TITLE:HAZARDSCOUT:MULTI PURPOSE INSPECTION ROBOT

DOMAIN:IOT

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PROBLEM STATEMENT

Current inspection and maintenance methods for critical infrastructure, such as pipelines and telecommunication cables, are often slow, labor-intensive, and carry significant risks for human operators. Tight spaces, obstacles like pipe joints, stairs, and the complexity of underground or overhead systems hinder efficient inspections. Additionally, existing systems struggle to effectively detect hazards such as gas leaks, fire risks, corrosion, or structural damage in real-time, leading to delayed response times and potential safety hazards. Manual inspections of pipelines, oil, gas, water systems, and telecommunication infrastructure are prone to errors, increasing operational costs and risking human safety during emergency situations like fires or leaks.

LITERATURE SURVEY

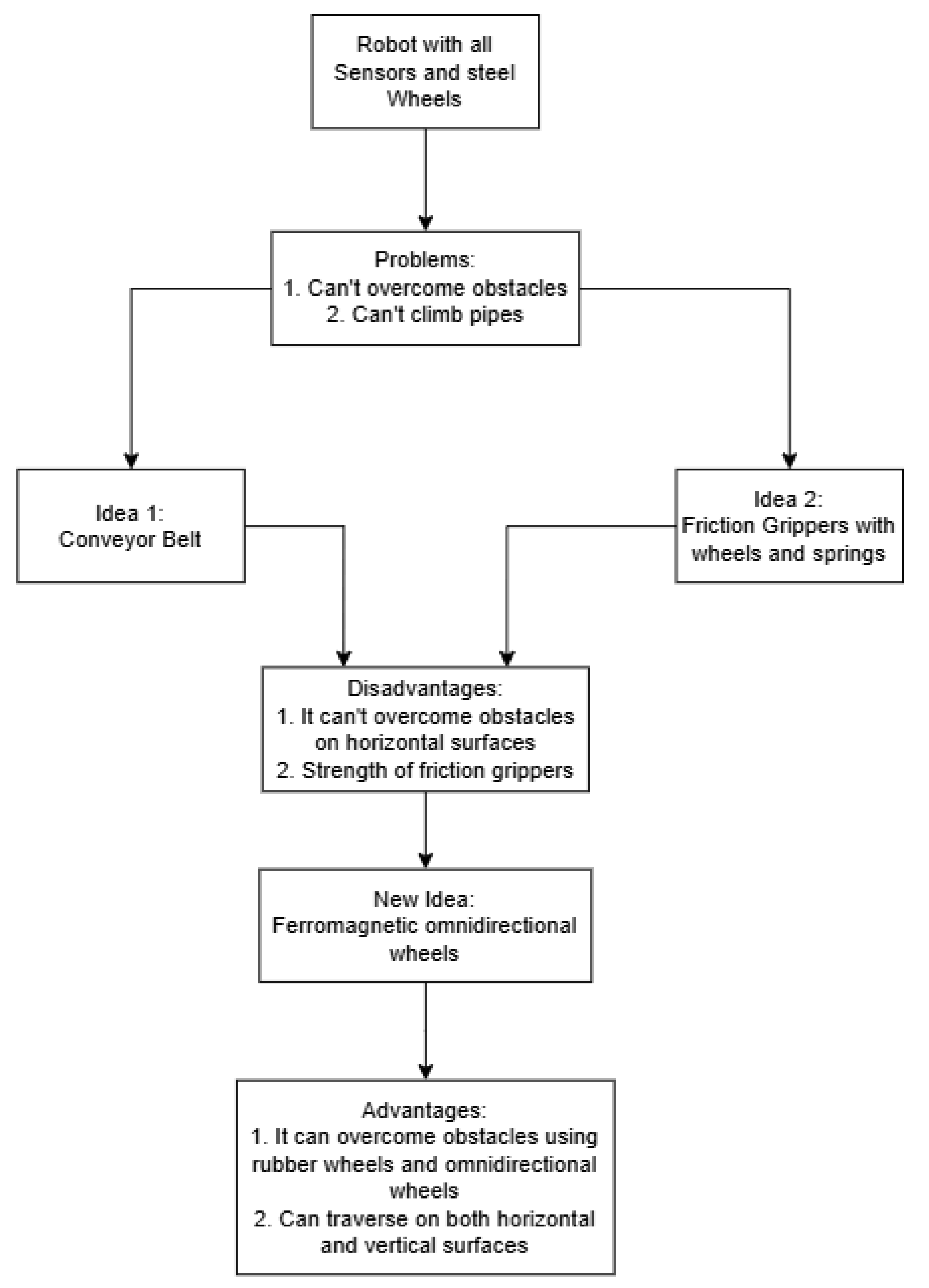
Sr No	Author(s) and Year of Publication	Title of the Paper	Key Methodology Followed	Findings	Gaps/Limitations	Future Work
1	J. Smith et al., 2023	Flexible Pipe Navigation in Robotics	Articulated joints for flexible navigation in pipelines	Capable of navigating through complex and narrow pipelines	Lacks autonomous decision-making ability	Add AI-driven navigation for better autonomy
2	N. Patel et al., 2023	Autonomous Firefighting Robots with Sensor Fusion	Data fusion from smoke, gas, and temperature sensors	Improved accuracy in detecting fire and gas leaks	Response time is still relatively high	Develop faster response algorithms
3	Y. Tanaka et al., 2023	Firefighting Robots with Water Jet Propulsion	Water jet propulsion and thermal imaging for fire suppression	Capable of extinguishing fires in challenging environments	Limited water supply for prolonged fire suppression	Integrate more efficient water storage or refuelling systems
4	X. Zhang et al., 2022	Magnetic-Wheeled Climbing Robots for Non-Destructive	Magnetic adhesion combined with adaptive mechanisms	Effective in detecting gas leaks in hazardous vertical environment	Limited to metallic surfaces	Expand to non-metallic surface climbing techniques

