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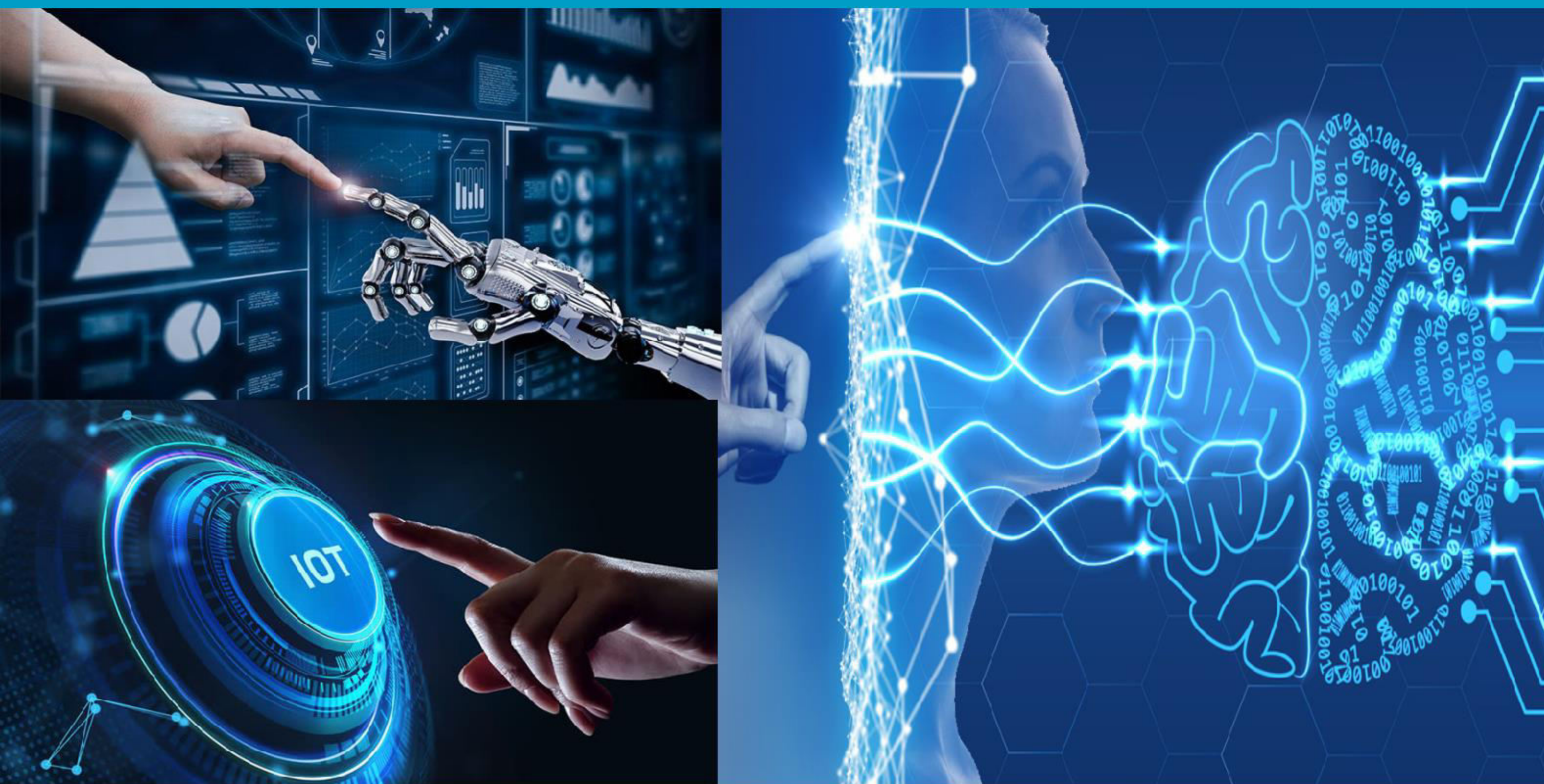

