S3.14STEROID project

NASA space apps challenge 2016

Preparatory steps

1. Detalised database (orbit, class, preassumptions on composition) developed by orbital telescope array.

2. Close exploration and radar geomapping by series of “a-hive” (asteroid hive) probes in the asteroid belt. Each a-hive is equipped with a huge set of cubesat-type drones (atomic battery, EHF georadar, gamma-spectrometer, EHF transmitter). A-hive seeds prospective, according to database, asteroids with orbiting (for larger one) and “anchor three microspine paws and crawl” cubesat explorers to determine their potential according to following purposes.

Asteroid selection criterias according to general purpose

Mission/purpose (general purpose changes according to step-by-step space expansion)
1. Mine valuable resourses for Earth, use metal and propellant for orbital construction
2. Resourses for Mars, possible Mars terraforming
3 Orbital habitat
4. “Sent in advance” series of propellant and resource storages for interstellar mission

Complex value of asteroid:

(Price of A resource per unit)*(amount of A resource)*(coeffitient of value of A) +(Price of B resource per unit)*(amount of B resource)*(coeffitient of value of) + .. + (Price of B resource per unit)*(amount of B resource)*(coeffitient of value of B)

Integral criteria of the asteroid attractiveness to snatch it

Transportation (changing orbit):

Criteria	Weight			
	1	2	3	4
Ability to be synergetically partnered with another asteroid	6	6	5	2
Elements of orbit and position according to Sun, Earth, Mars etc.	5	6	7	9
Ability to use gravitational assist of major asteroids and other bodies	4	4	3	2
Presence of substances suitable to be used as propellant	6	7	8	9
Mass, size	8	8	10	3
Energy needed for changing orbit to smaller heliocentric, areo- or geocentric	9	8	0	7
Orbital speed	7	7	3	5
Total for current purpose	45	46	36	37

Resource:

Criteria	Weight			
	1	2	3	4
Reliability of survey data	8	8	9	10
Metals for construction purpose	6	8	8	4
Rare earth element	10	8	8	5

Hydrogen, water, hydrocarbonates	2	10	8	10
Other mineral resources	1	2	5	1
Total for current purpose	27	36	38	30

Mining potential:

Criteria	Weight			
	1	2	3	4
Occurrence depth	4	4	6	9
Aggregate state, structure, chemically bound state of resource	5	5	6	8
Equipment needed for extraction	5	5	7	9
Total for current purpose	14	14	19	26

Orbital window:

Criteria	Weight			
	1	2	3	4
Interposition of potentially synergetic asteroids	6	5	5	2
Orbital window according to potential gravity assist bodies	7	7	8	10
Total for current purpose	13	12	13	12

Changing the orbit of choosen asteroid

We've explored some scenarios, based on actual and prospective technologies and our logistic assumptions. Different combinations of such drives as direct nuclear heating of propellant, plasma engine, solar sail, sail with laser/maser pumping from mediating platform and gravity assist can be used according to criterias of time/price ratio.

We've made two simplifyed physical models of most contrast transportation algorythms: one using nuclrear propulsion and another using smallest delata-vees with mininum price.

Short run

Simplified physical simulation includes mass of the Sun and of the sample asteroid in asteroid belt, and two real-scale orbits: existing and target one, which is approximated to the orbit of Earth to perform next orbital switch: from heliocentric to geocentric orbit.

First relatively short impulse with significant mass of propellant and second one, although short but with less mass of propellant, are made by two separated automatic "tugboats" (one in the asteroid belt and another one on the earth-like orbit), to avoid senseless transportation of equipment and propellant on the asteroid's inertial route from one orbit to another.

“Tugboat” in the asteroid belt (larger impulse) is operating by using easily melting parts of the asteroid itself or body of another asteroid with high percentage of easily melting substances on similar orbit as a propellant for nuclear engine to achieve powerful impulse.

Similarity of orbits of the asteroid with good industrial, constructional or habitat potential and other one with meltable substances, which could be used as a propellant, is included to the algorithm of target selection.

(https://www.youtube.com/watch?v=mwSNx3kNXdc)

Long run

Simplified physical simulation includes mass of the Sun and of the sample asteroid in asteroid belt, and two real-scale orbits: existing and target one, which is approximated to the orbit of Earth to perform next orbital switch: from heliocentric to geocentric orbit.

Relatively weak but continuous impulse in this simulation could be made by solar sail, solar sail with laser/maser pumping or plasma engine, which uses some concretions in asteroid shell, transported by small anchored bots to the thruster, as a propellant.

(https://www.youtube.com/watch?v=1OB3MKc2lu8)

Simulation is based on Grasshopper tool.

Hackaton tasks solved

Platform for search, evaluation and selection of asteroids for mining. Solutions for resource transportation.

We've set it a bit wider: selection of asteroids for current purpose (resources, terraforming, habitats, etc) and selection of the "best offer" and economically-based selection (algorythms of transportation, time window etc.)

So... what are we aiming for?

Cathegory:

Solar System & Beyond. Asteroid Mining

#spaceappsby #BringMeARock #SolarSystem #OutThere #s3.14steroid

Short summary: roadmap for serious challenges of humanity

Key questions

- search and further survey, unifyed database for asteroids;
- unified classifier of spectral classes of asteroids, based on existing dataset of "Tholen classifier", SMASS classifier;
- detailed database\classifier of asteroid according to geological data, to extend "The MPC Orbit (MPCORB) Database" up to mining catalogue
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- roadmap for future use of asteroids, according to step-by-step concept of space expansion
- which factors are important for asteroid-for-purpose selection
- key rules for automatic selection based on our complex criteria:
  - Transportation (changing orbit)
  - Resources

    - Mining potential
    - Time window
- rational, logical and elegant way of transportation of selected asteroid, compound made of extracted resources or of couple of synergetic asteroids (resource/propellant), selection tree for transportation engines and complex roadmaps for transportation
- vision of asteroid use on different steps of space expansion

To whom it is useful?

- Asteroid mining developers
- Asteroid search and survey developers
- Homo Sapiens Sapiens;
- Space logistcs companies;
- Space truckers and Flibustiers

What problem is solved?

"….I'm young and inexperienced Flibustier. What should I do? How to "snatch" my first asteroid? Where's that damned step-by-step gude??? - that's what he said, that young guy in in a fur hat on top of the spacesuit we met ten minutes before NASA Space apps Hackaton.

We have to help him!

Uniqueness

— Hey, You! You, I mean! Where is YOUR step-by-step Flibustier guide on asteroid mining?

Implementation

- First attempt to prospective design of flexible modular multymodal sysem for asteroid transportation, including physical models and further exploration on gravity assistance.
- Phyton module for The MPC Orbit (MPCORB) Databas, additional modules for database filtering according to selected asteroid properties ;
- Friendly user interface for “asteroid-to-purpose” selection with complex selection criterias

Technology

- Js
- Phyton
- Kangaroo Physics v0.099
- Grasshopper 0.9.0076
- Rhinoceros 5 (SR2)

S3.14STEROID team

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