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Validation and Confirmation of Satellite Flight software Technology using MATLAB

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ABSTRACT

This paper presents the confirmation and validation of satellite flight software using environments of MATLAB. The satellite becomes a valuable informative tool in educational field and the programs of engineering. The aerospace company investing resource to improve and developing the validation and verifications methodology depend on large scale aerospace mission which tend to focus resource on spacelab developing. This work looks at two kind of methodology in an attempt to develop the reliability of satellite include utilizing system of software model and creation of software requirement. This woke dose permit for basics software required to produce the resulting specifications. Additionally, resulting graph produce for specific satellite were high level did not find any issue, while Monterey phoenix is efficient tools to produces study of model-based system engineer concept.

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1. INTRODUCTION

The space industries have developed efficient techniques for validation and confirmation software in large communications satellite over last 60 years with large requirement improvement budget and too expensive [1-5]. Hence, with large satellite cost, large budget is available for all type of satellite. The validation and verification software cost are large also and this will easily dominate the small satellite budget which does not receive the same levels of software assurance as their large counterpart [6-10]. Particularly, the software assurance of small satellite software has received slight attentions due to cheap and quick development and elaborate small satellite software validations and verifications program cannot be followed [11-15]. Furthermore, when the small satellite is producing cheap and quick, the assignment failure cause by software problem could be tolerated [16]. The sequential launches or simulations of small satellite is sometime planned assume that software failure might happen [17-20]. Whatsoever information is lost from small satellite because of software problem might easily be recover from another satellites, while the hardware normally fails because to damage or wear and the software failure is resulting of defective software design or error of programs [21-25]. In existing time, the number of small satellites located in the orbit has grown expressively [26]. The government organization, industry, and academics are lunched small satellite at an aggregate speed approaches more than dozen each month [27]. Figure 1 illustrate the general small satellites grounds design the use NASA near earths networking for normal earth pass for little latency message [28-34]. This

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construction give separated database produced from MOC of telemetry and housework information that is available to stakeholder.

