Safety Critical Systems Project Report
Predictive Maintenance in Vehicle Systems

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1 Introduction

Predictive maintenance is a technique that uses data analysis tools and techniques to detect anomalies in your operation and possible defects in equipment and processes so you can fix them before they result in failure. Ideally, predictive maintenance allows the maintenance frequency to be as low as possible to prevent unplanned reactive maintenance, without incurring costs associated with doing too much preventive maintenance. When predictive maintenance is working effectively as a maintenance strategy, maintenance is only performed on machines when it is required. That is, just before failure is likely to occur. This brings several cost savings:

Minimizing the time, the equipment is being maintained Minimizing the production hours lost to maintenance Minimizing the cost of spare parts and supplies These cost savings come at a price, however. Some condition monitoring techniques are expensive and require specialist and experienced personnel for data analysis to be effective.

2 Process Model

Agile-Scrum software development: Scrum is an agile methodology where products are developed iteratively. Planning, sprints, stand-ups, and retrospectives are integral parts of scrum methodology.

3 Team Organization

- Scrum Master
- Front-end team
- Backend team
- Testing team
- Deployment team
- Maintenance team

4 Task Distribution

Since we are following Agile-Scrum methodology, we will be having bi-weekly scrums wherein we will discuss updates related to the tasks assigned and blockers if any. Since we are a small team of 4 people, every member will contribute in all the phases of the project life-cycle.

5 Requirement Management

- Read Literature.
- Understand the real-world use-cases of predictive maintenance.

6 Use Cases

- **Anti-lock Braking system and Traction Control Systems:** ABS components include: a wheel- speed sensor, a hydraulic modulator and an Electronic Control Unit (ECU) for signal processing and control and triggering of the signal lamp and of the actuators in the hydraulic modulator. If any of these components malfunction and the user is not notified in time to take corrective steps, there can be grave danger to the driver's, passengers' and pedestrians' lives.
- **Airbags:** There are a number of other reasons that may cause the airbags to fail.
  1. **Airbag backup battery** has already been depleted- Check for it have a threshold voltage that battery must have, and notify to users immediately.
  2. **Faulty Sensors:** Sensors may malfunction or be inadvertently tripped, which might fail to deploy during actual crash.
  3. **Soaked Airbag Module:** If your vehicle has been touched by water damage (maybe have a sensor to get the moisture level if it is regularly exposed and increasing moisture/water particles.
  4. **Damaged Airbag Clock Spring:** he airbag clock spring is there for the continuity between the electrical wiring of your vehicle and your driver-side airbag. The rotary electrical connector allows the steering wheel to turn while keeping a connection between the wheel's airbag, horn, and the electrical system. So, if the clock spring isn't working, then the airbag won't deploy. The clock spring will coil in and out with every turn of your steering wheel so it is only normal that it will become worn out over time. The poor connection will give way for potential airbag failures
- **Seat belt system switch sensors:** Seat belts plays major role in safety for effective working of airbags.
- **Autonomous Emergency braking system** is a crucial part of the autonomous car. It one of the standard safety equipment of a self-driving car. This AEB works by scanning the distance of the road measuring the distance of the front road. And everything is controlled here by using sensors like ultrasonic sensors etc. If these sensors don't work properly collision may occur. So,

one of the approaches of our system to diagnose whether these sensors work properly, if not it will notify the user for maintenance.

- In Germany autobahn, the minimum seed of driving is 130kmph. People usually drives their car at speed of 150-225 kmph. As we also know that entry and exit from autobahn is not possible from everywhere. If one of the cars runs out of fuel in the middle of autobahn, then there is nowhere to stop in the middle because if it is stopped then it will be a huge catastrophic, involving many cars and may cause a huge risk to human life. So, it is very important to check the fuel level so that the car does not stop in the middle of the autobahn, and it will safely exit from there and go to the nearest fuel station. That is why our system will monitor the fuel level in the running car and if the decreases to less than 5 percentage it will immediately notify user. And as it is an autonomous car means automatic driving to destination, and in this scenario, destination will have one more mid stop for fueling station.
- **Trouble code analysis:** Finding bugs in code that can lead to vehicle failures.
- **Roadside assistance:** Vehicle data helps roadside service providers determine where exactly the car broke down and what's wrong with it. It also helps determine if roadside assistance is even needed: maybe over-the-phone assistance about how to fix the car would be enough. Tracking vehicle health indicators: an early warning that a part is likely to fail and the estimated time to failure.

