

A SYSTEM AND METHOD FOR EXECUTING A PAINTING ACTIVITY

DESCRIPTION OF THE INVENTION:

FIELD OF THE INVENTION

[0001] The disclosures made herein relate generally to the field of robotics and more particularly to an autonomous operations system for handling a task, for
5 example, a painting activity.

BACKGROUND OF THE INVENTION

[0002] Execution of activities post primary construction may include painting, sanding and the like. For skyscrapers execution of these activities by humans becomes very channelling based on multiple factors. These factors may include
10 consequence caused by altophobia, higher level of pollution at greater height, safety requirements for painters and passersby.

[0003] The issues involved with execution of the painting activity for the skyscrapers may further involve constriction of flawless temporary structures such as cabling infrastructure, fibre optics and other instruments to support the
15 painting activity. To set up these temporary structures take a lot of time, capital and resources. Further, maintaining communication with the painters at high altitude and uncertainties of weather make execution of the painting activity even more difficult.

[0004] Furthermore, the painters executing the painting activity for the
20 skyscrapers need pay attention to detail when painting high buildings since they are visible from a distance. This is a challenge since high rise buildings are hard to access. In case of a painting mistake; it is harder to reach the section with the mistake to correct the painting error.

[0005] Hence, there is a need for an autonomous operations system capable of operating simple hand tools to perform a task without a need for manual intervention. Further, the systems needs to execute the painting activity by eliminating all the problems as discussed above.

5 **SUMMARY OF THE INVENTION**

[0006] This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

[0007] The present invention provides an autonomous system for executing a painting activity. The system comprises at least one scanning unit configured to obtain topographical data for a geography to generate a primary scanning report. In some example embodiments, the scanning unit comprises one or more sensors associated with an imaging device to obtain one or more category of images associated with the geography to obtain the topographical data.

[0008] In some example embodiments, at least one remote device, configured to generate a secondary scanning report based on one or more verification parameters; In some example embodiments, the one or more verification parameters include procedural analysis of the primary scanning report to detect one or more anomalies, irregularities in patterns associated with the primary scanning report.

[0009] In some example embodiments, one or more mobile units configured to generate one or more tool reports based on status of the respective one or more tools and the status of the respective one or more tools include location data and resources data.

[0010] In some example embodiments, a central control system, configured to obtain the scanning report and the tool report and determine an action report

based on the obtained scanning report and tool report and the one or more mobile units obtain the action report to execute the painting activity. Further, in some example embodiments, the action report comprises one or more instructions on multi-planar movement for the respective one or more mobile units to execute the painting activity by eliminating one or more obstacles

[0011] In some example embodiments, the one or more mobile units comprise a plurality of vacuum impellers to enable anti-gravity motion of the one or more mobile units on a vertical surface. Further, each of the plurality of the vacuum impellers comprise a first actuator; and the plurality of the vacuum impellers are connected based on a linear drive associated with a worm gear and controlled by a second actuator to execute the painting activity based on the action report

[0012] In some example embodiments, comprises a modular supply unit, configured to deliver resources to the one or more mobile units, wherein rate of delivery of the resources match with rate of execution of the painting activity.

[0013] In some example embodiments, the central control system, obtains quality control data, transmitted by the at least one scanning unit during execution of the painting activity; Further, the central control system, generates a feedback data based on the quality control data; and the central control system, transmits the feedback data to the respective one or more mobile units

[0014] Some embodiments of the invention may provide a method for executing a painting activity. The method may comprise generating, a primary scanning report of a geography based on topographical data by a scanning unit; generating, a secondary scanning report based on one or more verification parameters; generating, one or more tool reports based on status of the respective tools by one or more mobile units, obtaining, the secondary scanning report and the tool report to determine an action report, by a central control system and transmitting, the action report to one or more mobile units to execute the painting activity. The method may further comprise delivering, by a modular supply unit, resources to the one or more mobile units, wherein rate of

delivery of the resources match with rate of execution of the painting activity. Furthermore the method may comprise obtaining quality control data, by the central control system, transmitted by the at least one scanning unit during execution of the painting activity, generating , the central control system, a
 5 feedback data based on the quality control data and transmitting, the central control system, the feedback data to the respective one or more mobile units.

