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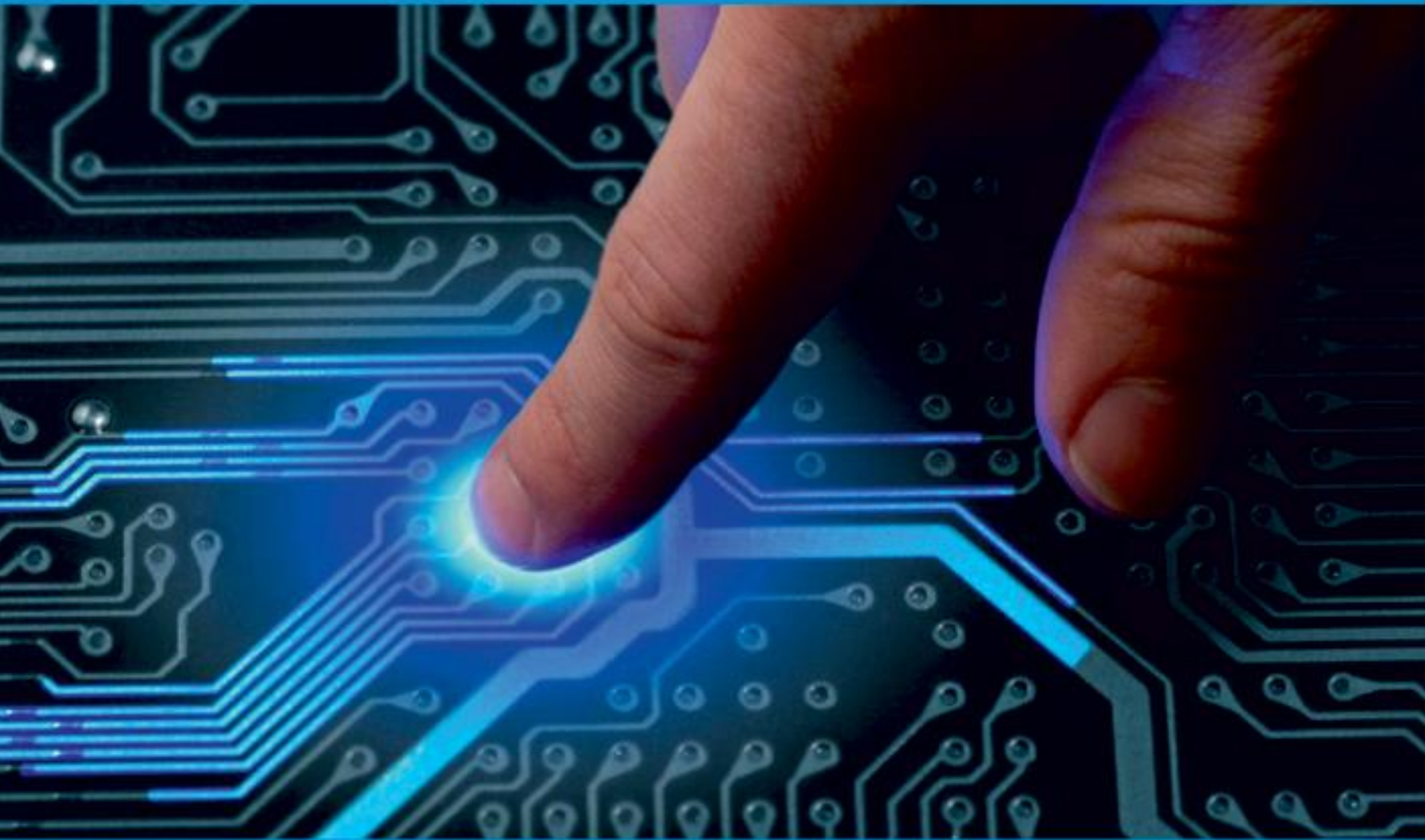

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Intelligence Rover

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ABSTRACT: The rover is the foremost tool used for research in disaster-struck areas. Equipped with an 180-degree camera, it can capture a large field of view. It also consists of a suite of sensors that comprises temperature, humidity, gas, and fire sensors. The combination of these sensors extends the scope of the rover's environmental monitoring and hazard detection capabilities.