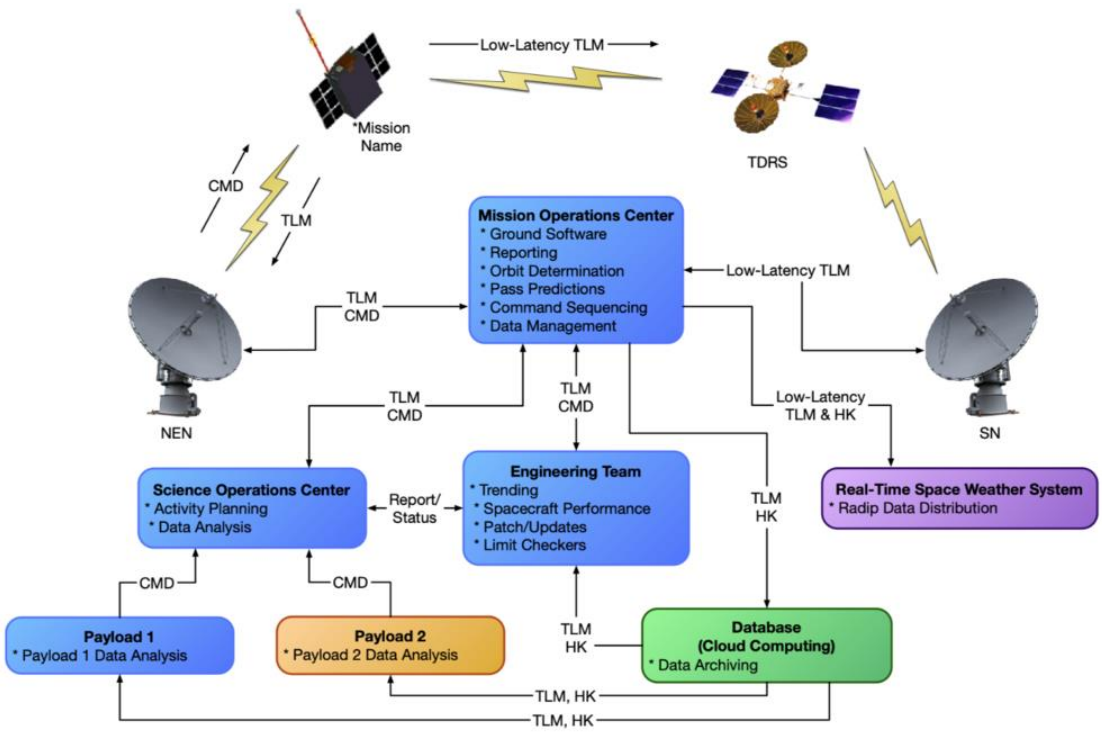

Figure 1: ground systems architectures for a smallest satellites under NASA's

2. MATERIAL AND METHOD

The aerospace block set in MATLAB has been used to perform the steps of satellite flight software design and verifications. The software portion is used to control the attitude and managing the actuators failure which is typically a part of large multi organize to build the satellite. To achieve this duty, all system should be modeled and attach the requirement to the model. The systems outline use SIMULINK model blocks for model reference to enable multiple teams by define subsystems interfacing in order to permit for independent works as illustrated in Figure 2. Hence, one could directly connect the requirement to this model via interface environment of requirement management of SIMULINK validations and verifications.

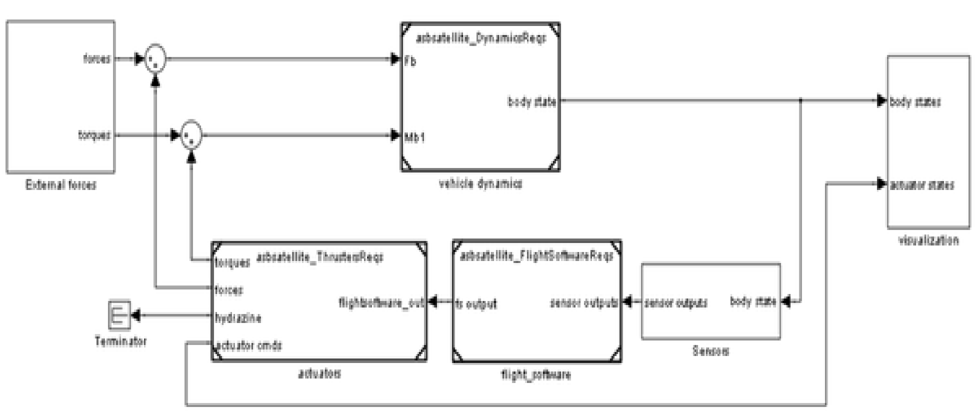

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Figure 2: satellite model outlines-based requirement

In circular orbits, the satellite travel with zero-degree disposition at 1500 km taken into account the effect of earth oblateness gravity models. The dynamic model of satellite rigid body has been modeled by 2-body/six degree/of freedom system as showing in Figure 3.

