Knowledge-Based Software System for Space Exploration

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Abstract

It has been observed that transformation in space exploration is done by various innovations in robotic spacecraft. Space exploration using spacecraft are becoming software-intensive supporting remote-control, increased productive science gathering and analysis, good troubleshooting during flight accelerated understanding of universe. Furthermore, software engineering approach will also incorporate in this system, therefore, the design, development and serving of different kinds of software in space exploration may be providing tools, techniques and a systematic approach of knowledge based software engineering for a robust and deep space discovery. The application of Artificial Intelligence technology to software engineering is known as Knowledge Based Software Engineering and operating these types of missions requires different kinds of expert systems, intelligent space systems, semantic technologies, neural networks, fuzzy logic, self adaptive systems, embedded intelligent systems, future aerospace systems, ultra-large scale systems, axiom systems, automated reasoning systems, automated fault-management systems and fault tolerance systems. In this research, various space explorations or scientific missions are discussed in exploring asteroid and deflecting it by using Knowledge Based Software Engineered (KBSE) system. Therefore, this paper discusses on the design and development of an "expert system" with the framework of hardware, software and mathematical formula that uses Knowledge-Based Software Engineering Approaches for space exploration. This expert system will work as an asteroid explorer and at the same time it will act as an asteroid deflector. Further, the proposed systems will be equipped with telescopic camera, sampler, laser range finder, solar cell paddle, X-ray fluorescence spectrometer, star tracker, light detection and ranging, fan beam sensor, sample, ion thruster, robotic precursor, nuclear interceptor and laser ablation payload, because, it is a need for a future Knowledge Based Space System for the study of primitive objects like asteroid and their deflection which will save our planet Earth as well as discovering different asteroids in space.

Keywords: *Knowledge Based Software System model, Sampling, Mathematical Format.*

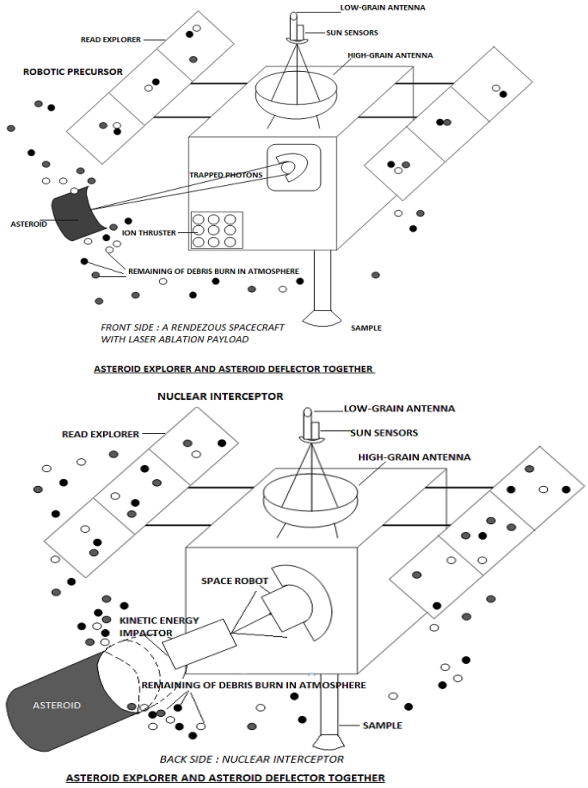
1. Introduction

This is a very old idea which is under consideration by engineering and techniques in building a spacecraft. Spacecraft can operate in environments like near-Earth and in deep space. The expert systems are evolving along with knowledge representation and process modeling in unexpected directions. This is covering various semantic technologies, on-board fault management, human robotic interaction, and natural language processing, agent-based simulation architecture and machine knowledge. There are various challenges made in building and sustaining spacecraft over such long missions and the contributions that knowledge based software engineering will be made in facing those challenges successfully. Knowledge based engineering is subset of knowledge based systems called expert systems in Artificial Intelligence because they capture expert knowledge and generates creative solutions. These systems used sensors, manipulators, fault management, computer architectures, improved software development tools and artificial intelligence for various rovers. A Knowledge Based Software System (KBSS) will be used in explaining knowledge based software engineered robotic system. So, advance engineering and technology is important in major space programs for extra-terrestrial exploration and resource utilization within economy limitations. In this paper, we will focus on a special robotic system required for space missions with the most effective knowledge based software engineering techniques that will offer spacecraft to survive, its new environmental challenges and updates of mission requirement [21] in space exploration of asteroids.