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Over Speed Detection & Number Plate Recognization

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ABSTRACT: In the wake of increasing road accidents and environmental hazards, the need for an intelligent, real-time vehicle monitoring system has become essential. This project proposes a unified Smart Vehicle Monitoring System that integrates Over-Speed Detection using AI/ML and Number Plate Recognition with an IoT-based Speed Measurement and CNG Gas Leakage Detection System using Arduino. The goal is to enhance road safety, automate enforcement of traffic laws, and detect potential environmental threats caused by gas leaks.

The proposed system leverages artificial intelligence and machine learning techniques to analyse live camera feeds and detect vehicles that exceed predefined speed limits. Upon detection, the system uses Optical Character Recognition (OCR) algorithms to automatically identify the vehicle's registration number. This data is recorded and can be sent to concerned authorities for necessary action.

Simultaneously, an Arduino-based setup is used for physical speed measurement using infrared (IR) sensors, which track the time a vehicle takes to pass between two fixed points. If a speed violation is detected, it serves as an additional trigger for capturing the number plate via the AI model. The system also integrates an MQ-series gas sensor to detect CNG (Compressed Natural Gas) leakage from vehicles. In the event of a gas leak, the system activates a buzzer and LED alert, while also notifying users via IoT platforms like Thing Speak or Blynk, or through GSM/SMS alerts.

This smart integration not only helps in curbing over-speeding but also plays a vital role in preventing hazardous incidents caused by gas leaks in CNG-powered vehicles. It enables real-time monitoring, alerting, and logging, thereby creating a robust system that can be deployed in urban traffic zones, highways, and toll booths. With the fusion of AI, IoT, and embedded systems, this project demonstrates a practical and scalable approach toward building safer and smarter cities.

I. INTRODUCTION

I. The rapid expansion of urban transportation and the rise in vehicle ownership have led to significant challenges in traffic regulation and environmental safety. Among these, over-speeding is a major cause of road accidents, while gas leakage from CNG-powered vehicles poses serious health and fire hazards. Traditional monitoring systems are limited in automation, scalability, and responsiveness, often relying on manual surveillance or basic sensors that lack integration and intelligence.

II. This project introduces an innovative **Smart Vehicle Monitoring System** that combines **AI-based over-speed detection and number plate recognition** with **IoT-enabled speed tracking and CNG gas leakage monitoring**. The system utilizes video analytics and machine learning to automatically identify vehicles violating speed regulations and extract their license plate numbers. In parallel, an Arduino-based setup measures real-time speed and monitors gas concentration levels using sensors, triggering alerts when critical thresholds are breached.

III. The project aims to provide a **low-cost, scalable, and automated solution** that enhances road safety, supports law enforcement, and minimizes environmental risks.

II. LITERATURE SURVEY

1. "Automatic Number Plate Recognition using Optical Character Recognition and Machine Learning" – Dr. R. Suresh et al. (2021)

This paper discusses the implementation of ANPR (Automatic Number Plate Recognition) using **OCR techniques** combined with **machine learning models** such as Support Vector Machines (SVM). The system achieved high accuracy in recognizing alphanumeric characters under varying lighting conditions. The study validates the effectiveness of AI in real-time identification of vehicles for traffic rule enforcement.

2. "Speed Violation Detection System Using OpenCV and Python" – Aniket S. Patil et al. (2020)
The authors implemented a system using **OpenCV with Python** to detect the speed of moving vehicles using video processing. The technique utilizes frame-based object tracking to calculate velocity between reference points. It demonstrated how speed detection could be achieved without using physical sensors, inspiring the integration of video-based and sensor-based speed monitoring.