Through the use of various types of sensors, the rover can conduct full environmental monitoring. Temperature and humidity sensors allow monitoring of the climate conditions, while gas sensors are capable of detecting hazardous gases in the air. Fire sensors can detect fires or hotspots early on, allowing prompt intervention in disasters.

Combining LoRa technology allows for wireless transmission of sensor data and remote control commands. This is a critical aspect of remote control of the rover in disaster zones where traditional communication infrastructure may be destroyed or lacking. Through this, real-time data transmission is made for fast decision-making by response teams in disasters.

Mobility for the rover is designed based on the Rocker Boogie, which ensures the ruggedness of the rover as it passes through tough terrains and over obstacles. This feature extends the rover's capability to cross challenging terrains typical in disaster areas, such as debris-filled landscapes or uneven surfaces.

In general, the project will be able to provide a complete and effective solution to the post-disaster investigation and monitoring. Through the use of advanced sensors, wireless communication technology, and rugged mobility capabilities, the rover provides a broad scope for assessment of the impact of disasters, hazard detection, and disaster response assistance.

KEYWORDS: Rover, Disaster-affected areas, Environmental monitoring, Hazard detection, LoRa, Remote operation, Real-time data, Rocker Boogie design, Post-disaster investigation, Disaster response, Versatile solution, Effective monitoring.

I. INTRODUCTION

The project is focused on the design of an advanced disaster monitoring rover able to operate effectively in dynamic and adverse environments. With the most advanced sensing technologies, the rover integrates a 360-degree camera along with a suite of environmental sensors, taking the capabilities of the rover to the next level. Additionally, robust mobility mechanisms, for example, the Rocker Boogie configuration, allow this rover to provide the unsurpassed capabilities needed to carry out comprehensive investigations into regions devastated by disasters. The rover is also able to navigate even through particularly harsh terrains and transmit real-time data wirelessly using LoRa communication technology. This means the provision of invaluable insights and support to teams responding to disasters to lessen risks, save lives, and accelerate recovery efforts in the face of adversity.

II. LITERATURE SURVEY

“SCALE: Safe community awareness and alerting leveraging the internet of things” by Kyle Benson, Charles Fracchia, Guoxi Wang (December 2015) when they conducted a study that pertains to environmental factors like smoke, explosive gas, and then alerts the residents in the form of phone calls. From there, the residents can confirm the event and contact emergency dispatchers.[1]

“A novel approach of fault management and restoration of network services in IoT cluster to ensure disaster readiness“ by Bishnu Prasad Gautam, Katsumi Wasaki, Narayan Sharma (July 2016) explores a new development monitoring device system: Tensai Gothalo providing the comprehensive fault detection and handling. Alternate network paths during faults, with minimal downtime.[2]

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"Water level meter for alerting population about floods" by J.A. Hernández-Nolasco, Miguel A. Wister Ovando, Francisco D. Acosta, Pablo Pancar (March 2016) examines water level sensor prototype aimed at monitoring water levels in rivers, lakes, etc., toward disaster preparedness. The sensor works based on simple circuits that detect water level change based on electrical resistance. [3]

"Real-time wireless sensor network for landslide detection" by M. V. Ramesh (June 2009) explores a system wireless sensor network for landslide detection. A WSN specially designed for monitoring and special algorithms for efficient data collection and analysis.[4]

"Design and Implementation of an IoT-Enabled Remote Surveillance Rover for Versatile Applications" by Bandi Raja Babu, Pathan Mohammed Afreed Khan, S Vishnu, K Lova Raju (December 2022) research on a system wireless sensor network (WSN) for landslide detection This research represents a WSN specially designed for monitoring and allows for efficient data collection and analysis through specialized algorithms.[5]

