

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. In this model we are going to use Vmodel XT in combination with Agile scrum.

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

5.1 Functional Requirement

- The application shall display statistical inferences drawn from the data along with the threshold that will be used to trigger predictive maintenance warning.
- The application shall be able to start/stop on user request.
- The application shall predict whether gearbox is healthy or maintenance is required due or gearbox has broken once it is started.
- The application shall graphically display the status of the gearbox based on the sensor values.

5.2 Non-functional Requirement

- The application shall continuously log information so that it can be used to diagnostics in case of system failure.
- The application should be able to operate irrespective of the size of the data.
- The application shall be platform independent and ensure the privacy and security of the data.
- The application shall be safeguarded against vulnerabilities.

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.
 - **Air pressure systems** also called as compressed air brake system, is a type of friction brake for vehicles in which compressed air pressing on a piston is used to apply the pressure to the brake pad or brake shoe needed to stop the vehicle. Air brakes are typically used in heavy trucks and buses. Typical operating pressure is approximately 100–120 psi. An Air Pressure System has 5 components i.e. Air compressor, Reservoirs, Foot valve, Brake chambers, Brake shoes and drums.

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 Milestone

9 Risk involved in the Project

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

Activities	Week47	Week48	Week49	Week50	Week51	Week52	Week01	Week02	Week03	Week04
<i>Feasibility and Planning</i>										
<i>Design and Validation</i>										
<i>Build and Validation</i>										
<i>Testing and Validation</i>										
<i>Customer Acceptance and Validation</i>										
<i>Deployment</i>										

Fig. 1. Scheduled Milestone

10 Data Flow Diagram

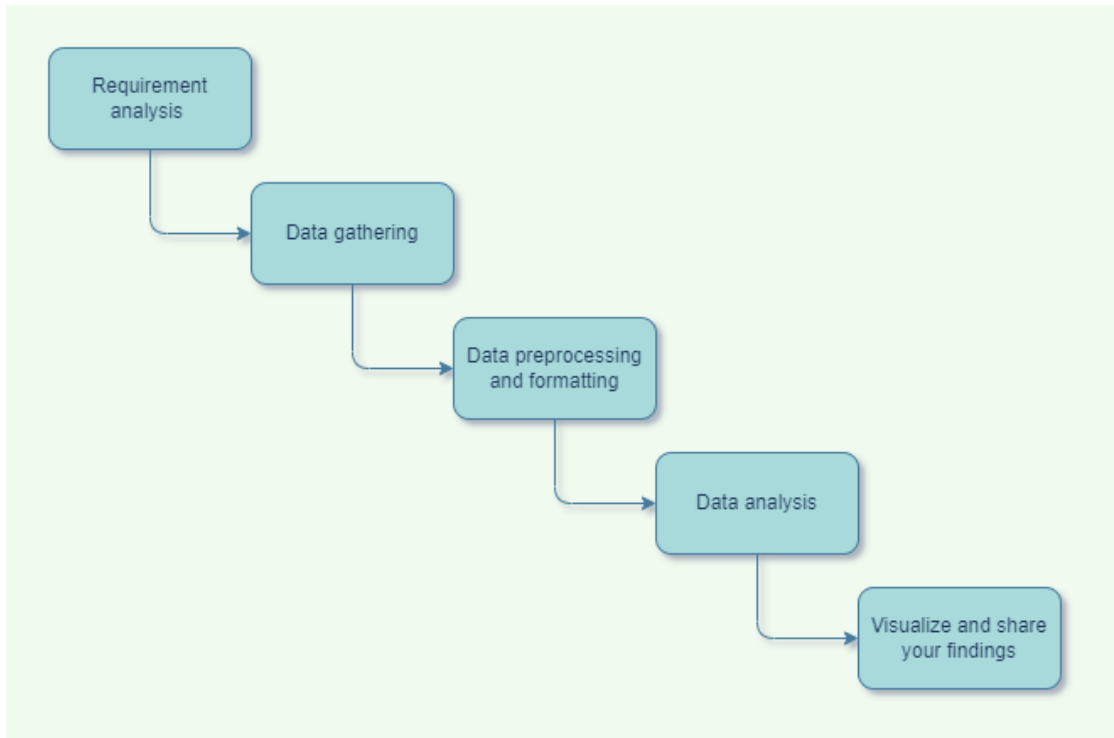


Fig. 2. Data Flow Diagram

11 Control Flow Diagram

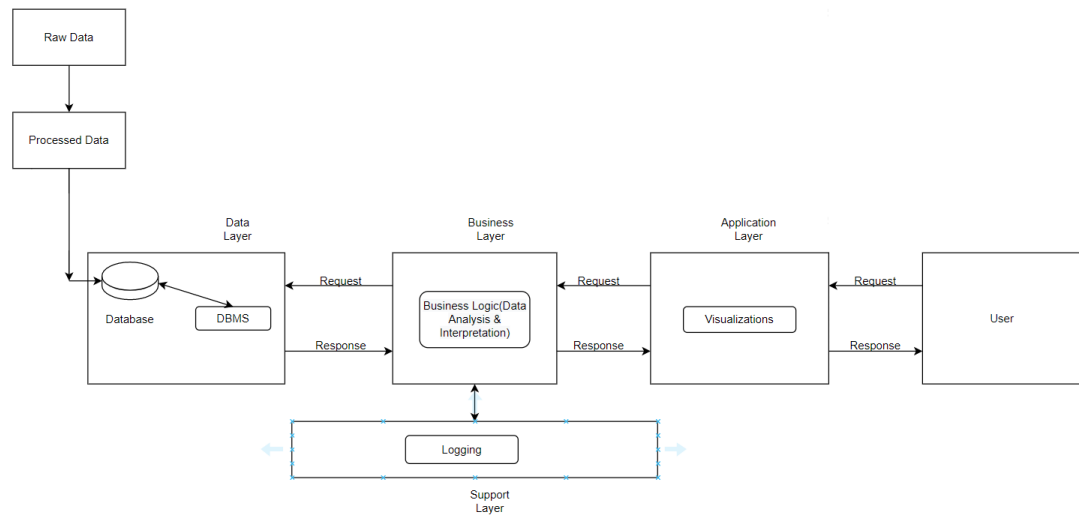


Fig. 3. Control Flow Diagram