Prognostics System For Military Wheeled Vehicles

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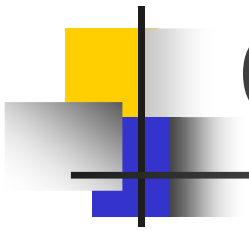
May 9, 2005



Overview

- System Description
- Goals
- Requirements Overview
- Optimization
- Difficulties
- Summary

Reasons For Prognostics

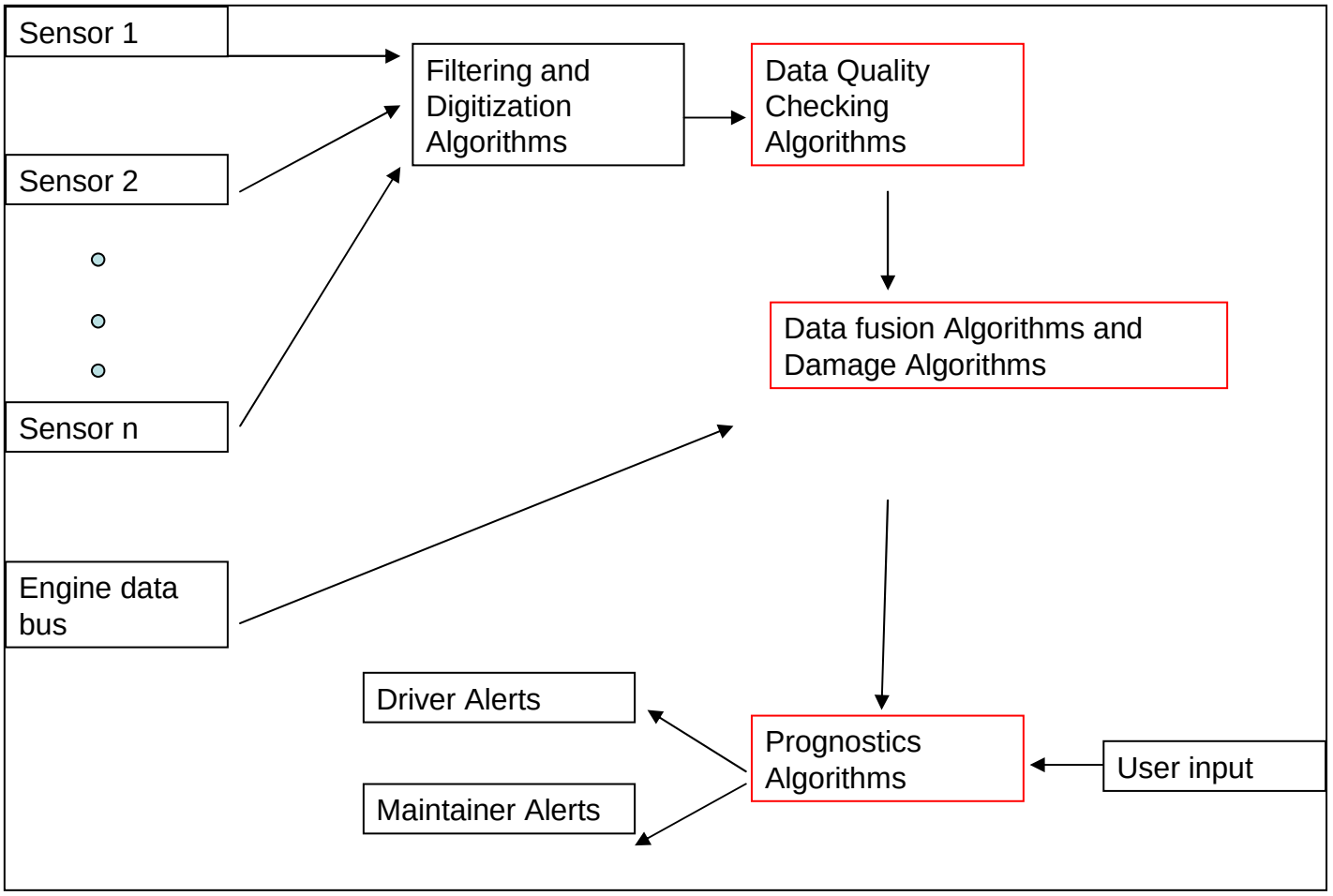
- Availability of Vehicles
  - Percentage of vehicles capable of performing a mission
- Components fail from fatigue damage
  - Suspension, drive train, structural
  - Vibration and shock loading from terrain
- System calculates the life remaining of select components from fatigue damage

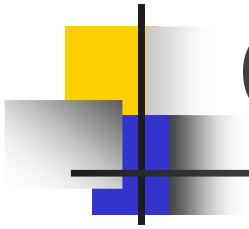
Prognostics System

- Multiple Inputs
  - Engine Data Bus
  - Suspension Sensor System
  - Sensors installed in vehicle
  - GPS
- Processing done on board the vehicle
- Size: 7”x5”x4” (l,w,h)
- Expandable inputs

Example of Application to a Wheeled Vehicle

Prognostics System





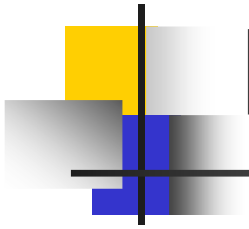
Goals

System Goals

- Logistics
  - Efficiency
  - Accuracy
- Mission Success
- Availability
- Cost Savings
- Decrease fatality
- Decrease loss of vehicles

