Biotech Innovation Challenge

Nanobots for Combating Soil Pollution

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INTRODUCTION

- The core idea of this project involves creating nanobots that can navigate through soil environments to minimize soil pollution.
- Aim to neutralize harmful contaminants like copper, nickel, lead, and cadmium using nanobots.
- Machine learning approaches would be used to help the nanobots make intelligent decisions in different soil conditions
- Nanosensors will be used to guide the movements of nanobot through the soil while releasing the payload organelle to neutralize the heavy metals identified..

INTRODUCTION

- The nanobots would be designed to protect themselves from potential threats and unnecessary interactions.
- This innovative approach aims to improve soil quality, promote plant growth, and contribute to a more sustainable environment
- The design of nanobots would be eco-friendly with biological neutralizing process and a sustainability of 1-2 months.

IMPLEMENTATION

- The core idea of this project involves **modelling nanobots** that can navigate through **soil environments** to minimize **soil pollution** while protecting themselves from potential threats and unnecessary interactions.

- **Approach:** A Nanobot-action **Simulation software** would be exclusively designed to have nanobots that initiate neutralization of heavy metals such as **copper, nickel, lead**, and **cadmium** their ion forms noticed on nanoscale.

- **Components**: Simulation of **operation** and **control** of nanobots using an **IoT system**, **Machine Learning** to program actions to be received and discovery of better ways of **biological synthesis** of **payload** and **durability** of nanobots.

IMPLEMENTATION-STEPS

Step 1

Organelle

Using VMD,GRAPH NN(To obtain Bacterium)

Simulation of organelle with 4 protein sequences (Reacting with heavy metals), using VMD

Step 2

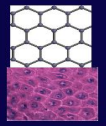
Modelling Payload Regenerator

Simulation of Catalysis Control using VMD and NAMD

Simulation of regeneration of two new organelles in controlled conditions

Step 3

Graphene



Keratinocyte

Materials used to make the outer layer of the nanobot. Simulation of the slimy eyes and nanosensor attachments, shape modelling.

Simulation with NAMD

Step 4

Simulation of link between nanobot body,regeneration chamber , and the control that comes into play to escape obstacles, using VMD and NAMD

Step 5

Simulation of nanobot spotting the target and communication using sensors connected to Arduino Cloud. Simulation of the running time of the bootstrapped compiler through which the nanosensors receive programmed instructions and a model of Nanobot's actions (The exact response time of the nanobots) in unforeseen conditions.

Involves VMD, NAMD and Graph Neural Networks

Step 6

VMD based Simulation of Nanobot's body near the regeneration chamber to release the payload properly at the target with additional coatings and apoptosis control of the organelle.

Simulation of identification of Heavy metal ions using NAMD

Simulation of nanosensors taking control to coordinate spring movements using NAMD. Arduino Cloud based communication.

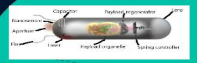
Uses Mutaton control probabilities and remedy simulation based on results from Graph NNs

Step 7

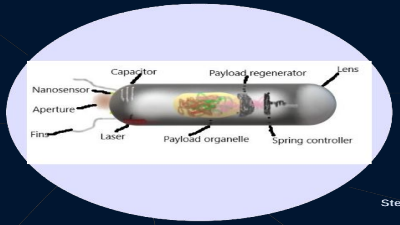
Continued Simulation in degradation of the nanobot while completing its cycle using NAMD.

Step 8

Basic Design



3d Printing of nanobot that neutralizes cadmium and Lead as a hardware equivalent of the best combination of simulation results.



KEY FEATURES TO BE CONSIDERED

- The nanobot capsule would be designed using graphene nanomaterial coated with keratinocytes.
- The nanobot would be designed with a nano-camera to identify the respective ions (Cd^{2+}, Cu^{3+}, Pb^{2+}, Ni^{3+}) which it would target, based on the colours of ions identified.
- The nanobot would have a payload synthesis chamber made of a pseudo organelle, coated with Ferric Oxide.

KEY FEATURES TO BE CONSIDERED

- The pseudo organelle in the nanobot would have the protein sequences found in *staphylococcus aureus* and *halomonas* bacteria.
- The key sequences that would be embedded in the organelle would be zeaxanthin, ectoine, Polyhydroxyalkanoates (PHAs) for functioning and a kinase to target cell division.
- The nanobot would also have a provision to direct laser rays, optical tweezers and for dynamic injection of the organelle, whose regeneration would be controlled within the nanobot through dna springs.