7 List of Deliverables

- Requirement Specification Document
- Functional Specification Document
- Design Document
- Unit Test Results
- Integration Test Results
- System Test Results
- Deployment Document
- User Manual

8 Risk involved in the Project

- Improper interpretation of customer requirements
- Inadequate requirement analysis
- Intercomponent interactions

9 Data Flow Diagram

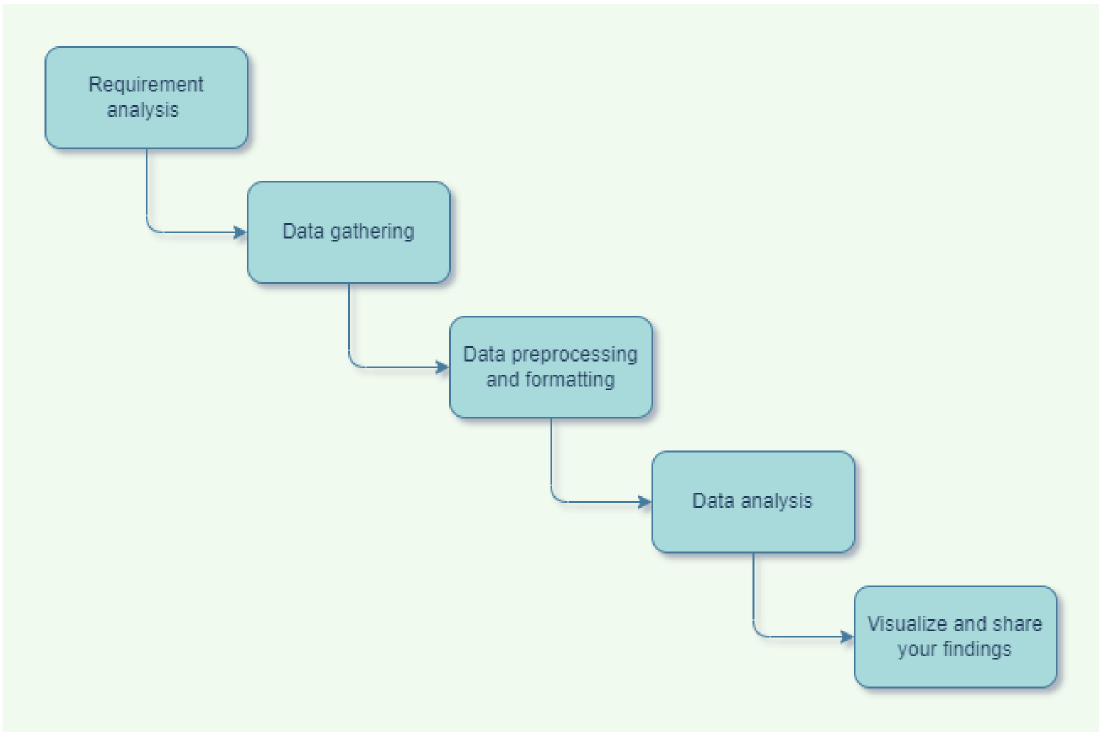

Fig. 1. Data Flow Diagram

10 Control Flow Diagram

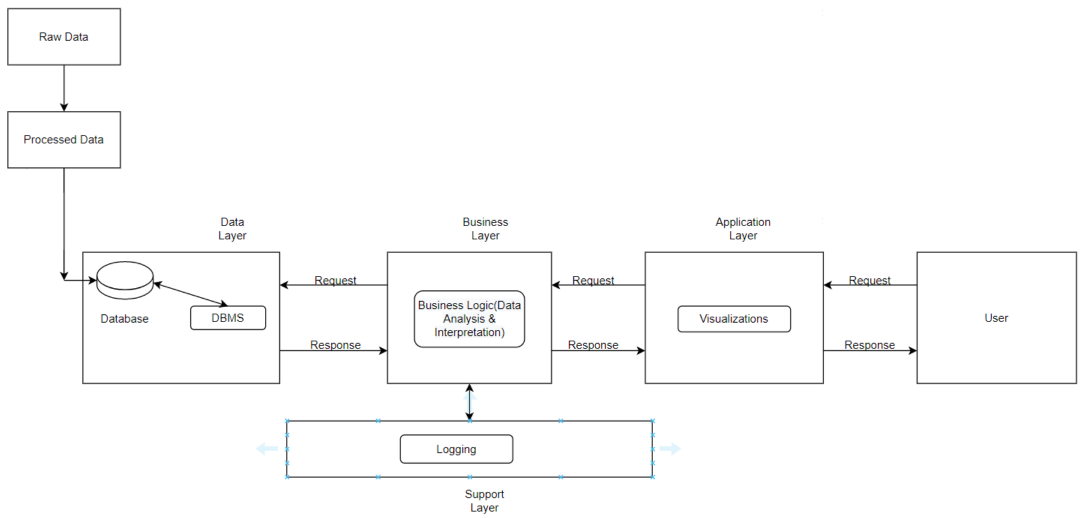

Fig. 2. Control Flow Diagram