LITERATURE SURVEY

5	M. Lee et al., 2022	Advanced Fire Detection and Suppression Robots	Use of thermal and infrared imaging with automated fire	Autonomous detection and suppression of fire in industrial settings	Limited to flat, open spaces	Limited to flat, open spaces
6	F. Wilson et al., 2022	Robots for Petrochemical Industry Inspections	Magnetic wall-climbing with real-time gas monitoring	Effective for inspecting industrial pipelines and tanks	Only applicable to specific environments (petrochemical)	Adapt design for broader industrial applications
7	D. Li et al., 2022	Wireless Sensor Networks for Industrial Safety	Integration of wireless sensor networks for continuous monitoring	Autonomous detection and alarming of gas leaks	High maintenance cost of sensor systems	Develop cost-effective WSNs for widespread use
8	A. Brown et al., 2021	Real-Time Data Transmission in Hazardous Environments	High-resolution cameras and sensors for real-time data	Reduces human exposure to hazardous environments	Data transmission sometimes fails in low connectivity areas	Improve connectivity in remote industrial areas

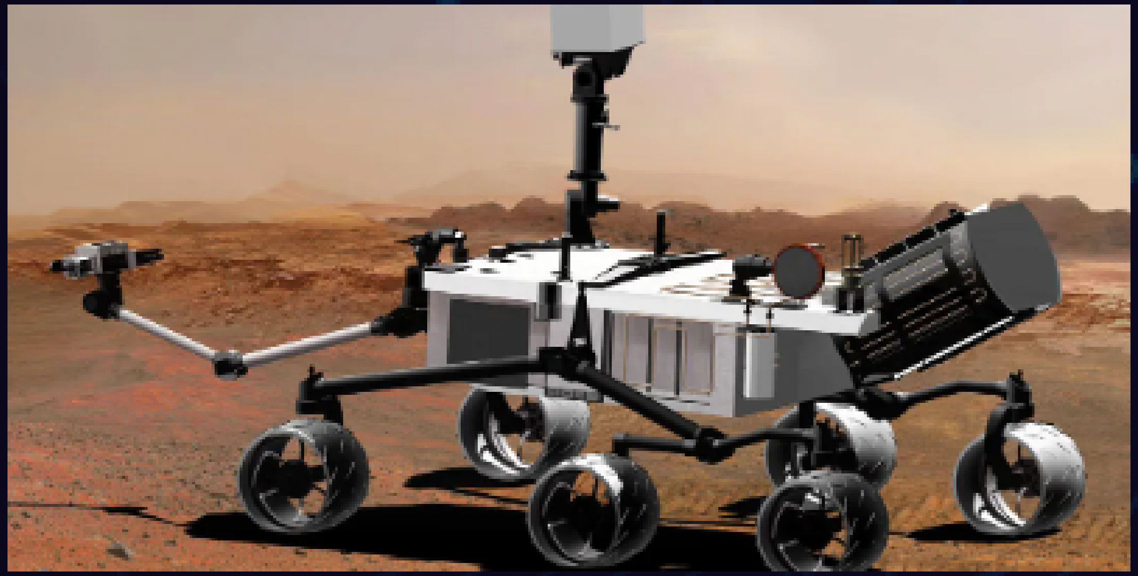
LITERATURE SURVEY

9	R. Diaz et al., 2021	Snake Robots for Confined Space Navigation	Serpentine movement for navigating confined spaces	Useful in post-disaster environments and confined industrial areas	Limited control in unpredictable environments	Enhance robustness to environmental changes
10	A. Kumar et al., 2021	Gas Leak Detection Using Multi-Sensor Robotic Systems	Multi-sensor integration for real-time leak detection	Accurate detection of gas concentration	High energy consumption of sensors	Improve energy efficiency of sensor networks



