Touch interception and utilization of satellite: an autonomous rendezvous scenario

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The spacecraft's lifetime is often limited by reliability and redundancy of its components. Furthermore, serious restrictions on duration of spacecraft operations are posed by finite amount of fuel or cooling agent. It is also clear that once a satellite is launched, it is extremely difficult to replace/modify its extremely expensive hardware on the orbit. A damaged or malfunctioning satellite can be considered as space debris or as an object requiring services. In both cases a servicing spacecraft is needed to intercept the failed one. In the paper we introduce and analyze a new scenario for the interception of a free rotating satellite with external perturbations on a Keplerian orbit. The interception maneuver is divided into several phases to be executed by the servicing satellite: (i) attitude and distance determination of the target object, (ii) own motion planning, (iii) determination of the optimal target position and orientation before docking, (iv) controlled approach, i.e. decreasing of a range between satellites, (v) orbiting of the servicing satellite around the target satellite, and (vi) docking, i.e. radial degreasing of the inter-satellite range till the satellites contact, while keeping constant the relative orientation between them. The autonomous trajectory planning and dynamic behavior of the servicing satellite during its maneuvers is described. Finally, a few examples of satellite motion simulations according to the proposed scenario are presented.