[0015] To the accomplishment of the foregoing and related ends, the one or more aspects comprise the features hereinafter fully described and particularly pointed out in the claims. The following description and the drawings set forth
 10 in detail certain illustrative features of the one or more aspects. These features are indicative, however, of but a few of the various ways in which the principles of various aspects may be employed, and this description is intended to include all such aspects and their equivalents.

BRIEF DESCRIPTION OF DRAWINGS

15 **[0016]** The foregoing and other features of embodiments will become more apparent from the following detailed description of embodiments when read in conjunction with the accompanying drawings. In the drawings, like reference numerals refer to like elements.

20 **[0017]** In the following description, for the purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the embodiments of the invention. It is apparent, however, to one skilled in the art that the embodiments of the invention may be practiced without these specific details or with an equivalent arrangement. In other instances, well-known structures and devices are shown in block diagram form in order to avoid
 25 unnecessarily obscuring the embodiments of the invention.

[0018] FIG. 1 illustrates a network environment, for executing a painting activity by an autonomous system, according to one embodiment of the invention.

[0019] FIG 2 illustrates a diagram of a scanning unit of the autonomous system, according to one embodiment of the invention.

[0020] FIGs.3 illustrates an operational scenario of executing the painting activity, in accordance with an example embodiment.

5 [0021] FIGs.4A-4B illustrates construction and assembly of the one or more mobile units (103), associated with execution of the painting activity.

[0022] FIGs.5A-5B illustrates the one or more mobile units comprising specific tools to execute specific tasks associated with the painting activity, in accordance with an example embodiment.

10 [0023] FIG. 6 illustrates one of the one or more mobile units to execute one of the specific tasks associated with the painting activity, in accordance with an example embodiment.

[0024] FIG. 7 illustrates a flowchart depicting a method for executing a painting activity, in accordance with an example embodiment.

15 DETAILED DESCRIPTION OF THE INVENTION

[0025] Reference will now be made in detail to the description of the present subject matter, one or more examples of which are shown in figures. Each example is provided to explain the subject matter and not a limitation. Various changes and modifications obvious to one skilled in the art to which the invention pertains are deemed to be within the spirit, scope and contemplation of the invention.

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[0026] In the present disclosure the problem of humans oriented high altitude painting activity is executed by an autonomous system. A primary object of the invention is to execute a painting activity based on co-ordinated action of all autonomous system components. Further object of the invention is to ensure effective execution of the painting activity by eliminating temporary construction. Another object of the invention is to use a swarm of robots (i.e.

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autonomous system components) to execute the painting activity. Another object of the invention is to enable effective communication to eliminate errors. Another object of the invention is to use wall climbing robots with tools to execute the painting activity, whereas the wall climbing robot is instructed based on real time monitoring.

[0027] As used in the application, the term ‘circuitry’ or ‘circuit’ refers to all of the following: (a) hardware-only circuit implementations (such as implementations in only analog and/or digital circuitry) and (b) to combinations of circuits and software (and/or firmware), such as (as applicable): (i) to a combination of processor(s) or (ii) to portions of processor(s)/software (including digital signal processor(s)), software, and memory(ies) that work together to cause an apparatus, such as a mobile phone or server, to perform various functions) and (c) to circuits, such as a microprocessor(s) or a portion of a microprocessor(s), that require software or firmware for operation, even if the software or firmware is not physically present.

[0028] This definition of ‘circuitry’ applies to all uses of this term in this application, including in any claims. As a further example, as used in this application, the term “circuitry” would also cover an implementation of merely a processor (or multiple processors) or portion of a processor and its (or their) accompanying software and/or firmware. The term “circuitry” would also cover, for example and if applicable to the particular claim element, a baseband integrated circuit or applications processor integrated circuit for a mobile phone or a similar integrated circuit in server, a cellular network device, or other network device.