PREVIOUS IDEAS

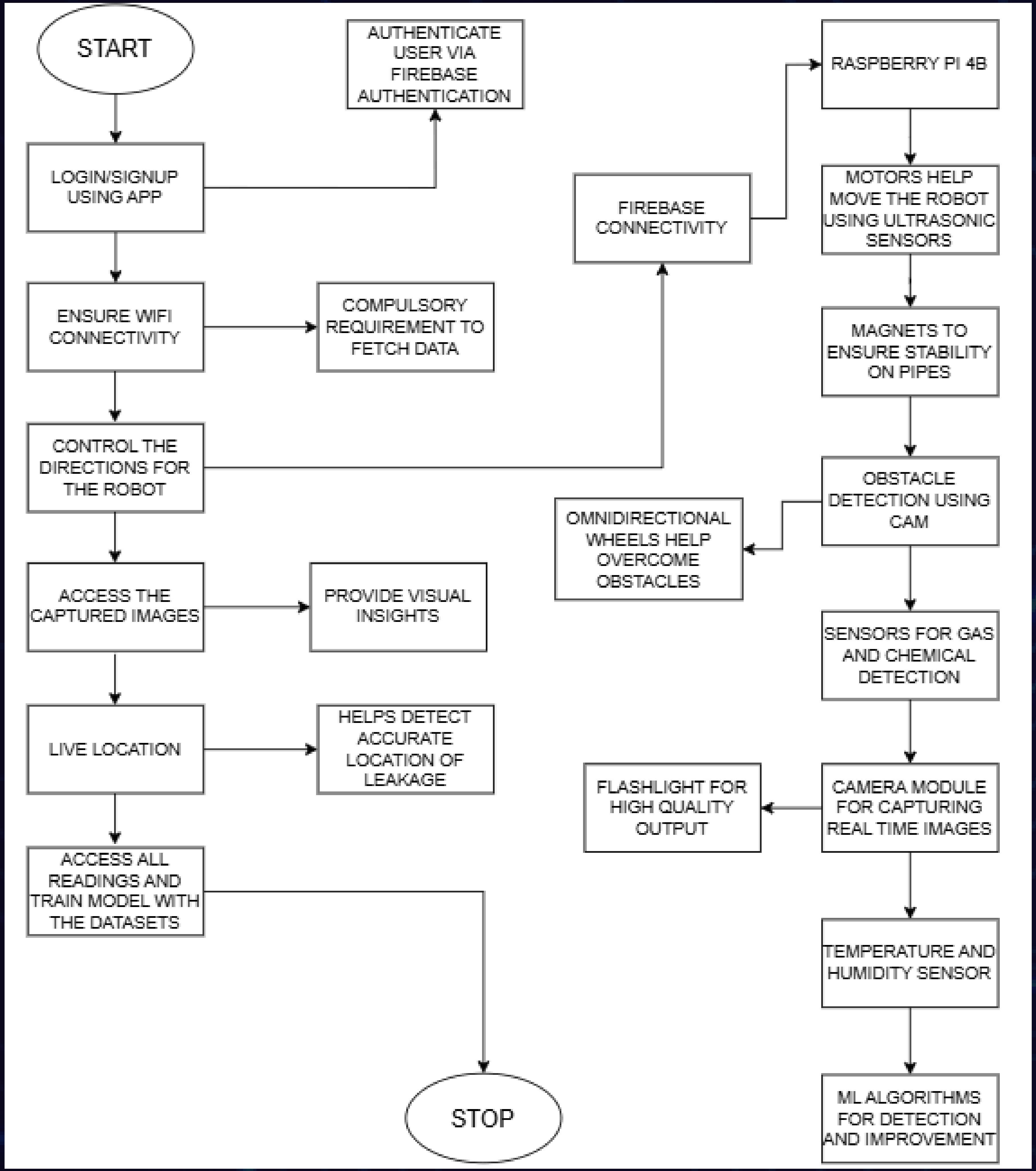
The diagram depicts the evolution of solutions for a robot to climb pipes and navigate obstacles. Initially, the robot with sensors and steel wheels struggled with climbing and obstacles. The first idea, conveyor belts, failed on vertical surfaces. The second idea, friction grippers, faced strength issues. Finally, ferromagnetic omnidirectional wheels were chosen, offering effective traversal on both horizontal and vertical surfaces while overcoming obstacles.



PROPOSED METHODOLOGY

We explored several ideas for our proposed methodology, but they were rejected due to specific limitations:

