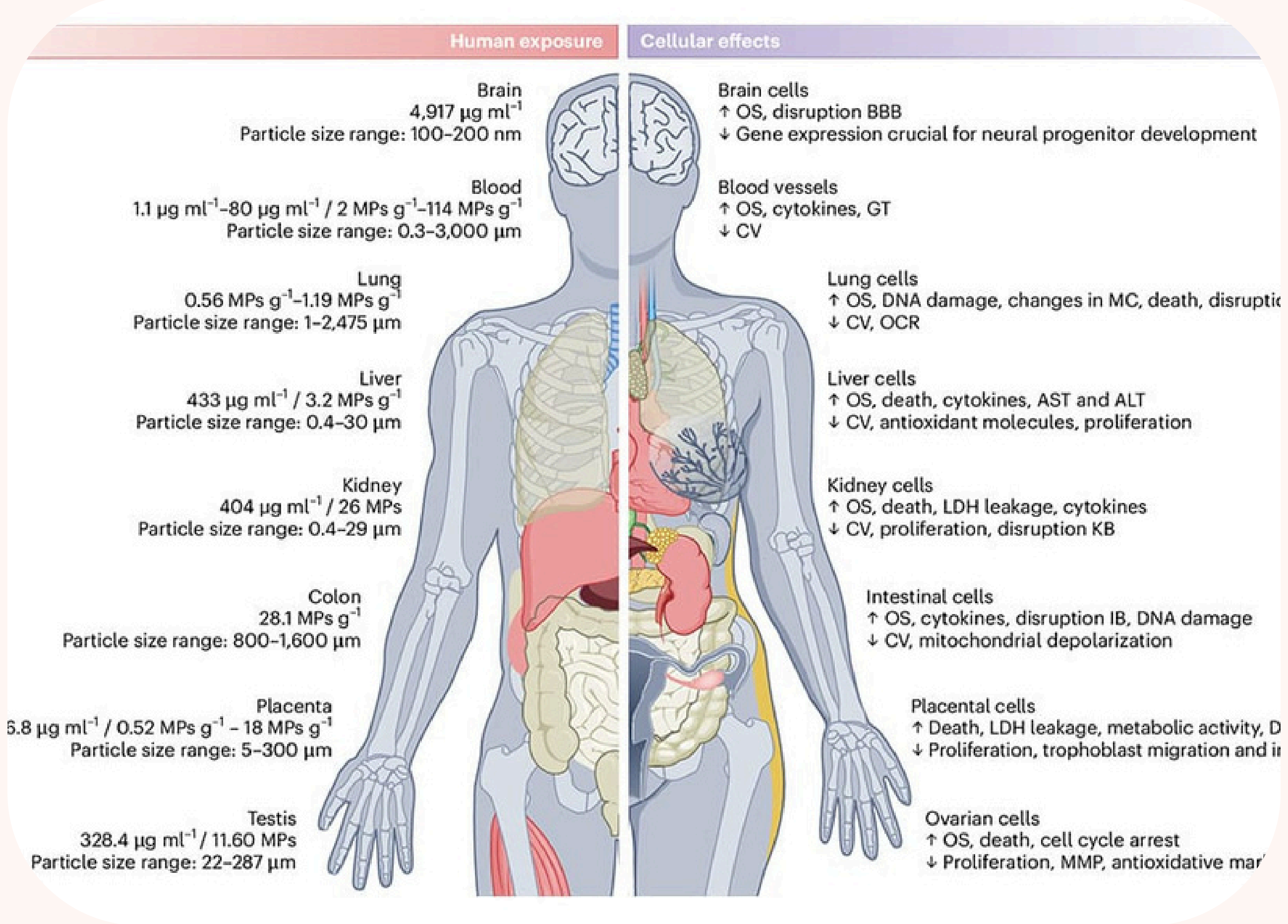
BENEFITS

- It is **low cost** and **portable** alternative to lab systems
- We can easily **detect this in real - time** in couple of minutes
- It **works on solar-powered** & field deployable
- It supports the **SDGs (CLEAN WATER ,LIFE BELOW WATER)**
- **Scalable** in field of research , industry and education

IMPACTS

- **ENVIRONMENTAL** : It will track & reduce plastic and water pollution
- **SCIENTIFIC** : Give real-time field data for research
- **SOCIAL** : Helps to generate awareness to citizens
- **POLICY** : We can create evidence based water quality monitoring policy
- **CLEAN** : This helps to clean our nation that also helps to decrease the rate of disease



REVENUE MODEL

- **HARDWARE SALES** : We can sale our KITS to agencies , industry & universities
- **SaaS DASHBOARD** : We give Subscription to cloud analytics & alerts
- **DATA MARKETPLACE** : We sell aggregated water data to researchers & govt
- **EDUCATIONAL KITS** : Low cost student kits for schools & NGOs
- **Funding & Partnerships** – Opens doors for CSR funding, government environmental schemes, & collaborations with water-purification companies.

FROM PROBLEM TO SOLUTION

Water Sources (rivers, lakes, tap water)

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Portable Sensor detects microplastics

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Data sent to dashboard/app in real time

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Govt/NGOs track pollution hotspots

↓

Targeted cleanup & stricter policies

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Cleaner environment & healthier life

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RESEARCH AND REFERENCES

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- Watkins, L., Sullivan, P. J. & Walter, M. T. : A **meta-analysis of sampling method's impact** on measured aquatic microplastic concentration. Environ. Sci. Technol. 55, 12930–12942, https://doi.org/10.1021/acs.est.1c03019 (2021).
- ITRC (Interstate Technology & Regulatory Council). Microplastics Team Materials. Washington, D.C.: Interstate Technology & Regulatory Council, MP Team. https://mp-1.itrcweb.org (2023).
- Beaumont, N. J. et al. Global ecological, social, and economic impacts of marine plastics. Mar. Pollut. Bull. 142, 189–195, https://doi. org/10.1016/j.marpolbul.2019.03.022 (2019).
- The **NOAA NCEI Marine microplastics database** : Research Paper
- Marine Microplastic concentrations
- **OECD Data Explorer** - archive
- Kaggle

A SHORT VIDEO THAT DESCRIBES "HOW MICROPLASTIC ARE HIDDEN DANGER FOR ALL"

https://drive.google.com/file/d/1BCzbZokgpT3w5z5oDj5EUVlbrxez3PlW/view?usp=sharing