2. Design of Knowledge-Based Software System

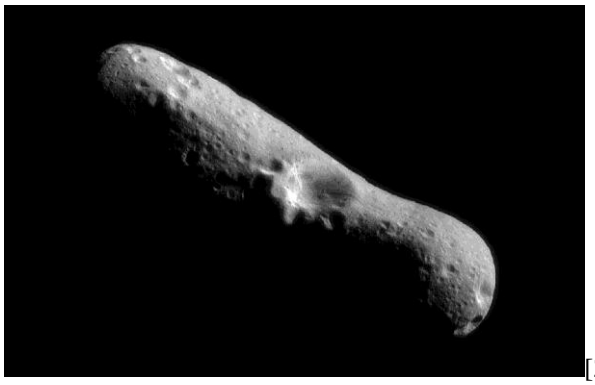
Software engineering is an application of systematic, disciplined, quantifiable approach that involves defining, designing, developing and maintaining software systems and advancement in software [1]. It will be used to achieve a software system known as expert system. An expert system is a computer program that provides a methodology for reasoning about information in the knowledge base. In this paper, a Knowledge Based Software System (KBSS)

will be used in explaining knowledge based software engineered robotic system. This will act as an asteroid explorer along with an asteroid deflector arranged together in a same system with various other functioning parts. It will be explained using steps along with logic, developing certain indices or tests through research methods and techniques and how to apply these techniques. There will be various assumptions given through a lot of techniques. It is explained by a three dimensional figure engineered system with front and back side as shown below:

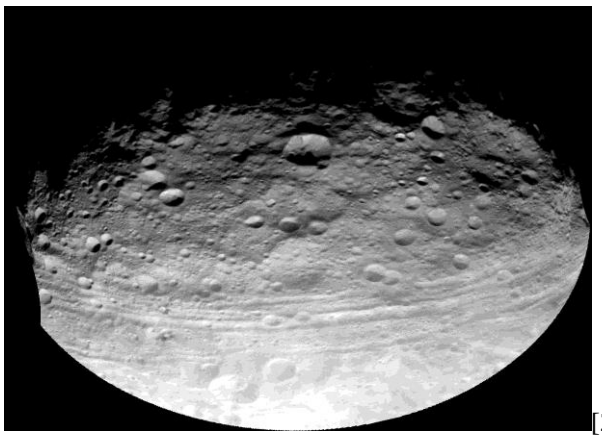


2.1 Sampling Site

There will be a selection of units like people and organizations from a population to generalize results back in population from which they are chosen covering population and sampling frames upon quantitative models.


[24]

Asteroid Overview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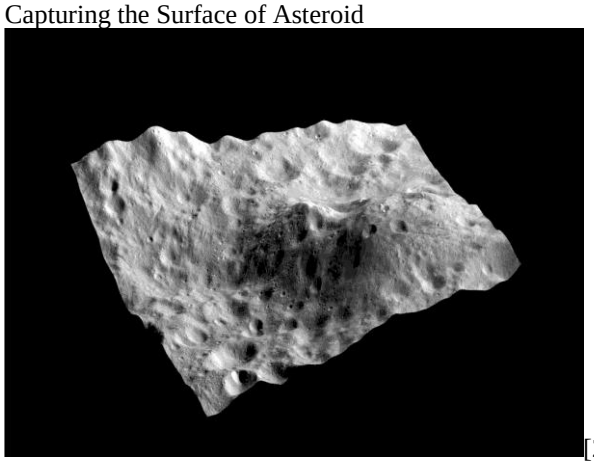
Capturing the Surface of Asteroid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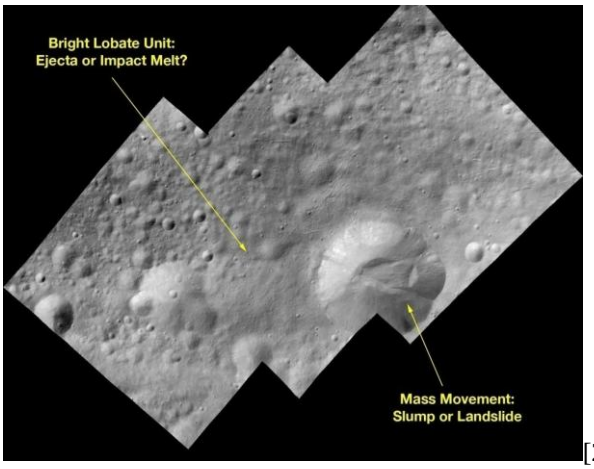
Dark Hill on Asteroid



