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BIGDATA ANALYTICAL FRAMEWORK FOR LAUNCH VEHICLE AVIONICS SYSTEM AUTOMATED CLEARANCE USING ADVANCED ML ALGORITHMS

Abstract

Launch vehicle avionics system performs navigation, guidance, control, sequencing telemetry, tracking and telecommand functions required during the entire flight duration. These avionics packages, which are distributed across different stages of launch vehicle, undergo rigorous testing to demonstrate the predicted reliability goals. Testing includes functional verification of all avionics systems such as flight profile simulation, static integrated flight runs, control system checks, pyro sequence etc. As part of each test, ground checkout system issues sequence of commands to onboard avionics packages and responses are acquired and logged. Test data analysis is carried out offline by respective system design agencies. This data consists of time series monitoring of more than 1500 onboard telemetry parameters and about 2000 checkout system parameters. These multivariate parameters have spatial and temporal relations which are event based and non-stationary. The volume and rate of parameters necessitates integration with big data analytical platform.

Present mode of manual data analysis is tedious and prone to errors. Forthcoming missions, including Gaganyaan with quad redundant avionics system, have complex test conditions resulting in enormous volume of data which demands automation of data analysis. A novel method of integrating big data and time series analysis is proposed which is capable of data analysis in real time and identifying the launch vehicle anomalies like sensor failures, unwanted response in non-related parameters, non-variation of expected parameter etc. Since the data stream are having a reduced time resolution as compared to full sample data, the proposed solution uses integrated stream and batch processing. Anomaly detection from stream data will trigger batch data analysis for detailed inference and is crucial for comprehensive system performance evaluation and anomaly detection.

As accuracy is the utmost factor, the proposed scheme uses a fusion of advanced Convolutional Neural Networks(CNN) and Long Short-Term Memory (LSTM) Networks targeting significant reduction of false negatives. Algorithms are implemented in bigdata framework through seamless integration of open source technology Apache Hadoop ,Kafka and SparkML. This analytical framework is integrated to launch vehicle data platform for the last 5 missions with definite clearance criteria and has successfully identified anomalies. Integrating Bigdata framework with ML fusion algorithms, the solution

could provide efficient and accurate clearance to launch vehicle avionics system having very minimal false negatives with reduced time of clearance, to ensure the safety and reliability of the Launch vehicle system.

Keywords: Bigdata, time series analysis, non stationary, anomaly detection