1. Conveyor Belts with Magnets
2. Rover with Autonomous Vehicle
3. Frcition grippers with wheels



ARCHITECTURE DIAGRAM

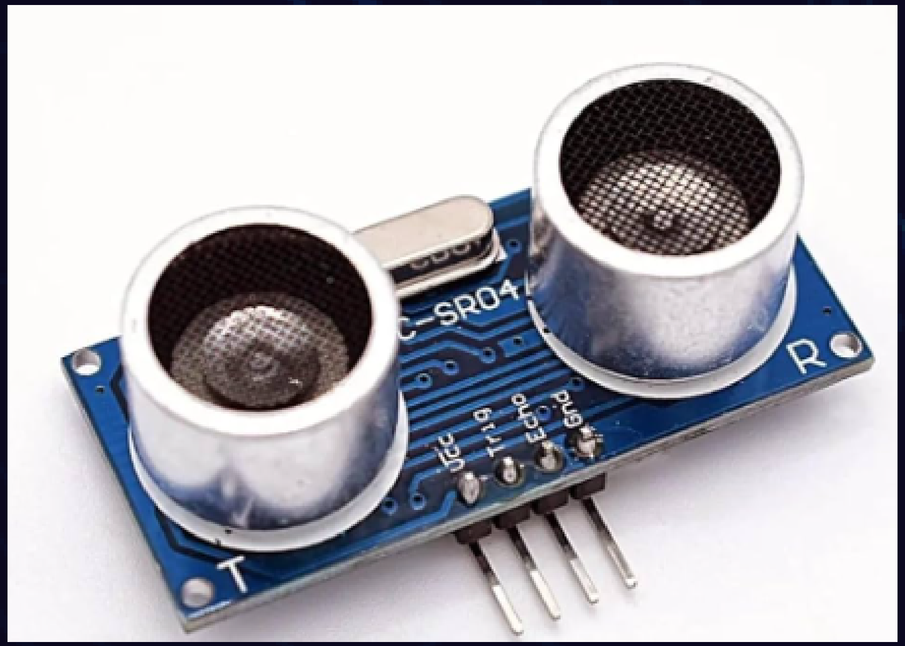
The diagram illustrates the operation of a robotic system designed for pipe inspection and gas leakage detection. It begins with user authentication via an app using Firebase, followed by ensuring WiFi connectivity to control the robot. The robot employs various features such as omnidirectional wheels for obstacle navigation, magnets for stability, and advanced sensors for detecting gas leaks and capturing real-time data. The collected data is analyzed using machine learning to provide accurate insights and live visuals, enhancing detection capabilities and delivering precise outcomes to users.