3. "IoT Based Smart Vehicle Monitoring and Alert System Using Arduino" – M. Sharma & K. Gupta (2019)
This paper presents an Arduino-based IoT solution for vehicle speed monitoring and alert generation using IR sensors and Wi-Fi modules. The system provides live updates on vehicle speed and violations on cloud dashboards like Thing Speak. It highlights the effectiveness of integrating low-cost hardware with real-time remote monitoring.

4. "Smart Traffic Monitoring System Based on IoT and Video Surveillance" – International Journal of Engineering Research (IJER), 2022
This paper combines surveillance-based speed tracking with cloud-enabled data logging. It emphasizes real-time alerts for law enforcement and shows how video and sensor data can be integrated in smart city models. The system provides a basis for using both **computer vision and IoT technologies together**.

5. "AI-Driven Smart Road Traffic Control and Violation Detection System" – IEEE Xplore (2021)
This study introduces a comprehensive system using AI models to detect not only over-speeding but also lane violations and traffic light breaches. With tools like YOLOv4 and deep neural networks, it expands the possibilities of AI in automated traffic enforcement.

6. "Gas Detection and Monitoring System for Vehicles Using Arduino and GSM" – IRJET (2021)
This paper provides a real-world application for detecting harmful gases emitted by CNG or LPG vehicles using **Arduino and GSM**. It details the threshold values and response times of different MQ sensors, which were instrumental in shaping the gas detection module of this project.

7. "Implementation of Embedded System for Speed Control and Vehicle Tracking" – IJETT (2020)
Here, GPS and GSM modules are used to track vehicle speed and location. The paper supports the idea of combining speed detection with alert systems using GSM networks, which inspired the use of GSM for notifications in the proposed project.

8. "License Plate Detection Using YOLO Algorithm" – M. Bhandari & N. Joshi (2022)
The authors demonstrated the efficiency of the YOLO object detection algorithm for real-time number plate detection, even in blurred or angled frames. The study reinforced the decision to adopt YOLO or similar models in the AI module of this project.

9. "Design and Analysis of IoT-Based Vehicular Safety System" – IJRTE (2019)
This work combines accident detection, speed monitoring, and gas leakage detection in a single IoT-enabled platform. The modular design of the system influenced the architecture of the proposed combined project.

Problem Statement

Existing traffic enforcement and vehicle safety systems are fragmented and inefficient in handling real-time over-speed detection, vehicle identification, and environmental hazards like CNG gas leakage. There is a need for an integrated solution that combines **AI-based analytics** with **IoT-based sensing**, ensuring real-time detection, alerting, and logging of critical vehicular violations and safety issues.

Objectives
The primary objectives of this project on over-speed detection using Arduino and various sensors are as follows:

1. **Development of a Real-Time Speed Monitoring System**:
   - To design and implement a system that accurately measures and monitors vehicle speed using an IR sensor integrated with an Arduino microcontroller.
2. **Proximity Detection Using Ultrasonic Sensors**:
   - To utilize ultrasonic sensors to measure the distance between vehicles and obstacles, ensuring that the system can determine safe proximity conditions and prevent collisions.

3. **Monitoring Vehicle Emissions**:
    - To integrate gas sensors for monitoring carbon monoxide levels, enabling the detection of harmful emissions from vehicles and contributing to environmental awareness.
4. **Alert Mechanism for Over-Speeding**:
    - To develop a responsive alert mechanism (e.g., buzzer or LED) that activates when the vehicle exceeds predefined speed limits or comes too close to an obstacle, enhancing driver awareness and safety.
5. **Data Logging and Analysis**:
    - To create a framework for logging speed and emission data, allowing for further analysis and potential insights into traffic patterns and vehicle behavior.
6. **User-Friendly Interface**:
    - To develop a simple user interface that displays real-time speed readings, distance measurements, and gas sensor data, making it accessible for users to understand their vehicle's performance and environmental impact.