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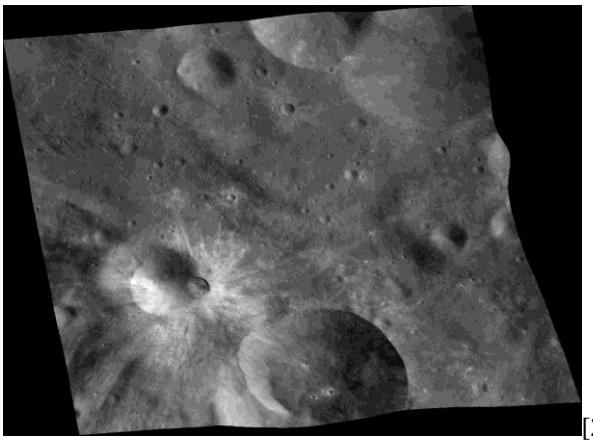
Bright-Rayed Crater on Asteroid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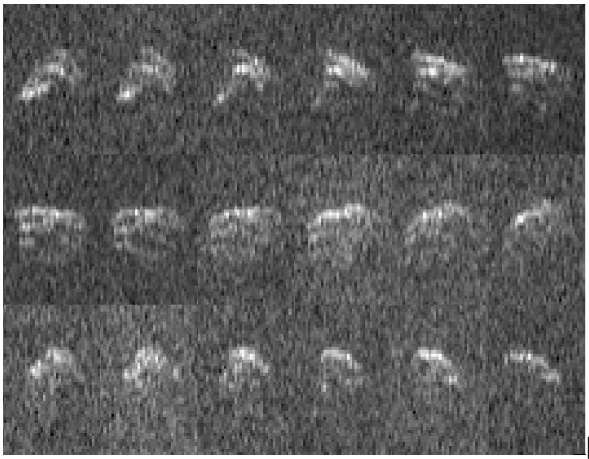
Crater Characteristics on Asteroid

2.2 Collection of Sample

In sampling, samples are collected and on the basis of that data is prepared. In this knowledge based software engineering, how sample is collected for space exploration will be shown along with details as shown below:


[24]

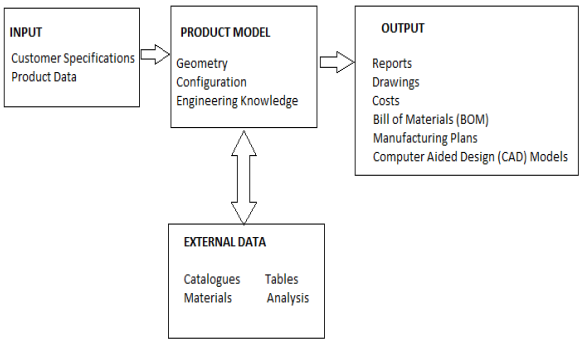
Goldstone Antenna situated in southern California Mojave Desert near Madrid


[24]

Goldstone Radar Images of Asteroid 2013

2.3 Software Model

Through sampling statistical information is made for construction of knowledge based software system in studying near-earth asteroid nature for space exploration and qualitative or quantitative nature is made. It is scientific procedure providing required estimates with associated margins of uncertainty, arising from examining only a part and not the whole.



KNOWLEDGE BASED SOFTWARE ENGINEERING SYSTEM

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2.4 Mathematical Equations

Mathematical formula for estimation of probability and non-probability sampling as major methods of sampling is as given below:
Final formulation of new estimated method = Reference error amounts + Charge factors value.

$$N_{errors,total} = \sum_{i=1}^{n} \left(\prod_{j=1}^{m} C_{ij} \right) * R_i$$

C= change factor values for every identified component
R= reference error amount of ith component
n = number of identified components
m = number of identified change factors

[6]

3. Discussion and future scope

The paper discusses designing a framework for explaining a knowledge-based software system. We have also focused on design and development of conventional applications, modified for areas specific for expert systems that are knowledge acquisition, verification and validation. The biggest outcome is creating a system that has asteroid explorer along with asteroid deflector together itself working with maximum performance essentials using knowledge-based software engineering techniques. This KBSS is effective in every aspect with the biggest achievement in space exploration. The system after the completion that is an explorer take various sample of asteroids its shape, size, density, etc. and the asteroid deflector deflecting the hazardous asteroid away from the Earth, will return back to Earth to provide sample to laboratories for future discoveries. These KBSS must have fault-management techniques along with theory of neural networks and fuzzy logic. Thus, a robust future expert system is made to carry out various space missions.

4. Conclusions

There is a construction of an expert system for various space missions known as a knowledge-based software system. The typical information system tools and knowledge based systems are used for monitoring, exploration, deflection, coordination control and design decisions. There is an outline of method for gathering data and presentation of a theoretical framework including different perspectives on the innovation, support and knowledge sharing for the engineers.

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