OMNIDIRECTIONAL WHEELS

- Wheels with rollers at angles to enable movement in all directions.
- Rollers are usually angled at 45° to the wheel axis.
- Forward, backward, sideways, diagonal, and rotational motion.
- Used in robotics, automated vehicles, and industrial systems.
- High maneuverability, precise movement in tight spaces.

MAGNETS

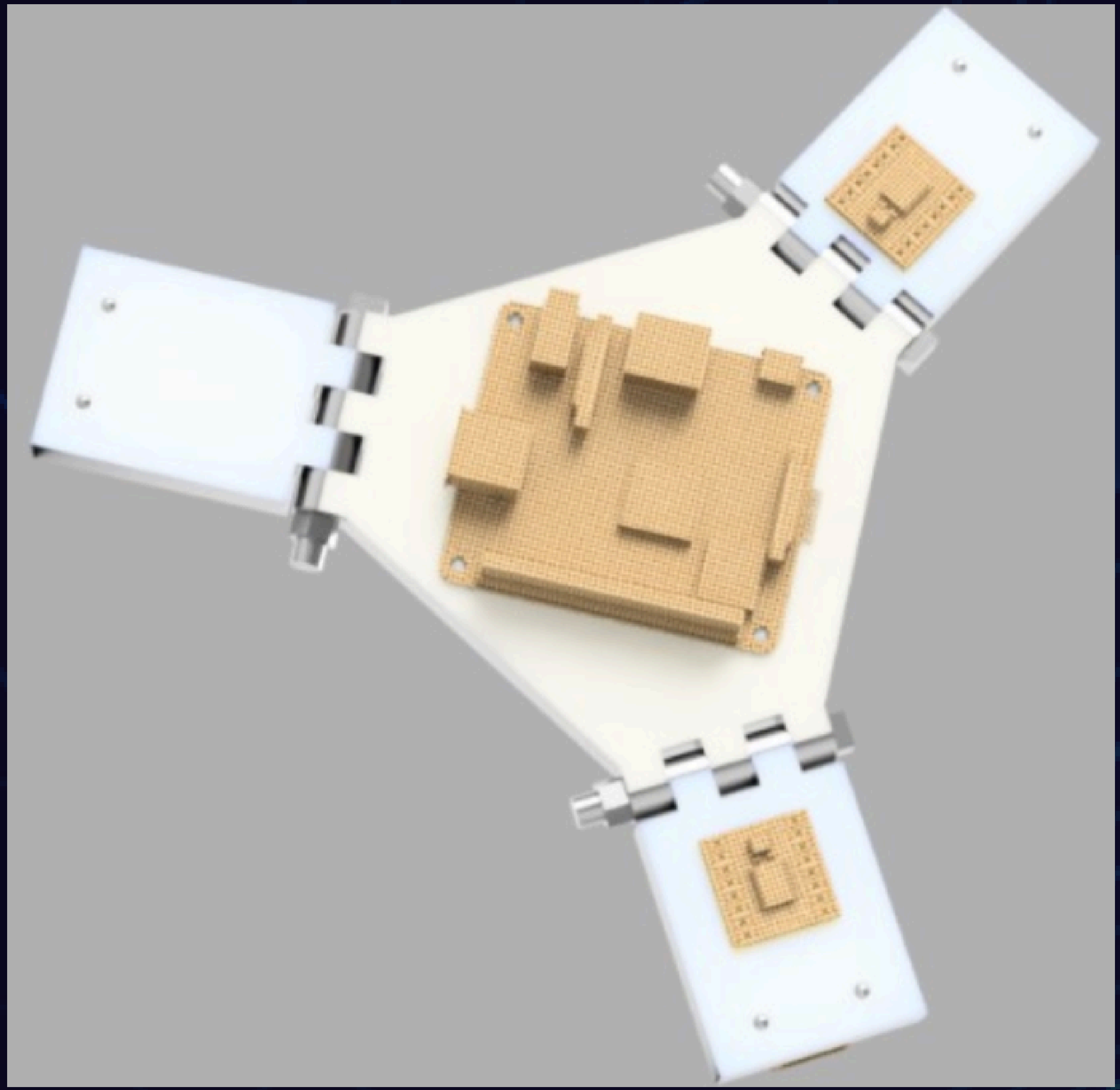
- Strong rare-earth magnets made from neodymium, iron, and boron (NdFeB).
- Extremely powerful, with high magnetic field intensity.
- Compact size with strong magnetic force, ideal for high-performance needs.