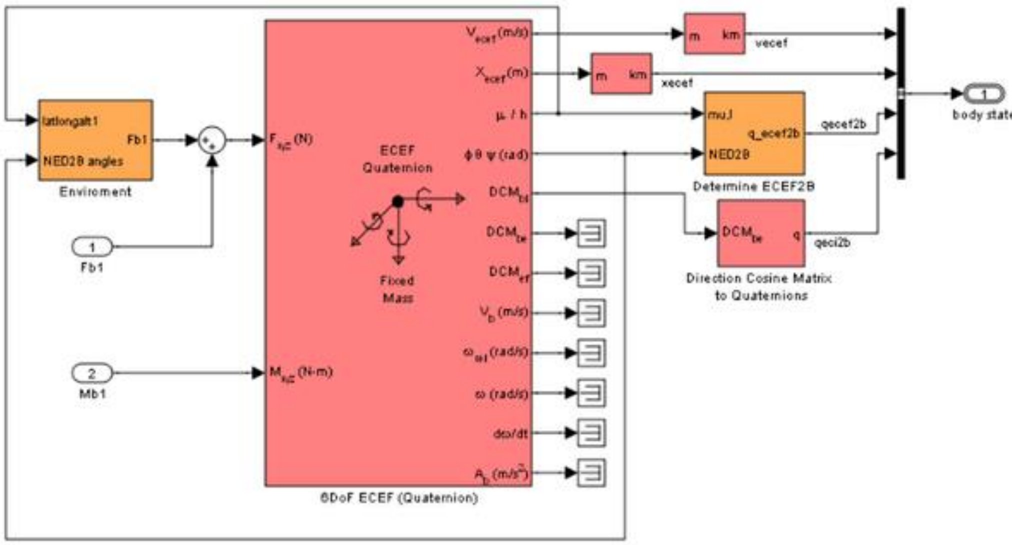

Figure 3: the dynamics model of satellite rigid body

The test harness model is designed in order to verifying the satellite dynamic model which contains the models of satellite dynamic. To make sure that the stable orbit has been selected and the satellite rotate with outside force only, the assertion blocks is used to performs the test also were applied correctly as shown in Figure 4. The harness model is also consisting of visualization block which is used to enable the designer to watch the earth orbit of satellite as illustrated in Figure 5.

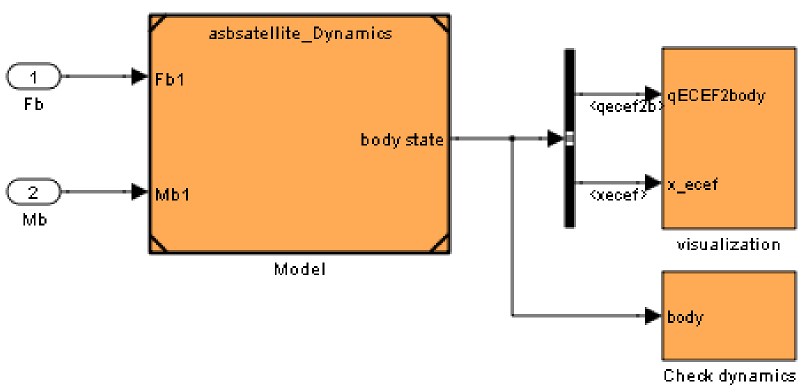

Figure 4: satellite dynamics test harness model

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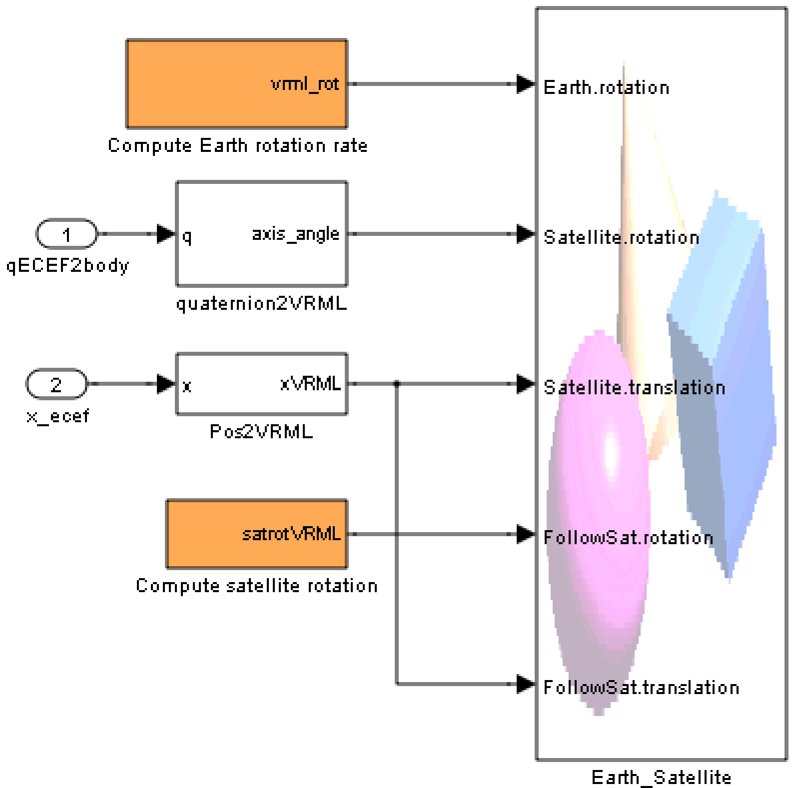