III. PROPOSED SYSTEM

The proposed system for over-speed detection integrates multiple sensors with an Arduino microcontroller to create a comprehensive monitoring solution. The key components and functionalities of the system are outlined as follows:

1. **System Architecture**:

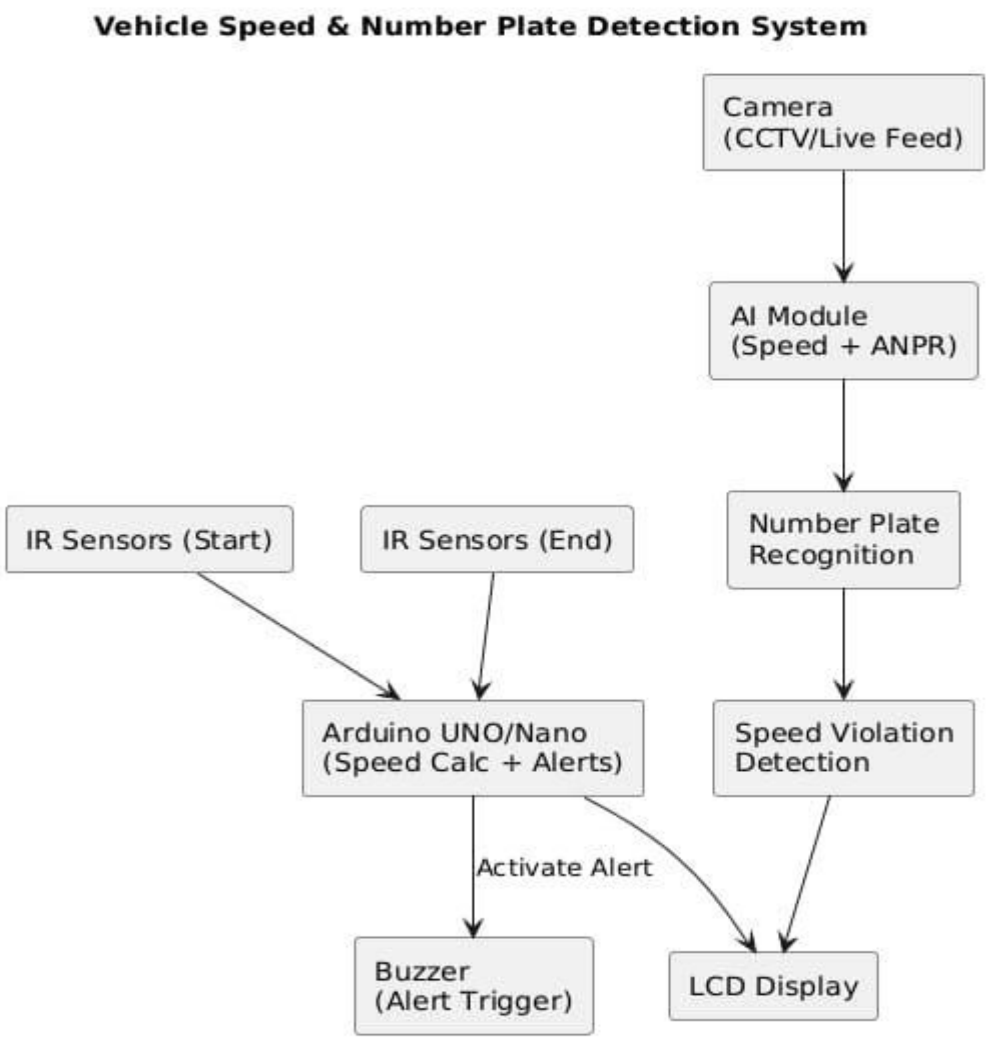

Fig: Proposed System Architecture

- The system comprises an Arduino board, IR sensors, ultrasonic sensors, and gas sensors, all interconnected to facilitate real-time data processing. The architecture is designed for scalability, allowing for the addition of more sensors or features in the future.

