Indian Institute of Technology Gandhinagar

ES 408 (Mechatronics)

Fire Fighting Robot

Under the guidance of Prof. Madhu Vadali

Mayur Patil 21110126

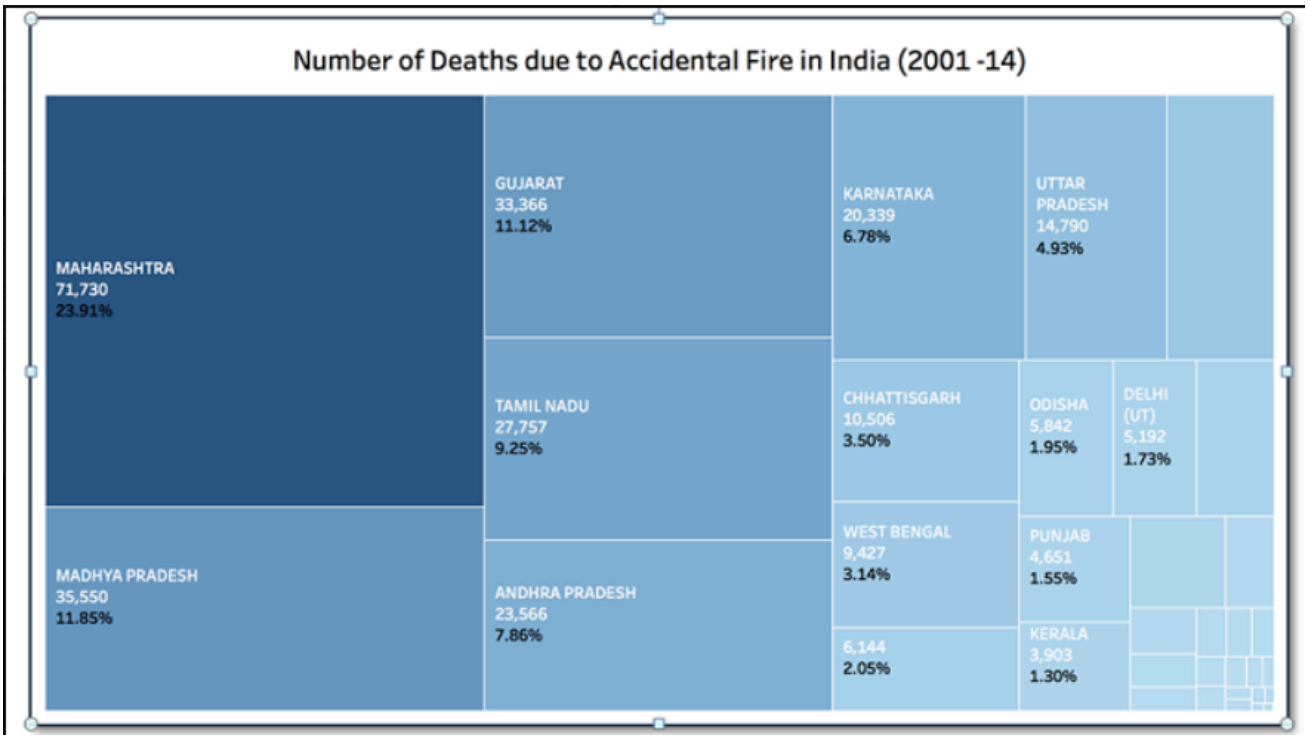
Nitya Janak Shah 21110191

Priyal Ranka 21110167

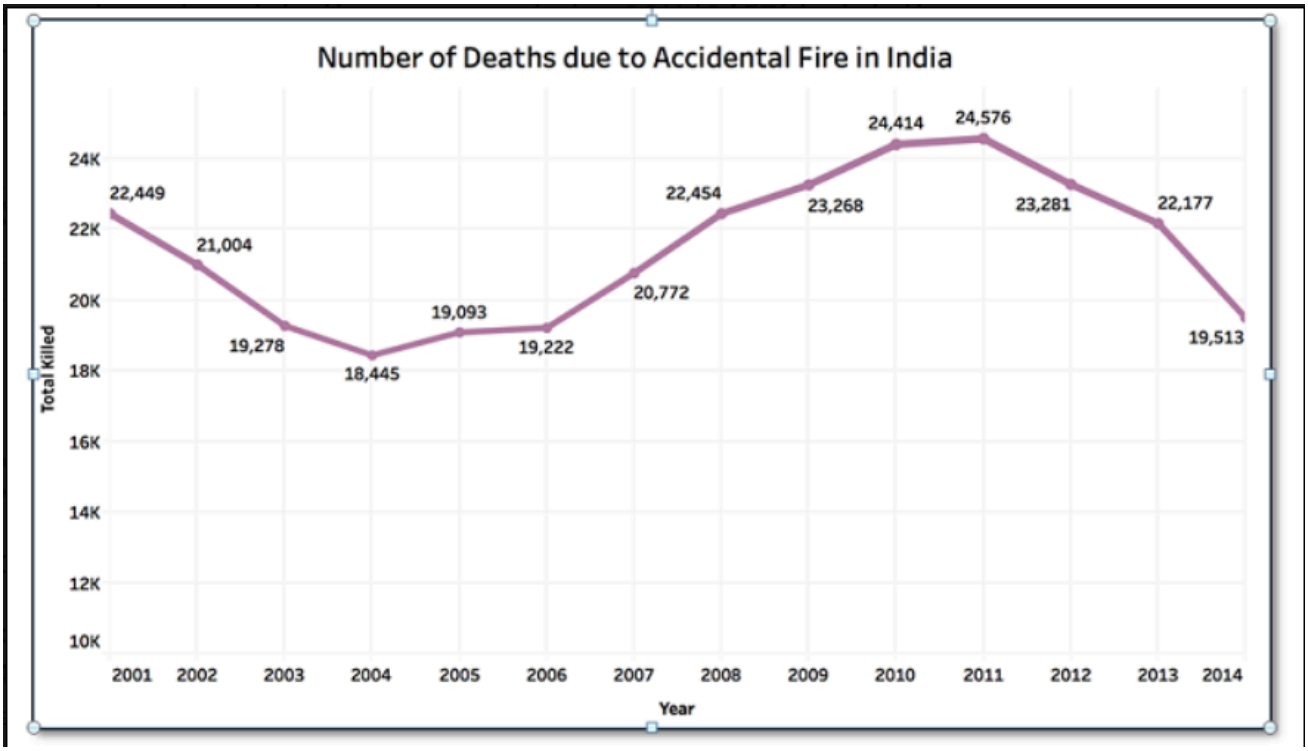
Project Statement

Development of a Remote-Controlled Firefighting Robot to Enhance Safety and Efficiency in Extreme Hazard Environments.

Necessity of this project



The graph highlights the number of deaths due to accidental fires amongst the states, with Maharashtra having a significantly greater burden than the rest.At 71,730, Maharashtra accounts for 23.91% of all