Figure 5: Visualize sub-system for satellites dynamic test harnesses

The main pieces of satellite flight software are including the attitude controlling, navigations, and failure detections which is work together in this model. To examine these parameters, the flight software model is used with subsystems of aerospace block as shown in Figure 6.

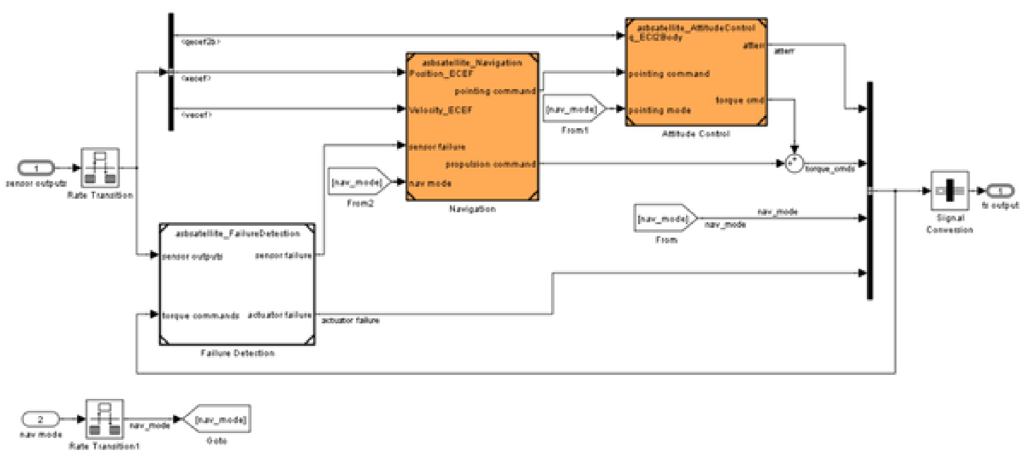

Figure 6: the model of satellite flight software

The detection of failure situation is determined by detection block if the thrust sensors and actuator has failed. The failure detection model shown in Figure 7 is simplified serves as working placeholder to give indication signal that no failures is occurred.

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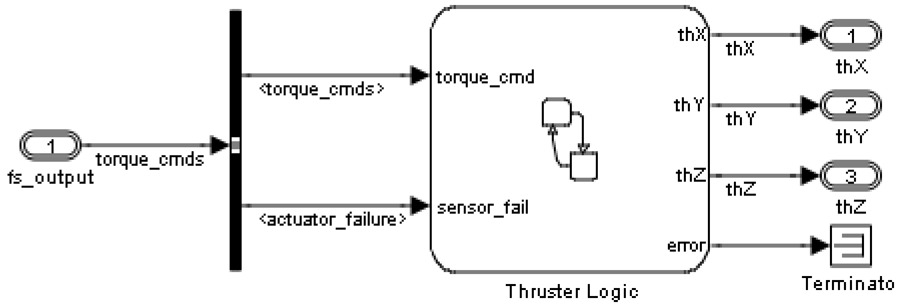

Figure 7: failures management and thrusters controlling model

The satellite courses of satellite management with respect to three degree of freedom is navigated by the model illustrated in Figure 8 which is designed inside the attitude control subsystem. This navigator system is simplified model which serve as work place holder to gives pointing command until the full navigations model is supply. The wanted orientation of satellites with there rotation degree of freedoms is managed by attitude control model. The attitude is the more important task that used to ensure the satellite instrument and antennas which will be able to correctly functioning by pointing the wanted position.