"Development and Evaluation of a Novel Robotic System for Search and Rescue" by Andrea Cachia, M. Nazmul Huda, Pengcheng Liu, Chitta Saha, Andrew Tickle (July 2019) research and Rescue robotics are a relatively new field of research that is growing rapidly with the emergence of new technologies. However, the robots that are usually applied to the field are
generally small and have limited functionality, and almost all of them rely on direct control from a local operator.[6]

"Development and Control Method of Six-Wheel Robot with Rocker Structure" by Sadman Hafiz Durlov, Md. Najmus Salehin and Md. Yousuf Sazid (November 2007) This paper designs a rescue robot with a rocker-bogie mechanism and an elevation mechanism using rope-pulley. In the countries like Bangladesh, where infrastructural vulnerabilities encourage frequent incidents, relying solely on human rescue units risks impairing the safety of the army personnel. This involves researching the rocker-bogie and elevating mechanisms to accompany this project and provide inspiration.[7]

"Unmanned multipurpose all terrain rover using rocker bogie mechanism" by Devi R, B. Dharrun, P. Gokul Raj, C. Gowtham, A.S. Kabilan (August 2021) the rocker bogie mechanism as one of the most preferred mechanisms for its Mars rovers due to its great accuracy and efficiency in running on difficult terrains. Therefore, this research work used the same technology in the proposed rover, which is mainly designed for running on tough earth terrains by evenly distributing the weights. The proposed rover model can be used for rescue related operations in military as well as others fields.[8]

"IoT Controlled All Terrain Rocker Bogie Robot" by Prasath Kumar. S, Auvai Saraswathy. M, Malligeshwari. H and Nandhini. Su (July 2019) Rocker-bogie is the type of suspension system wherein the two wheels from each side of the vehicle are connected with a swingarm on rotary axle. Both levers are connected with a differential mechanism. Under the case when the vehicle does not use turnable wheels and turns only by velocity difference or heading difference of each side or the object, then increased traction on the most loaded wheels causes lifting of the swingarms in the opposite direction. The situation is undesirable because it leads to high inclination of the vehicle's body and threatens to fall over. This paper describes a way of active adjustment of the speed of each wheel to avoid swingarms lifting. The algorithm increases or decreases the angular velocity of selected wheels depending on the rotation speed, acceleration, and traction. The parameters are calculated according to the velocity of swingarm lift angle changes compared with the vehicle's relative rotation speed. The theoretical description comprises the geometry of vehicle suspension, used sensors, and wheels speed control circuitry. The algorithm is implemented on the existing vehicle, and the experimental part includes a comparison of behavior with and without active control on different surfaces.[9]

"Security Surveillance Bot for Remote Observation During Pandemics" by Asha Rashmi Nayak, Saishree CS Ayyar, O. Aiswarya,Mahitha CH,N. Mohankumar (June 2020) Internet of Things is the fourth industrial revolution that is now considered. From small wearables to smart cities, IoT now forms an integral part of society. IoT has affected the field of Robotics too. The Surveillance Robot is based on such a combination of IoT and Robotics. The movement of the robot is remotely controlled by the user. The robot moves according to user instructions and transmits live video footage. Raspberry Pi microcontroller is used to control the robot action. The purpose of the robot is to move around in an area and transmit live video information which the users can see on the user screen. Thus the action of surveillance is done. The surveillance robot has various applications in the field of defense, healthcare, apartment security, etc. This paper proposed an economic, low maintenance, and easy to deploy surveillance robot.[10]

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III. METHODOLOGY

Existing System:

Manual Inspection:
In the event of a disaster, most human responders usually conduct on-site inspections to gauge the extent of damage and identify areas that should immediately be prioritized.

Time-consuming: Manual inspections are generally very time-consuming as responders have to physically navigate through the damaged areas, hence slowing the overall response process.