deaths. Madhya Pradesh comes in second with 35,550 deaths (11.85%) and Gujarat third with 33,366 deaths (11.12%). Other states such as Andhra Pradesh , and Tamil Nadu have considerably less death figures



https://www.firestudy.in/2024/05/fire-statistics-in-india.html

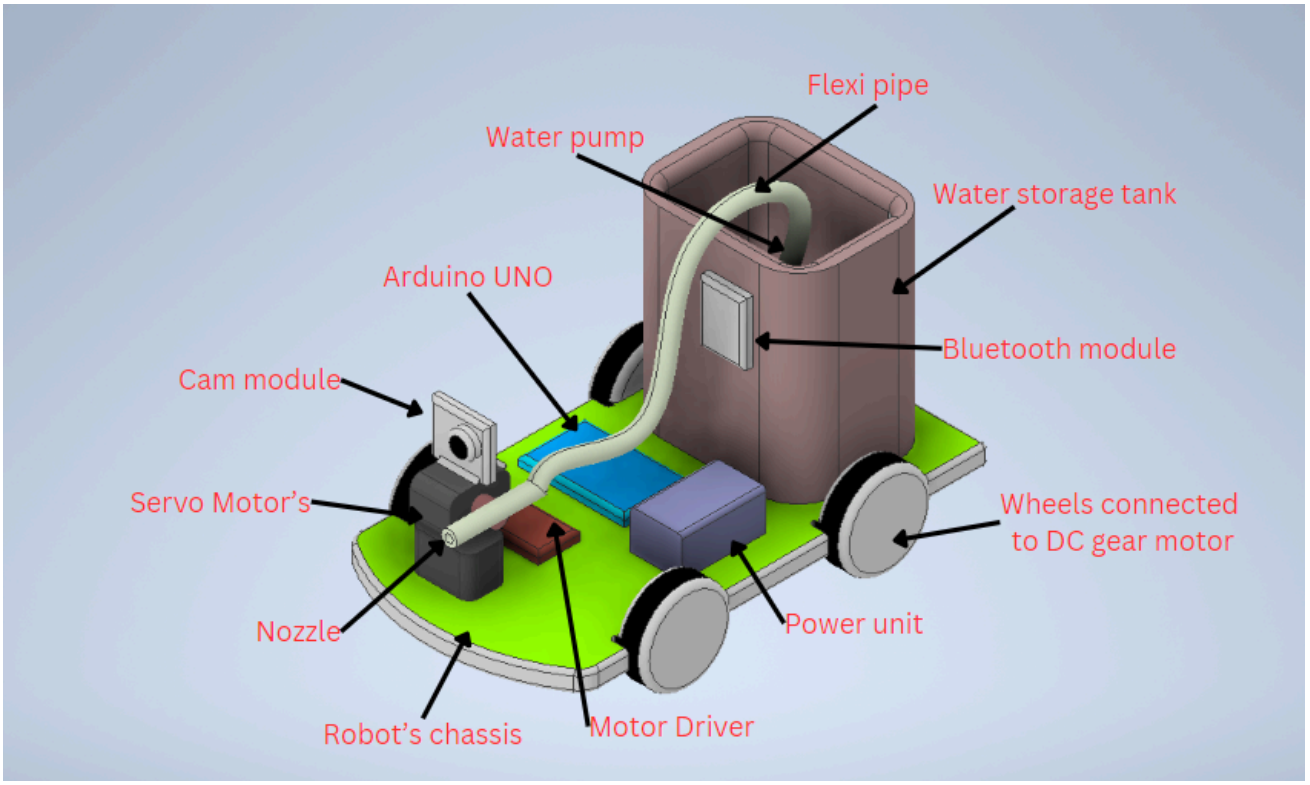
From 2001 to 2014, the number of accidental fire cases in India is depicted in this graph. There were around 22,449 instances in 2001. The number of cases decreased until 2004, reaching its lowest point at approximately 18,445. From 2004 to 2011, there was a notable increase, reaching a high in 2011, and the number of cases continued to decline after 2011.

