

considered. A surveillance robot that covers an area by pointing a camera at a location from any of a near infinite number of vantage points will require different planning techniques than a vacuuming robot which covers an area by simply traveling over it.

Brief Summary of the Invention

[0006a] According to a first aspect of the present invention, there is provided A method of performing surface processing on a three dimensional object using a robotic manipulator, with a stationary or mobile base, in a work environment comprising the steps of: obtaining a base model of said three dimensional object; generating a surface model from said base model by performing a surface scan of said three dimensional object and augmenting said base model with range data and surface property data obtained from said scan; planning a temporal sequence of states of said robotic manipulator to maximize processing of said surface of said three dimensional object; scanning said surface of said three dimensional model before said surface is processed to control or modulate a processing tool connected to said robotic manipulator; processing said surface with said processing tool, scanning said surface of said three dimensional model as said surface is being processed and updating said surface model with new surface property data; adjusting said set of positions and poses for said robotic manipulator based on said updated surface model; and continuing processing of said surface and said updating of said surface model until said surface reaches a desired state.

[0006b] According to a second aspect of the present invention, there is provided a system for performing surface processing on a three dimensional object in a work environment comprising: one or more robotic manipulators, each of said robotic manipulators including an end effector having a surface processing tool, a ranging sensor and one or more surface property sensors attached thereto; a computer running software for controlling said one or more robotic manipulators, said software comprising:

a surface property analyzer, for processing surface properties sensor data before and after the processing point of said processing tool to classify the current state of said surface; a surface model for storage of the geometry of said surface and said current state of said surface; a surface process planner for planning a sequence of processing actions to be carried out by said processing tool based on an observed state of said surface stored in state surface model; a surface process modulator for modifying said planned sequence of processing actions based on real-time feedback from said ranging sensor and said one or more surface property sensors; and a surface coverage planner, for planning movements and poses of said one or more robotic manipulators to maximize coverage of said surface.

[0007] The system disclosed herein precisely maneuvers one or more machine vision components and/or one or more surface processing devices over the surface of a three-dimensional object. The vision systems gather data about the surface that are used to inform the surface process. These data include both intrinsic properties of the surface, such as color, texture or abstract classification results, along with precise estimates of the distance and orientation of the surface relative to the processing point. These data are used to accurately plan for and modulate the surface process to efficiently generate high-quality results. In the preferred embodiment of the invention, the machine vision components are comprised of multi-spectral cameras with corresponding illumination sources that can discriminate between various layers of paint and underlying substrates, and the surface processing device is a high-power laser scanner, originally designed for laser welding, which is used to remove coatings from aeronautical surfaces.

Description of the Drawings

[0008] Figure 1: Core Operational Principles. The symmetry of the Surface Property Analyzers allows surface classification data to be generated both immediately before and immediately after processing.