Accessibility limitations: Access to disaster-prone areas can be difficult due to reasons such as debris blocking roads, or the conditions caused by disasters can be dangerous to allow the response members to navigate the damaged areas physically.

Remote Sensing Technologies: Technologies such as aerial drones or satellite imagery are used to collect data and imagery from disaster-prone regions without a physical presence on the ground.

Weather limitations: Bad weather conditions such as heavy rain, fog, or storms limit the effectiveness of aerial drones and satellite imagery in collecting data. Even though remote sensing technologies provide a lot of valuable data, they cannot capture full details as they may lack the resolution that captures fine details, especially if such details require much details in a densely populated urban setting or those with complex structures.

Fixed Sensor Networks: Sensor networks comprising fixed devices are set up in disaster-prone areas and are used to continuously monitor the environmental parameters surrounding them, such as temperature, humidity, or seismic activity.

No mobility: Since fixed sensor networks are static, they cannot be mobilized easily for translocation to other areas as a result of the changing face of a disaster. Thus, fixed sensor networks are essentially ineffective in providing comprehensive coverage.

Real-time data acquisition: While fixed sensors provide localized data, they may not always capture real-time information from rapidly changing or dynamic disaster environments, hence delaying response efforts.
Overall, these methods have their strengths and limitations, and an effective disaster response strategy involves a combination of these approaches to help surmount their respective
limitations and enhance situational awareness and response capabilities.

IV. PROPOSED SYSTEM

Rover Deployment: This is the deployment of rover systems, which can be remotely controlled. Operators can direct the rover to disaster sites from a safe distance, usually with wireless communications. Operators can direct the rover under what could be a dangerous operation with complete control of the rover's movement and data collection ability.

LoRa Communication and Sensor Integration: To meet remote control and data transmission requirements, LoRa communication modules are integrated into the rover. LoRa is recognized because of its wide-range characteristics and low power usage, making it applicable for that type of application. Concerned with this, the rover integrates some additional sensors, such as the temperature, humidity, gas, and fire sensors. These sensors enhance some additional monitoring of the environment and hazard detection abilities, informing the responders about what's going on at the disaster site.

Suspension System, Rocker Boogie Mechanism: The Rocker Boogie mechanism is a type of suspension system often deployed in planetary rovers deployed on Mars, for example. The mechanism is composed of a set of jointed articulations and wheels to improve the rover's mobility and stability as it moves through tough terrains. The incorporation of this mechanism in the design of the rover allows it to work through challenging terrain better, thus accessing regions that would be inaccessible by an ordinary wheeled vehicle.

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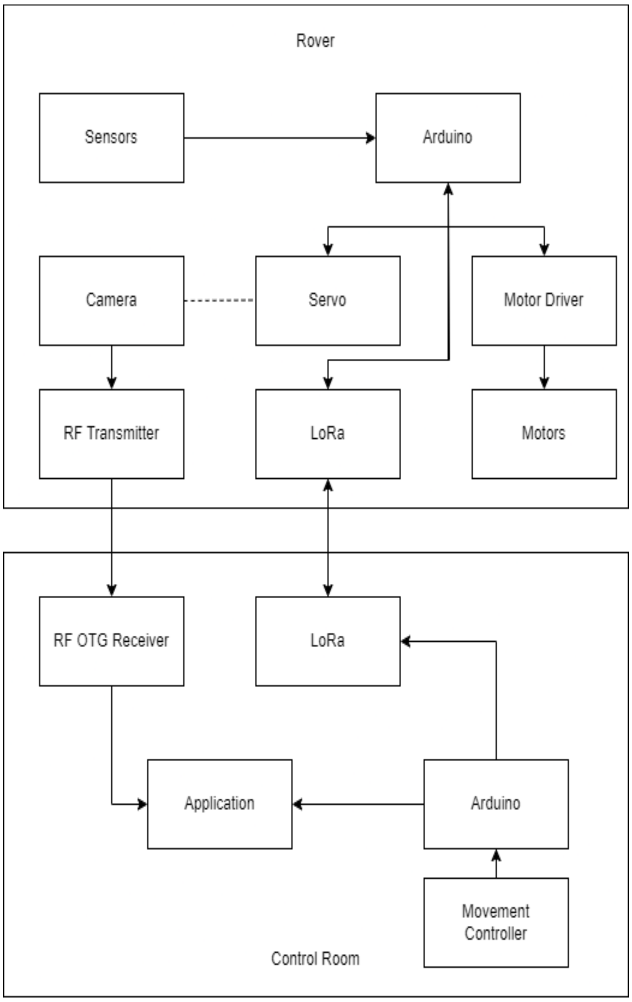
Mobile App Development: A mobile application will be developed, giving an interface with the rover to users, which include operators and responders. The app allows users to view and receive live information coming from different sensors captured by the rover such as temperature, humidity, gas levels, etc., and also the images caught by the camera. This will help in enhancing situational awareness among the responders and will enable them to decide promptly based on information from the rover during the disaster response missions.