KEY FEATURES TO BE CONSIDERED

- A simulation of working of the nanobot would be provided subject to different conditions through NAMD and Graph Neural Networks.
- The best enzymes for catalysis would also be modelled through Graph Neural Network Models to improve the current neutralizing processes and modification of the solubility products.

TECHNOLOGY STACK

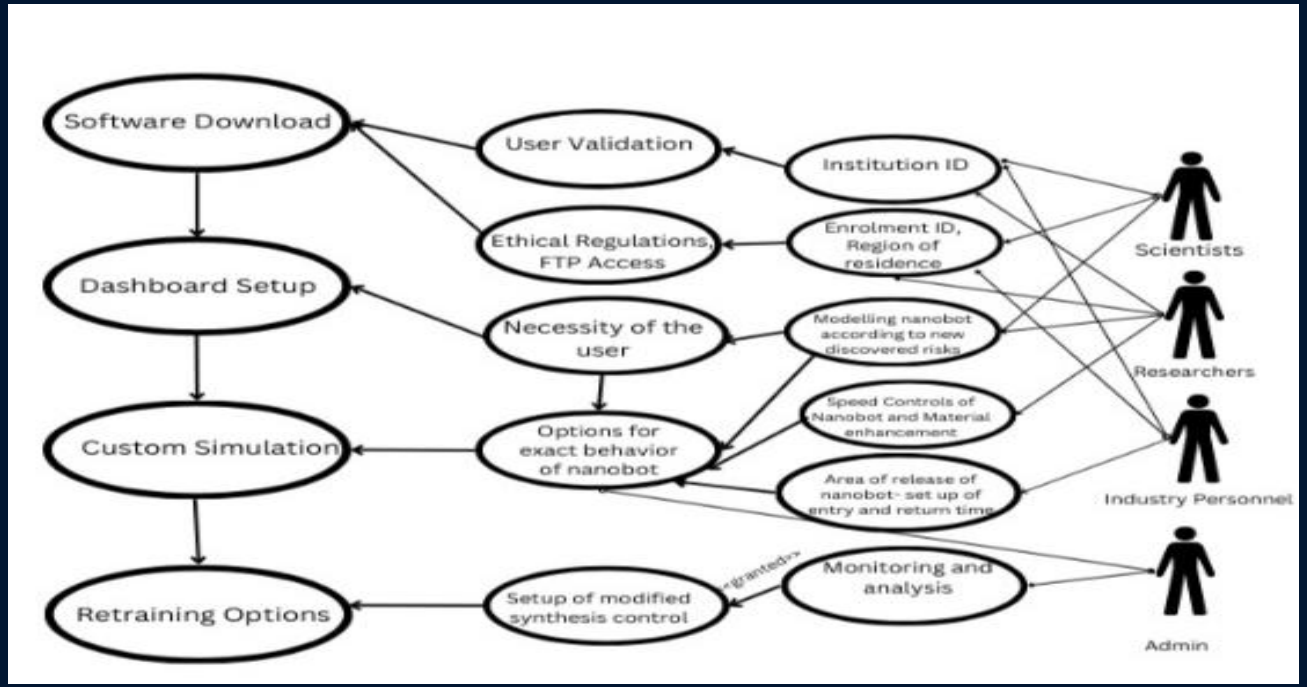
- **VMD:**Simulation Software,Display ,analyse and visualize biopolymers,i.e, organelles
- **NAMD:** Simulation software, supports quantum chemistry analysis, with nanobot, nanosensor modelling
- **PyG:** Used to model Graph NN sequence, helps in predicting the mutation in protein, functioning and time of survival of payload
- **Arduino Cloud:** Arduino is integrated with nanosensors for spring controls to guide the movements of nanobots within simulation.

USE CASE MODULES

- To Improve agricultural soil ,contaminated with heavy metals.
- To Remediate polluted urban areas for safe redevelopment.
- To Restore land after mining activities.

USE CASE PROCEDURE

The simulation software developed would be used by professionals before 3D printing nanobot as shown:



NEED AND IMPACT

- This innovative approach aims to **improve soil quality**, promote plant growth, and contribute to a more sustainable environment with significant ***reduction*** in **biological** and **chemical side-effects** and ***precision*** in tracking **exact location** of pollutants.

