بسم الله الرحمن الرحيم

شبكة المعلومات الجامعية

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جامعة عين شمس

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AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Computer Engineering and Systems

Satellites Health Monitoring System using Inductive Monitoring Approach

A Thesis submitted in partial fulfillment of the requirements of the degree of

Master of Science in Electrical Engineering

(Computer Engineering and Systems)

By

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Bachelor of Science in Electrical Engineering

(Electronics Engineering and Electrical Communications)

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AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

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Degree: **Master of Science in Electrical Engineering (Computer and Systems Engineering)**

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Statement

This Thesis is submitted as partial fulfillment of Master of Science in Electrical Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this Thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

Mohamed Ali Mohamed Abo Arais

Signature

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Date: 22 May 2021

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Thesis Summary

Nowadays, satellites are included in our daily activities for several purposes. Once the satellite is launched and enters its orbit, it operates independently, and during orbital flight, the satellites are exposed to a variety of dangers that threaten their mission. Therefore, monitoring the health of satellite systems during missions is essential for the success of satellite missions.

The Thesis discusses traditional satellite health monitoring systems and the new trend of data-driven techniques and proposes an enhancement to the learning module to a data-driven technique called IMS "Inductive monitoring system."

The Thesis is divided into five chapters in addition to lists of contents, tables, figures, and a list of references

Chapter One: Introduces the thesis research topic and gives an overview of the research problem, its motivation, and our research objectives.

Chapter Two: discusses the theoretical background of this Thesis and present the required essential concepts for this research understanding like an introduction to satellites, their design, systems for monitoring their health, and the categories of satellites, introduction to techniques for machine learning, data mining, and comparison, and the algorithms used in each technique, and an explanation of the inductive satellite monitoring system, it is working theory

Chapter Three: discuss the proposed improvement to the learning process of the inductive monitoring system for satellites by comparing the algorithm used for learning which K-means is and proposing a new algorithm, which is One class SVM and Suggested dataset to validate the results by applying it on IRAZU CubeSat telemetry data

Chapter Four: This chapter will explain the practical steps for applying the comparison between learning using the Kmeans algorithm and learning with the One-Class SVM algorithm.

Chapter Five: In this chapter, we will conclude the results, discuss them, and suggest other areas for improvement for future studies to improve the inductive monitoring system.

Keywords: CubeSat, Machine Learning, Data Mining, Clustering, K-means, one-class SVM.

ABSTRACT

Nowadays, Satellites are included in our daily life activities for several purposes. Some of them are used for Remote Sensing, communications, navigation, weather broadcast, and deep space telescopes.
Once the satellite is launched and enters the orbit, it operates autonomously and can communicate with the ground station when it enters the visibility zone of the ground station. During the orbital flight, it will be exposed to various mechanical, thermal, and electromagnetic effects, directly impacting its operations and mission success. Therefore, Satellite health monitoring is essential for the Satellite mission's success.
As a satellite mission became more sophisticated, satellite health monitoring became more challenging to handle.

David L. Iverson invented so new trend used by the satellite operators to use a Data-Driven technique for Satellite health monitoring called IMS "Inductive Monitoring system." IMS uses Applied Data Mining and Machine Learning techniques on the archived satellite telemetry data to build a knowledge-based model and use this model to be applied on the newer telemetry data from the satellite to monitor the satellite's health.

IMS usually uses the K-means algorithm for the learning Algorithm. In this Thesis, we are proposing a One-Class SVM Algorithm to be used instead. In this Thesis, we applied both learning Algorithms on real CubeSat Housekeeping Telemetry data, and One-Class SVM showed an improvement in the ability to capture anomalies data from the CubeSat telemetry data.

Publication List

The research work of this Thesis is published as :

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