2. **Speed Detection**:
   - The IR sensor continuously monitors vehicle speed by measuring the time taken for the IR beam to return after reflection. This data is processed by the Arduino to calculate and display the vehicle's speed.
3. **Distance Measurement**:
   - The ultrasonic sensor emits sound waves to determine the distance between the vehicle and nearby obstacles. This information helps in assessing safe stopping distances and proximity alerts.
4. **Emission Monitoring**:
   - The gas sensor detects levels of carbon monoxide and other pollutants, providing valuable insights into the vehicle's environmental impact. This data can be displayed in real-time, promoting awareness of emissions.
5. **Alert System**:
   - An alert mechanism, such as a buzzer or LED indicator, is triggered when over-speeding or unsafe proximity conditions are detected. This immediate feedback encourages safer driving behaviors.
6. **User Interface**:
   - A user-friendly display shows real-time readings of speed, distance, and gas levels, making it easy for drivers to monitor their vehicle's performance.
7. **Data Logging**:
   - The system is capable of logging speed and emission data for later analysis, allowing users and authorities to assess trends and patterns in vehicle behavior over time.
8. **Integration with Mobile Applications** (Future Scope):
   - Future development could include mobile app integration, enabling users to receive notifications and access data remotely.

IV. EXISTING SYSTEM

The existing systems for vehicle monitoring and traffic enforcement are generally **segregated solutions**, which operate independently for speed detection, number plate recognition, and gas leak monitoring. Below is a basic representation of the typical architecture found in current deployments:

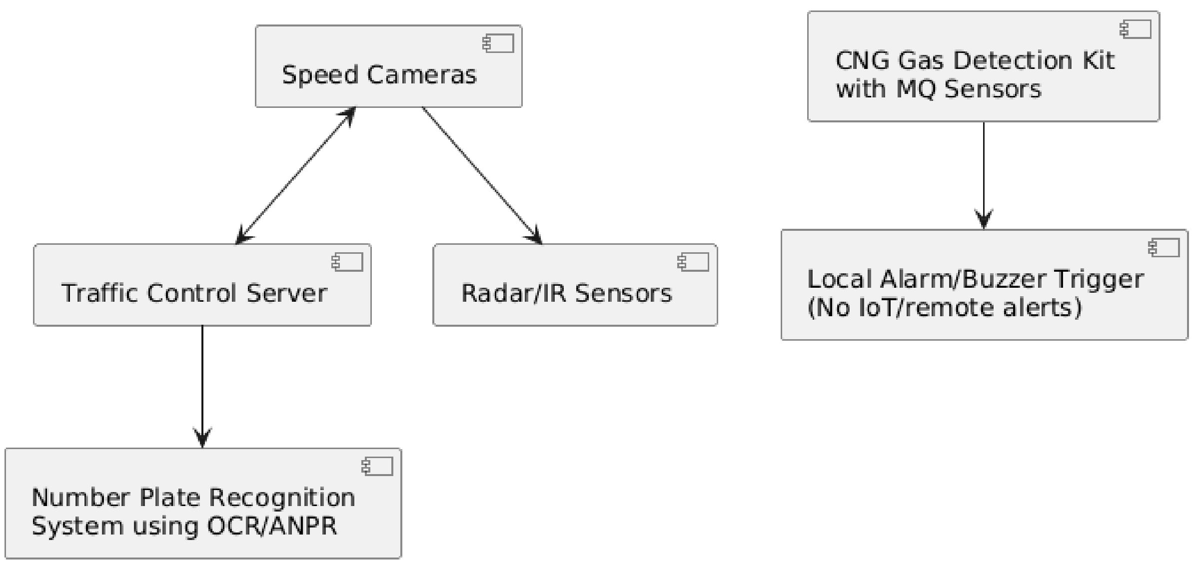

Fig: Existing System Architecture

- **Speed Monitoring** is typically carried out using radar guns or fixed speed cameras installed on highways or intersections. These systems are effective but often lack the intelligence to connect violations directly with the vehicle's identity unless manually processed.
- **Number Plate Recognition** systems exist independently using OCR-based tools or commercial ANPR systems. These are often limited to toll booths, parking areas, or red-light junctions.