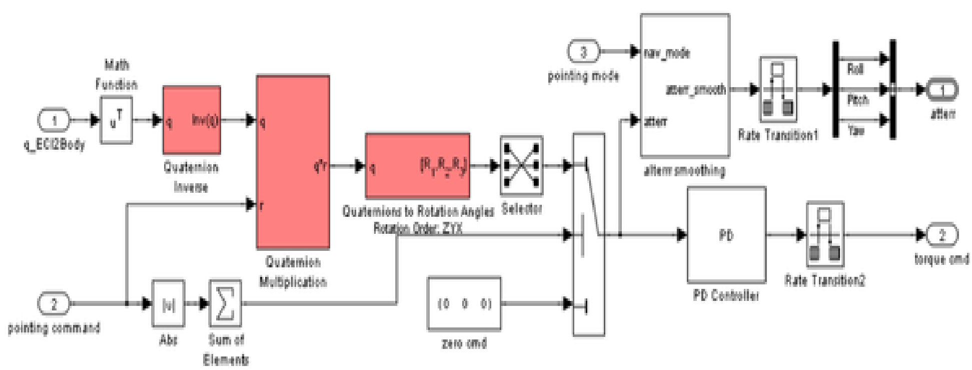

Figure 8: Navigators and attitude control models

The failures managing and thrusters controlling systems consists of logics to turn axis torque command into individual thruster's command to hydrazine the actuator. The aerospace blocks are used to build the thruster actuator model which highlight the subsystem as shown in Figure 9. To convert the axis torque command into individual thruster's command, two steps were achieved includes thruster actuations and failure detections. The failures detections are firstly completed and the model checks the thruster pack for failure. Hence, in case of no failure is happens, the model executes the torque command for simultaneous axis. In addition, in case of fail thrusters pack, only one axis at times could be actuated. Through failures, the axis executes one determination by trust controlling system to have axis with the large torques commands.

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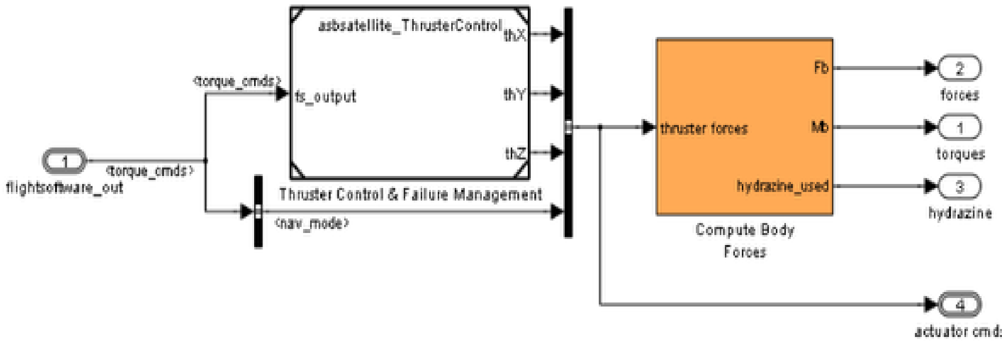

Figure 9: the model of hydrazine thruster actuators

After the failure detection is completed, the model determines which thruster to fire for specifics torque commands. Four packs are included in the satellite model with three thrusters for each one which is totally equal to 12 thrusters. In order to creates the suitable moment, two thrusters should be fired by using the axis, command sign, and failure existence to determine which thruster will fired. The state flow of failures managing and controlling logic in thrusters' actuators is modeled as illustrated in Figure 10.