- Creation of nanobots with **eco-friendly** practices can be followed after a thorough study conducted by stakeholders through the **simulation software** developed subject to **ethical regulations** and dependencies.

DEPENDENCIES

- **Tcl,Tk,OpenGL,FFTW, Plugins and Extensions,Message Passing Interface (MPI)** associated with VMD.
- GPU License from Google Cloud.
- A system with **RAM** capacity of at least **8GB** to support the deliverable software that takes **4GB** RAM.

SCOPE AND FEASIBILITY

- To create nanobots capable of navigating through soil environments.
- Integrating machine learning into nanobots for intelligent decision-making in various soil conditions is achieved.
- The integration of input taken from the nanolens(simulated with Au-nano) as a device belonging to an IoT cloud involves image processing to identify the correct ions and trigger movements in the nanobot.
- Simulating the impact of nanobots addresses a lot of problems in making the hardware equivalent, reducing the cost involved as better material synthesis is achieved.

SHOWSTOPPER

- Proper modelling showing the control of the reaction area in the soil and the payload regeneration chamber.

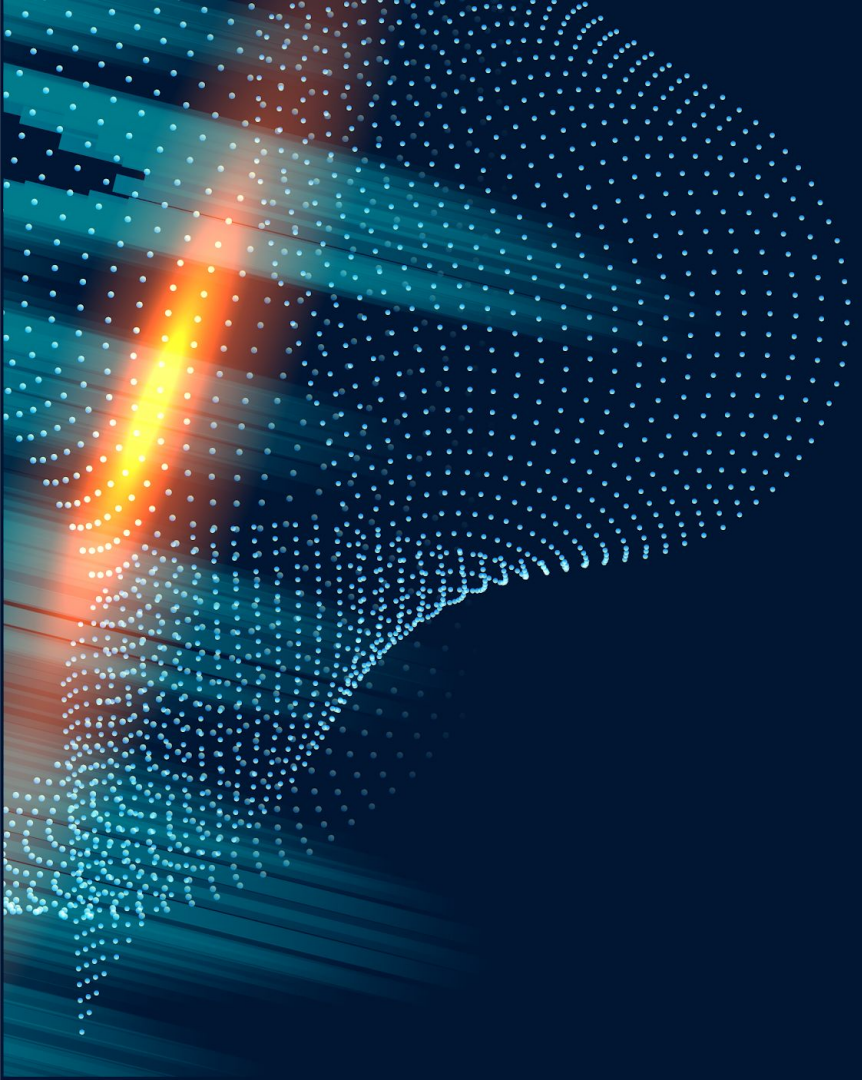
- Risk minimization in re-absorption of heavy metals by plants by simulating control of solubility products of reagents associated in all steps.

DETAILS

Video explanation of the prototype design

DETAILS

Link to Demo



THANK YOU

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