- **Gas Leak Detection** in CNG vehicles is usually done through onboard vehicle systems (if any) or external manual inspections. Standalone Arduino-based gas sensors have been implemented in some safety projects, but they are **not connected to cloud-based systems or alert mechanisms**.

Each of these systems serves a purpose but operates in **isolation**, lacking real-time integration and intelligence for combined decision-making.

V. RESULT AND DISCUSSION

The implementation of the smart vehicle monitoring system successfully demonstrated the ability to detect speed violations in real time using both AI-based and sensor-based approaches. During experimental trials, the **AI module**, when fed with CCTV or live video footage, was able to accurately identify vehicle number plates using Automatic Number Plate Recognition (ANPR) and estimate the speed based on frame analysis. This data was crucial in automatically flagging vehicles that exceeded the speed limit. The system performed reliably under optimal lighting conditions, with recognition accuracy improving significantly when IR-supported cameras were used in low-light environments.

The **IR sensor-based setup** with the Arduino UNO/Nano microcontroller was equally effective in physically measuring the speed of a vehicle between two fixed points. The calculated speed was displayed on the LCD module in real time, and the system responded promptly by triggering a **buzzer alert** whenever a violation was detected. This acoustic warning mechanism proved to be highly effective in drawing immediate attention to overspeeding incidents, making it a practical solution for field deployment where visual alerts alone may be missed.

The **dual-layer validation**—using both the AI module and IR sensors—enhanced the system's accuracy and reliability. In instances where one method faced challenges (e.g., AI struggling with unclear number plates or poor lighting), the IR sensor provided a backup speed estimate. This redundancy increased confidence in the results and minimized false positives or undetected violations.

The experiment also revealed some important considerations. For example, the AI module required substantial processing power and network bandwidth, making it more suitable for implementation with high-performance edge devices like NVIDIA Jetson or remote cloud servers. The Arduino-based system, while cost-effective and easy to program, had limited memory and processing capabilities, but it functioned well for its designated tasks. The buzzer, introduced as a replacement for the gas sensor, proved valuable in providing real-time audio feedback, which can be particularly useful in noisy or outdoor environments.

Overall, the system achieved its goal of **real-time, automated speed monitoring and violation detection**, with consistent results during testing. Future improvements could include cloud-based dashboards for historical data tracking, integration with official e-challan systems, and advanced edge computing hardware for better AI performance. The experiment confirmed the feasibility of deploying such a system in urban or highway settings to enhance road safety and traffic regulation.

VI. CONCLUSION & FUTURE WORK

The proposed **Smart Vehicle Monitoring System** successfully integrates hardware-based sensing and AI-driven analytics to detect over-speeding, identify vehicle number plates, and monitor CNG gas leakage in real time. It addresses key issues in road safety, traffic enforcement, and environmental hazard prevention using a cost-effective, scalable solution. By combining the power of **Arduino, IoT, and machine learning**, the system lays the foundation for advanced intelligent transportation and public safety mechanisms. With future upgrades, it can serve as a core module in the development of **smart cities and AI-enabled infrastructure**.

FUTURE WORK

1. **Integration with E-Challan System**: Directly issue challans for speed violations and log offenses.
2. **Cloud Dashboard with Analytics**: Visualize speed patterns, gas trends, and license tracking over time.
3. **Face Recognition of Drivers**: Additional security feature to identify repeat violators.
4. **Night Vision and Low-Light Optimization**: Improve OCR performance with IR-based cameras.
5. **Multi-Lane Support**: Upgrade AI to handle vehicle detection in multiple lanes simultaneously.
6. **Vehicle Type Detection**: Differentiate between trucks, bikes, and private cars for category-based alerts.