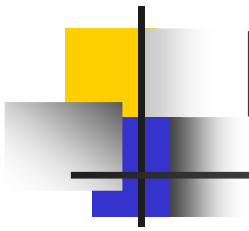
Project Goals

- Organize requirements
- Verify requirements
- Optimization
- High-level representation of system
- Way to identify and address concerns of system



Requirements Goals

- Traceability
  - Use Case to component
  - Requirement to test/analysis and training
- Requirements Layering
- Test Requirements
- Training Requirements
- Verify Requirements
- Requirements to specifications

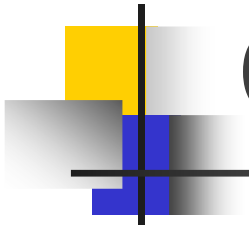


Requirements

- User requirements (10)
- Performance requirements (9)
- Functional requirements (13)
- Testing/analysis requirements (15)
- Training requirements (8)

Verification of Requirements

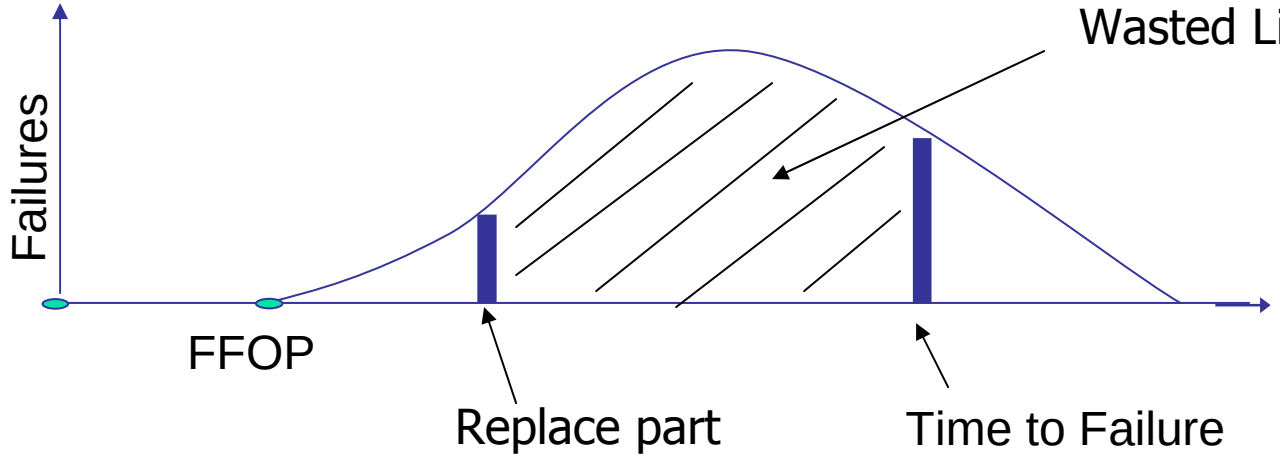
Requirement	Description	Testing/Analysis & Training Requirement
U1	Driver understands what alert message means.	T3
U2	Maintainer understands what alert message is for.	T3
U3	Driver or maintainer knows the expected mission profile.	T5, T6
U4	Maintainer understands how to calibrate sensors.	T7
U5	Maintainer orders replacement part before failure.	T8
U6	Driver understands course of action when an alert occurs.	T2
U7	Maintainer understands course of action when an alert occurs.	T1
U8	Maintainer understands data downloading procedure from system.	T7, T4
U9	Alerts must not impede driver's ability for mission success.	A3
U10	Maintainer resets life of component when that component is replaced.	T4
P1	Sensors are calibrated and operational.	A4,T3,T7



Optimization Problems

- Wasted life vs. cost of failure
- Number of sensors vs. model refinement
  - How many sensors are needed to have accurate model
  - Are extra sensors worth the cost?
- Refinement of model vs. repair cost
  - Cost of model refinement vs. cost of repair
  - Is the ROI high enough to implement more accurate model?

Wasted Life vs. Cost of Failure



- Optimize problem in Excel for wasted life vs. cost of failure
- In future detailed study will be performed

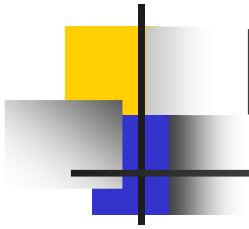
Wasted Life vs. Cost of failure

Wasted Life

- Spare part cost
- Repair cost @ motor pool
- Cost of wasted life of part

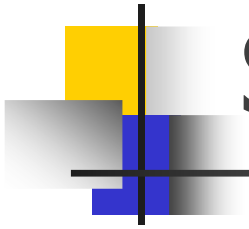
Cost of failure

- Recovery of vehicle
- Repairmen for unscheduled maintenance
- Cost of system availability
- Repair in field



Difficulties

- Overall Difficulties
  - Being aware of current goals vs. long term goals
  - Keeping a high level of abstraction
- Requirements
  - Developing testing, training, and analysis requirements for verification
- Optimization
  - Finding numbers for optimization



Summary

- Requirements engineering is important for this application
- Performing optimization important for ROI
- Future work
  - Verification of design
  - Application to multiple vehicle platforms