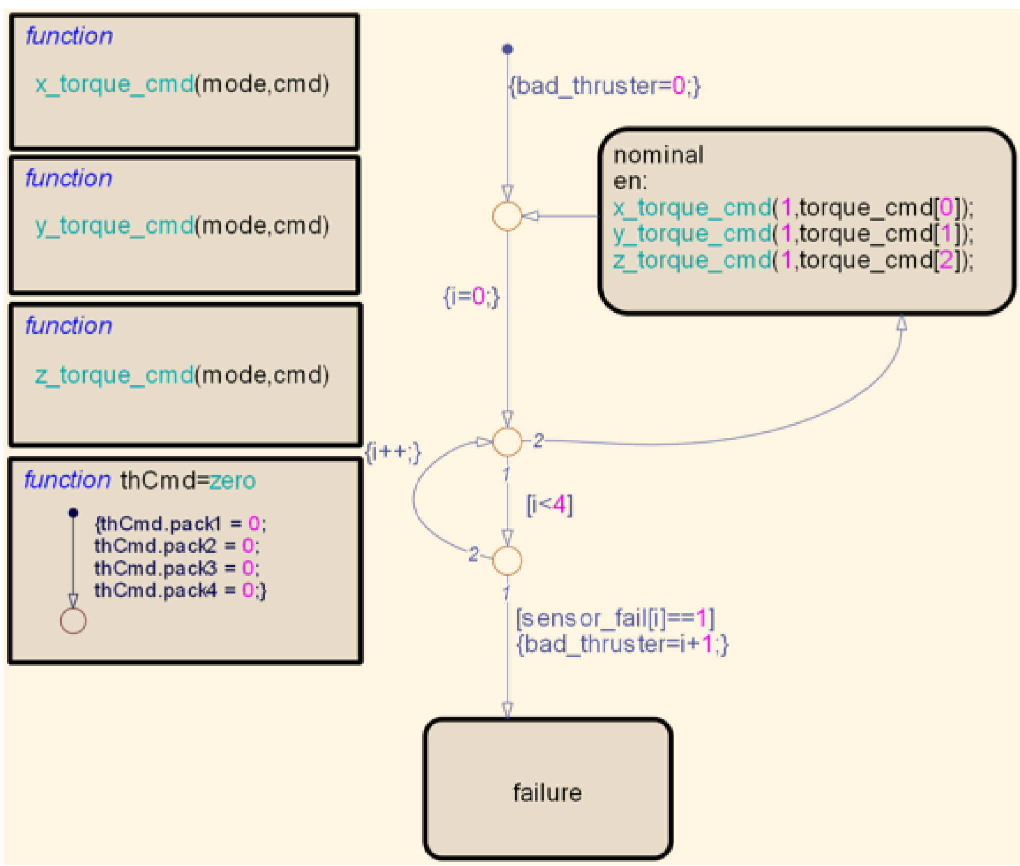

Figure 10: state flow model of thruster controlling system and failure logic manage

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The test harness model is designed to verify the thruster actuator includes hydrazine thrust actuators, signal creation, and assertion blocks to store the test case and performs check of these situations respectively. Figure 11 shows the hydrazine thrusts actuators test harness models.