[0029] The word “exemplary” is used herein to mean “serving as an example, instance, or illustration.” Any aspect described herein as “exemplary” is not necessarily to be construed as preferred or advantageous over other aspects.

[0030] In this description, the term “application” may also include files having executable content, such as: object code, scripts, byte code, markup language

files, and patches. In addition, an “application” referred to herein, may also include files that are not executable in nature, such as documents that may need to be opened or other data files that need to be accessed.

[0031] The term “content” may also include files having executable content, such as: object code, scripts, byte code, markup language files, and patches. In addition, “content” referred to herein, may also include files that are not executable in nature, such as documents that may need to be opened or other data files that need to be accessed.

[0032] As used in this description, the terms “component,” “database,” “module,” “system,” and the like are intended to refer to a computer-related entity, either hardware, firmware, a combination of hardware and software, software, or software in execution. For example, a component may be, but is not limited to being, a process running on a processor, a processor, an object, an executable, a thread of execution, a program, and/or a computer. By way of illustration, both an application running on a computing device and the computing device may be a component. One or more components may reside within a process and/or thread of execution, and a component may be localized on one computer and/or distributed between two or more computers. In addition, these components may execute from various computer readable media having various data structures stored thereon. The components may communicate by way of local and/or remote processes such as in accordance with a signal having one or more data packets (e.g., data from one component interacting with another component in a local system, distributed system, and/or across a network such as the Internet with other systems by way of the signal).

[0033] In this description, the terms “communication device,” “wireless device,” “wireless telephone,” “wireless communication device,” and “wireless handset” are used interchangeably. With the advent of third generation (“3G”) wireless technology and four generation (“4G”), greater bandwidth availability has enabled more portable computing devices with a greater variety of wireless

capabilities. Therefore, a portable computing device may include a cellular telephone, a pager, a PDA, a smartphone, a navigation device, or a hand-held computer with a wireless connection or link.

[0034] FIG. 1 illustrates network environment, for executing a panting activity by an autonomous system, according to one embodiment of the invention. Throughout the disclosure the network environment and the autonomous system may interchangeably be used with the reference numeral (100). Referring now to the drawings, FIG. 1 illustrates an environment (100) within which various forms of data are generated and processed to execute the painting activity by the autonomous system and a method of using thereof can be implemented. The environment (100) may include a scanning unit (101), one or more mobile units (103), a central control system (105), a remote device (109) and a network (107). Throughout the disclosure the scanning unit (101), the one or more mobile units (103), the central control system (105), the remote device (109) may collectively be referred as autonomous system components. The scanning unit (101) may be communicatively coupled to the central control system (105) and the remote device (109). Further, in some example embodiment the scanning unit may be communicatively coupled with the one or more mobile units (103). The communicative coupling may be performed using a network (107). In some example embodiment, based on the communicative coupling the autonomous system components may establish a full duplex communication amongst each other.

[0035] The network 107 may include the Internet or any other network capable of communicating data between devices. Suitable networks may include or interface with any one or more of, for instance, a local internet, a PAN (Personal Area Network), a LAN (Local Area Network), a WAN (Wide Area Network), a MAN (Metropolitan Area Network), a virtual private network (VPN), a storage area network (SAN), a frame relay connection, an Advanced Intelligent Network (AIN) connection, a synchronous optical network (SONET) connection, a digital T1, T3, E1 or E3 line, Digital Data Service (DDS)

connection, DSL (Digital Subscriber Line) connection, an Ethernet connection, an ISDN (Integrated Services Digital Network) line, a dial-up port such as a V.90, V.34 or V.34bis analog modem connection, a cable modem, an ATM (Asynchronous Transfer Mode) connection, or an FDDI (Fiber Distributed Data Interface) or CDDI (Copper Distributed Data Interface) connection. Furthermore, communications may also include links to any of a variety of wireless networks, including WAP (Wireless Application Protocol), GPRS (General Packet Radio Service), GSM (Global System for Mobile Communication), CDMA (Code Division Multiple Access) or TDMA (Time Division Multiple Access), cellular phone networks, GPS (Global Positioning System), CDPD (cellular digital packet data), RIM (Research in Motion, Limited) duplex paging network, Bluetooth radio, or an IEEE 802.11-based radio frequency network. The network 110 can further include or interface with any one or more of an RS-232 serial connection, an IEEE-1394 (Firewire) connection, a Fiber Channel connection, an IrDA (infrared) port, a SCSI (Small Computer Systems Interface) connection, a Universal Serial Bus (USB) connection or other wired or wireless, digital or analog interface or connection, mesh or Digi® networking.