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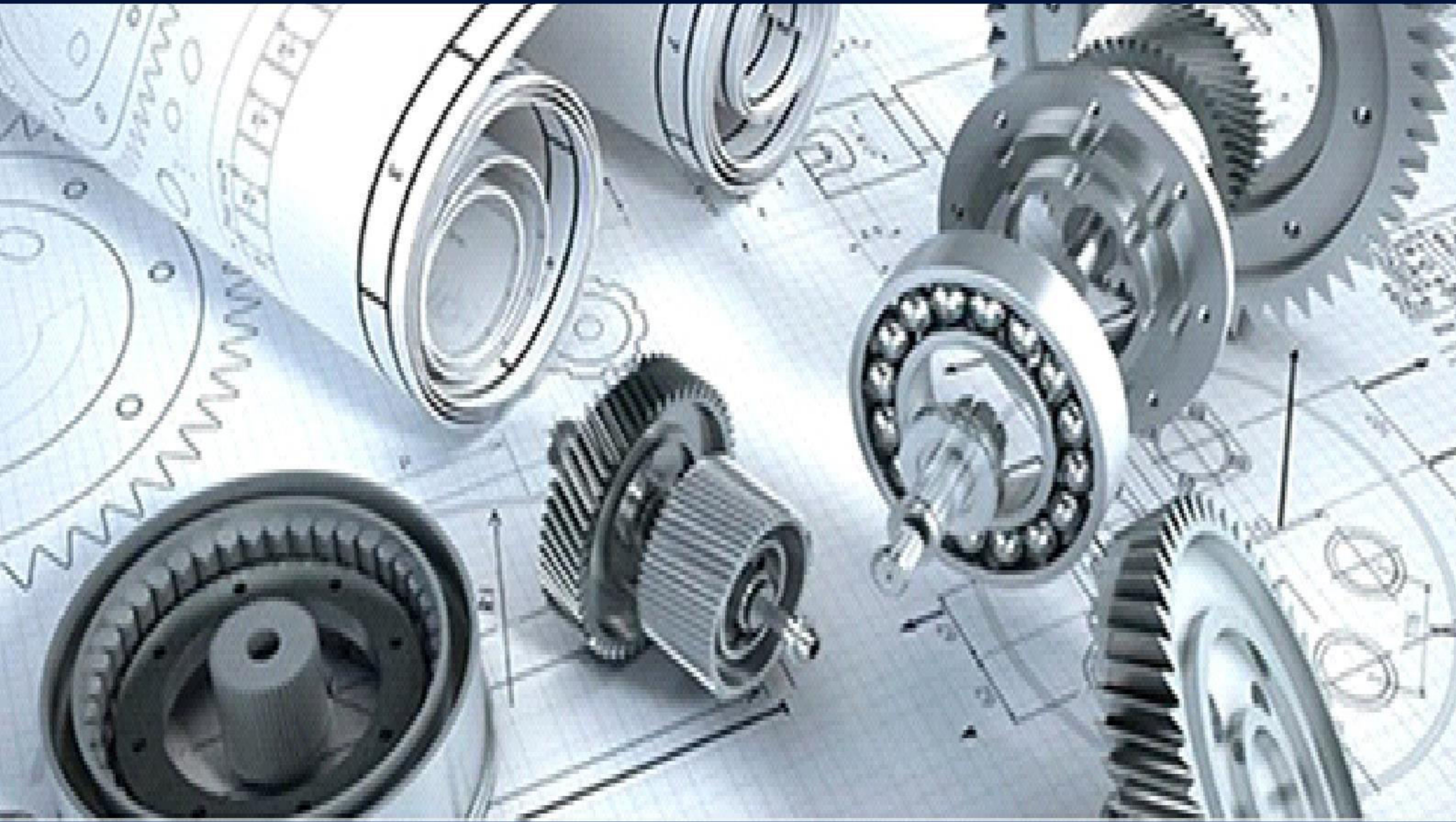

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