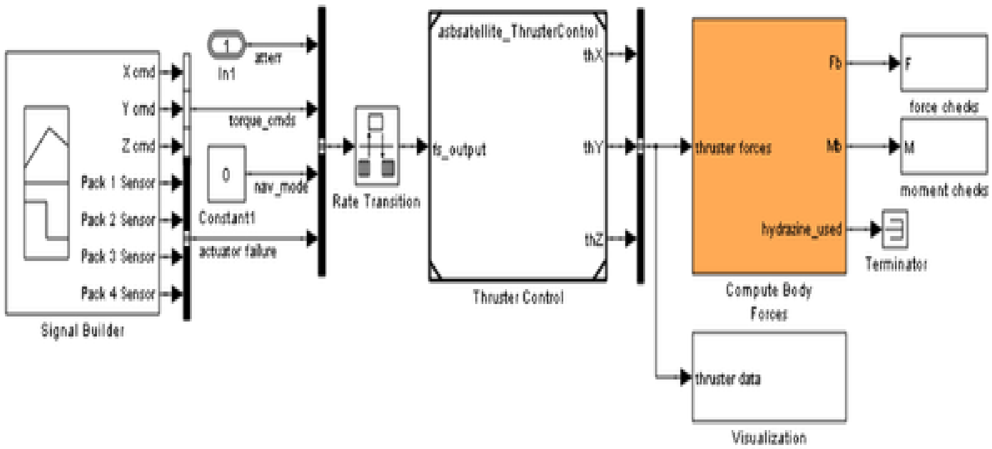

Figure 11: the model of hydrazine thrusts actuators test harnesses model

3. RESULTS AND DISCUSSION

After the designing and run the suggested model in MATLAB, the optimize test of the tuned parameters such as threshold values that should set the torque command to reach before the thruster actuated firing. The model should calculate the torque threshold values to conserve the fuel and indicate when the thruster must be going on. Due to thruster is off or on, firing the thruster as soon as the torque command is not zeroing because this will cause the thruster is always firing that will waste limited supply of the fuels. The attitude errors are another factor of determine the torque threshold values which should be small as possible. Hence, the torque threshold values should select prudently. The system test results has been used to plot the optimal values of hydrazine per cycles and the attitude errors cross is determined also. This cross is found of about 0.05 from torque threshold as illustrated in Figure 12.

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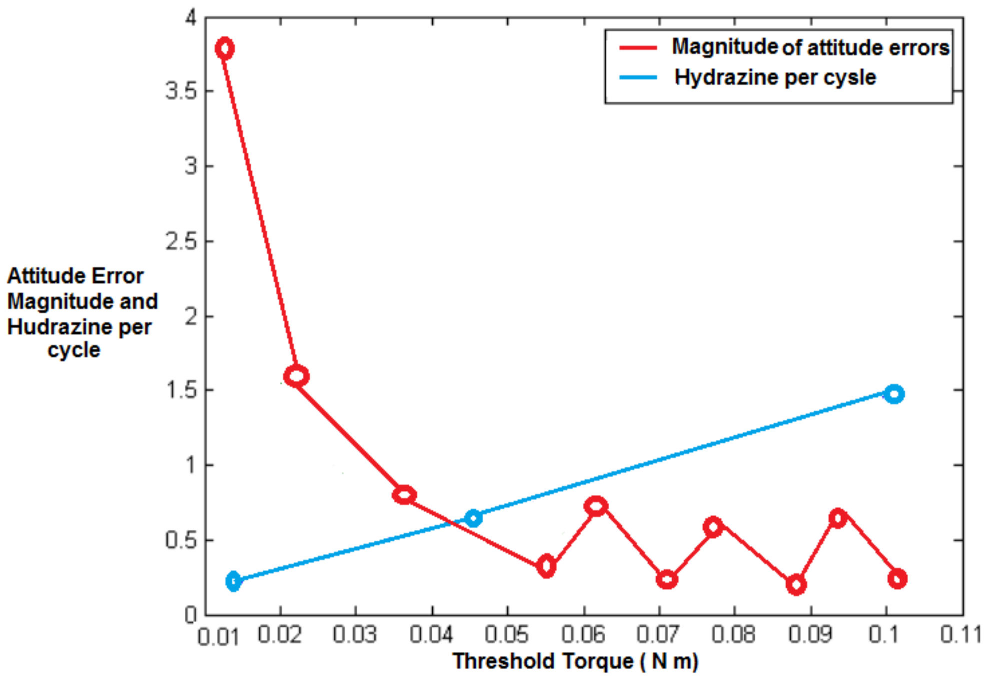

Figure 12: the results of partial test cases

4. CONCLUSION

This paper introduces the development and confirmation of satellite flight software technology using MATLAB with the faults tolerant software techniques that could be used to implement the run times monitoring under software verification after or before launching the satellite. Faults tolerant software designs could be combined with run time monitoring for effective deal with the errors of software that escapes the verifications processing that exposed after launch or prior the launch to generate the effects of ionizing radiations. This work has attempted to provides a calculation of software assurance techniques used in existing time in validation and verifications. The model base design tools usage a graphical technique, state flow, and other construct to specifies the software architectures and create the detailed software modeling so that the designer not needs allocated memories, declares variable, and iterations loop. The error should be found in all software correcting by change the model and then automatically generate the codes. The advantages of the model-based design involve reduction the verification time and high ability. After modified the core performances model, the results was specified as software requirements and developed after some trials.

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