Firefighting is inherently dangerous, requiring individuals to enter hazardous environments to extinguish fires, rescue victims, and mitigate disasters. Despite significant advancements in protective gear and firefighting techniques, the risks to human life remain high, particularly in chemical fires, confined spaces, and structurally unstable buildings. Traditional firefighting methods often limit the ability to assess and respond to these threats effectively, leading to potential delays and increased danger to firefighters and civilians.

There is a critical need for innovative solutions to address these challenges that can enhance the safety and effectiveness of firefighting operations. A remote-controlled firefighting robot offers a promising approach to combatting fires in dangerous environments without exposing human firefighters to life-threatening risks. Such a robot would be capable of navigating through hazardous areas, assessing the situation, and applying firefighting measures while being controlled remotely by trained personnel.

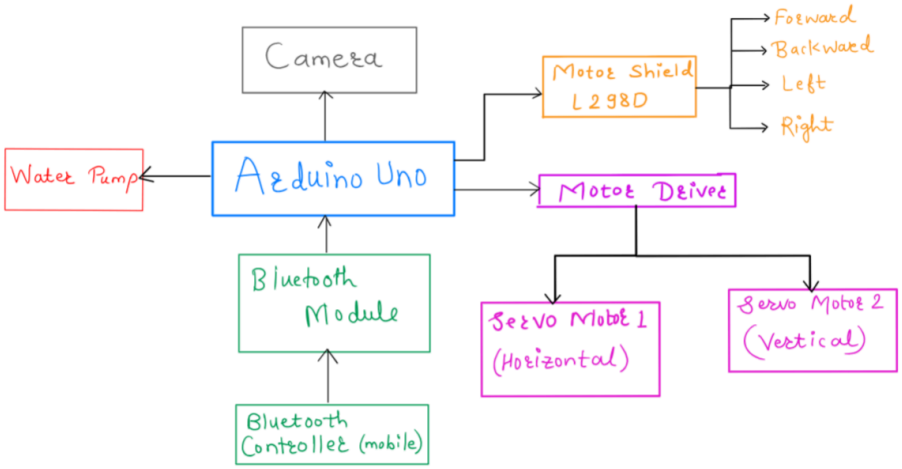
Developing a remote-controlled firefighting robot would revolutionise how fires are managed, particularly in scenarios where human access is limited or impossible. By reducing the need for human intervention in the most dangerous situations, this technology could significantly decrease the risk of injury and loss of life while improving the overall efficiency and effectiveness of firefighting operations.

Proposed solution’s design



This robot is equipped with four DC gear motors that drive its wheels. A pan-tilt mechanism is mounted at the front, enabling it to spray water with adjustable coverage from top to bottom and left to right. Additionally, this mechanism houses a camera, providing 180-degree coverage in both the vertical and horizontal planes. The robot is designed to transmit video from the camera module via Wi-Fi to other devices and can be controlled remotely through a mobile phone using Bluetooth connectivity.

Architecture of the robot



Block Diagram

The proposed fire-fighting robot is designed with a robust mechatronic architecture that integrates various components to perform its task efficiently. The entire system is integrated, such that the Arduino UNO acts as the central controller, coordinating the inputs from the camera and sensors with the outputs of the water pump, servo motors, and motor shield.

A camera mounted on the robot continuously captures video of the surroundings. The Arduino receives input from a camera. Upon detecting a fire, the Arduino generates control signals to activate the water pump and servo motors, directing the extinguishing mechanism towards the fire.

The robot is equipped with a water pump that draws water from an onboard tank. The pump is directly controlled by the Arduino UNO, which regulates the flow of water based on the severity of the fire. The water is sprayed through a nozzle mounted on a dual-axis platform controlled by two servo motors. These servo motors allow precise control of the nozzle’s angular position, enabling the robot to direct the water spray accurately in both the horizontal and vertical planes. This dual-axis control ensures that the robot can effectively target the fire, regardless of its location within the robot's range.

To navigate the environment, the robot is equipped with a motor shield (L298D) that controls the movement of the robot’s wheels. The motor shield is connected to the Arduino UNO, which sends commands to move the robot forward, backwards, left, or right, depending on the location of the detected fire. This mobility allows the robot to approach the fire source and position optimally to extinguish the flames.