V. ARCHITECTURE DIAGRAM



VI. EXPERIMENTAL RESULT

The sensors record information of the surroundings. Information is sent from the sensors on the transmitting end to the Arduino Uno. The Arduino Uno processes information and sends information to the LoRa module.The LoRa module on the transmitting end, through a wireless transmission, sends information to the LoRa module, the receiving end. The LoRa module on the receiving end receives the information and sends it to the Arduino Uno. The Arduino Uno processes the information and sends it to the application software. The application software receives information from the sensors and provides a user interface that allows him to command the rover's movement.

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VII. RESULT

VIII. CONCLUSION

Accordingly, the combination of remote-controlled rover technology, LoRa communication, and integration with sensors marks a leap forward in disaster response capabilities. This is achieved through the provision of real-time monitoring of the disaster situation and data collection, facilitated through the developed mobile app, thus providing critical situational awareness and guiding effective decision-making in the event of a crisis. Added to this, improved mobility and accessibility through the Rocker Boogie mechanism have facilitated the rover to navigate through challenging terrains while accessing remote areas for thorough data collection. All this methodology promotes proactive risk management, which will consequently reduce the effects of a disaster and help build resilience within the affected community.

IX. FUTURE SCOPE

Advanced Sensor Integration and Artificial Intelligence: Future generations would integrate advanced sensor technologies such as LiDAR enabling precise mapping of disaster areas and detection of minute environmental changes. Artificial intelligence algorithms could also be incorporated into the rover to help it analyze data streams from the sensors and quickly make decisions regarding the detection of hazards.

Multi-rover collaborative swarm intelligence: Disaster response missions might be made much more potent using multi-rover missions. Swarm intelligence can be deployed for these rovers to communicate, coordinate and share tasks for
efficient disaster response. Such an approach could significantly increase coverage, robustness, and flexibility to the ever-changing dynamics of disaster conditions.

Integration with unmanned aerial vehicles and satellite systems: The integration with UAVs and satellite systems can be employed for all-round aerial and ground-based monitoring of disaster areas. UAVs can offer fast aerial reconnaissance while satellite systems offer coverage over large regions. Combined data collection with data from the rover would help create a more holistic view of the disaster terrain, which would aid in the decision-making process for resource allocation.

Adaptive Mobility Systems and Terrain Negotiation: Future advantages in the mobility system can include adaptive mechanisms wherein changes in the rover's movement regarding the terrain have been dynamically made with respect to the given terrain. This may be achieved by predictive algorithms that are directed at searching for optimizing paths depending on the features of the terrain. In addition, a wide variety of state-of-the-art locomotion technologies inspired by nature, like legged or hybrid wheeled-legged designs, could be put forward to enhance rover performance in traversing very rough terrains likely to be rife in disaster zones.

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