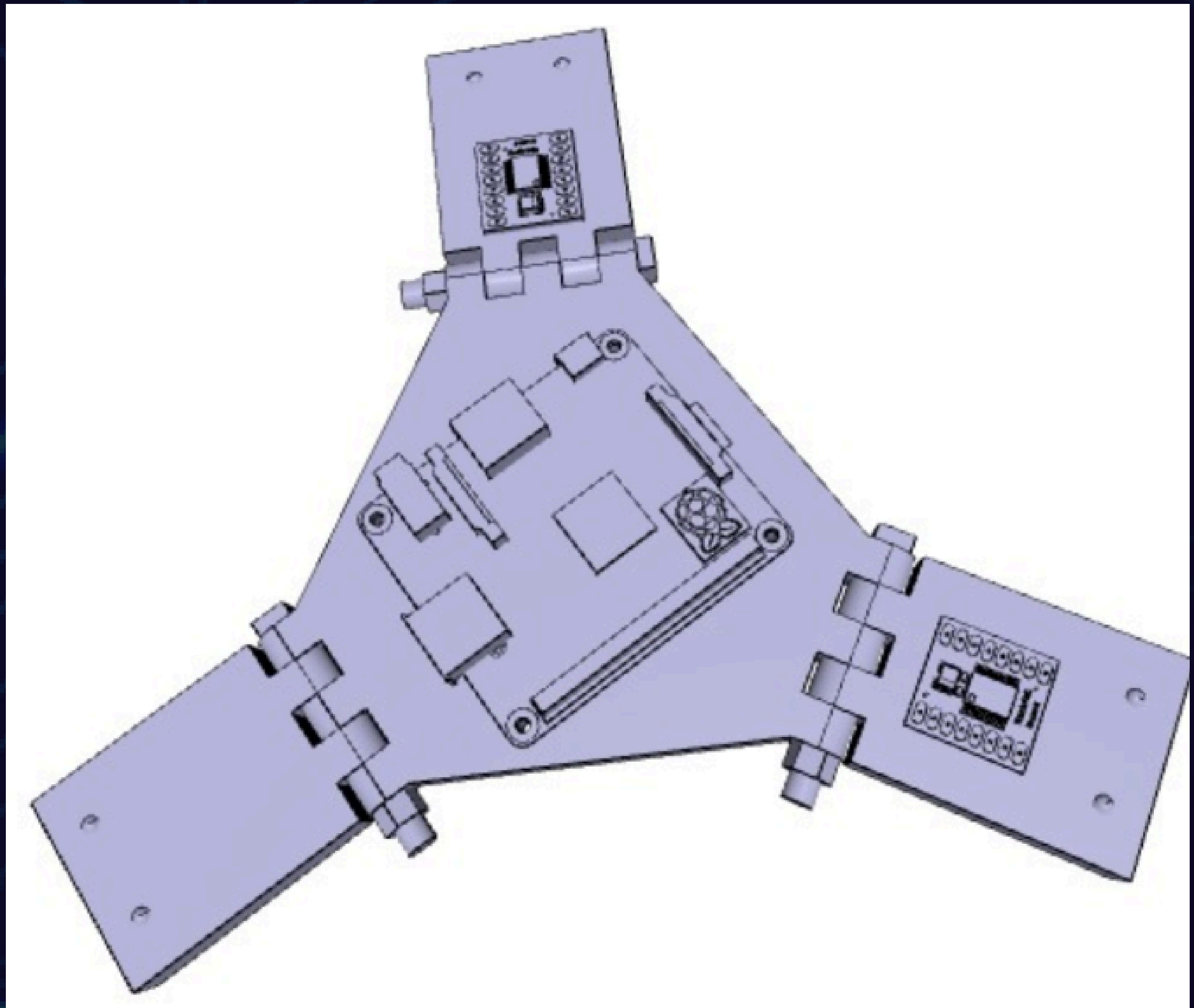


SENSORS

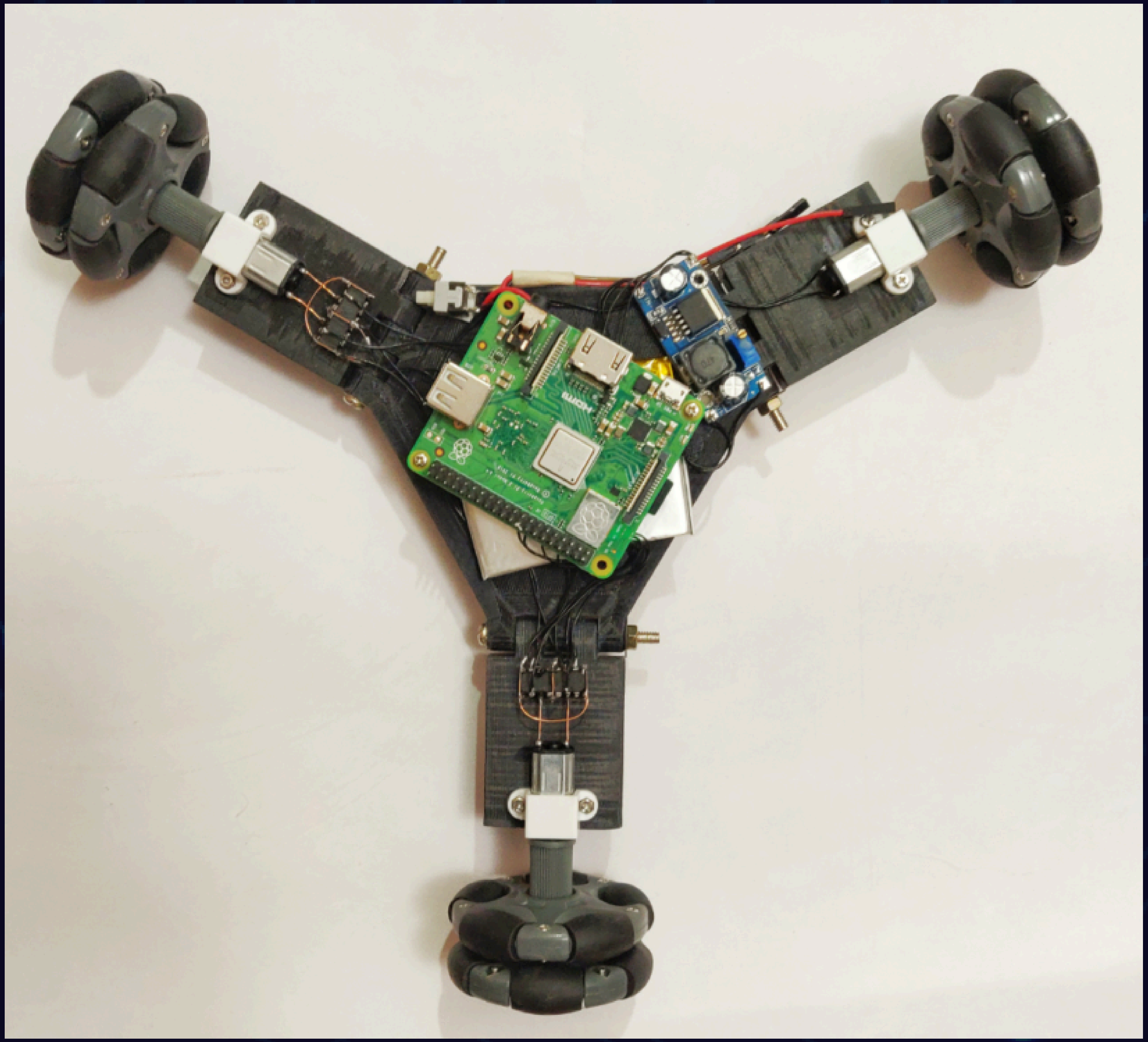
1. Gas Sensors or any other chemical sensor: We chose the MQ5 gas sensor for its high sensitivity to natural gas, LPG, and methane, ensuring reliable leak detection and compatibility with embedded systems.
2. Camera Module: Provides visual inspection and real-time video feedback for navigation and obstacle detection.
3. Ultrasonic Sensors: Detect nearby objects to avoid collisions and adapt to varying pipe diameters.
4. Temperature and Humidity Sensors: Monitor environmental conditions to enhance gas sensor reliability and reduce false positives.

CAD DESIGN





PROPOSED DESIGN



SURVEY

Dear Sir,

I hope this email finds you well. I am writing to request your permission to conduct a survey for a final year project I am working on at Dwarkadas Sanghvi College of Engineering. The project involves deploying an innovative robot designed for pipeline inspection and maintenance. The robot is engineered to detect structural issues, wear and tear, or corrosion in pipelines, and can traverse pipelines in oil, gas, and water distribution systems.

This robot is equipped with friction grippers that adapt to various pipe diameters, ensuring a secure grip for stable traversal. It can move vertically and horizontally along pipes, overcoming obstacles such as joints and clamps. The robot is fitted with advanced sensors, including a camera for real-time imaging, and additional sensors for temperature, humidity, and gas detection. Its compact and adaptable design makes it ideal for inspecting pipelines that are otherwise difficult to reach or monitor manually.

By capturing high-resolution images and environmental data, the robot can provide valuable insights into the condition of the pipeline infrastructure. We believe this technology will greatly enhance BMC's ability to monitor and maintain pipelines efficiently and proactively.

We would appreciate the opportunity to conduct a survey in order to assess the feasibility of deploying this technology within your pipeline systems. Please let us know if we can proceed with scheduling a meeting or site visit at your earliest convenience.

Thank you for your time and consideration. I look forward to your positive response.

Best regards,
Kruti Shah
Dwarkadas Sanghvi College of Engineering

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THANK YOU