[0036] In an alternative embodiment, dedicated hardware implementations, such as application specific integrated circuits, programmable logic arrays and other hardware devices, can be constructed to implement one or more of the methods described herein. Applications that may include the apparatus of various embodiments can broadly include a variety of electronic and computer systems. One or more embodiments described herein may implement functions using two or more specific interconnected hardware modules or devices with related control and data signals that can be communicated between and through the modules, or as portions of an application-specific integrated circuit. Accordingly, the present system encompasses software, firmware, and hardware implementations.

[0037] In accordance with an embodiment, each of the autonomous system components may comprise a communication unit and a control unit (not shown). The communication unit of each of the components may be connected to the network (107) to fetch and transmit data. Further, the control unit of each of the autonomous system components comprises a dedicated processor and a memory (not shown). The dedicated processor and the memory execute one or more required tasks based on the data fetched by the respective autonomous system components. The one or more tasks executed by each of the processors of the autonomous system components may be explained in detail in further parts of the disclosure.

[0038] In some example embodiments, the processor may be of any type of processor, such as 32-bit processors (In general n- bit processor, value of n ranges from 2^4 to 2^8) using a flat address space, such as a Hitachi SH1, an Intel 80386, an Intel 960, a Motorola 68020 (or other processors having similar or greater addressing space). Processor types other than these, as well as processors that may be developed in the future, are also suitable. The processor may include general processor, x86, x86-64, ARM, RISC-V, ISA based processors, Digital Signal Processing (DSP) chip, an Application Specific Integrated Circuit (ASIC), Field Programmable Gate Arrays (FPGAs), etc.), firmware or a combination thereof.

[0039] Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and anyone or more processors of any kind of digital computer. Generally, a processor receives instructions and data from a read only memory or a random-access memory or both. The essential elements of a computer are a processor for performing instructions and one or more memory devices for storing instructions and data. Generally, a computer also includes, or be operatively coupled to receive data from or transfer data to, or both, one or more mass storage devices for storing data, e.g., magnetic, magneto optical disks, or optical disks. However, a computer need not have such devices. Moreover, a computer

can be embedded in another device, e.g., a mobile telephone, a personal digital assistant (PDA), a mobile audio player, a GPS receiver, to name just a few. Computer readable media suitable for storing computer program instructions and data include all forms of non-volatile memory, media, and memory devices, including by way of example semiconductor memory devices, e.g., EPROM, EEPROM, and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto optical disks; and CD ROM and DVD-ROM disks. The memory may be a non-transitory medium such as a ROM, RAM, flash memory, etc. The processor and the memory can be supplemented by, or incorporated in, special purpose logic circuitry.

[0040] The processes and logic flows described in the specification can be performed by one or more programmable processors executing one or more computer programs to perform functions by operating on input data and generating output. The processes and logic flows can also be performed by, and apparatus can also be implemented as, special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application specific integrated circuit).

[0041] In accordance with an embodiment, the memory includes both dynamic memory (e.g., RAM, magnetic disk, writable optical disk, etc.) and static memory (e.g., ROM, CD-ROM, etc.) for storing executable instructions that when executed perform the inventive steps described further in the document.

[0042] In accordance with an embodiment, network includes one or more networks such as a data network, a wireless network, a telephone network, or any combination thereof. It is contemplated that the data network may be any local area network (LAN), metropolitan area network (MAN), wide area network (WAN), a public data network (e.g., the Internet), short range wireless network, or any other suitable packet-switched network, such as a commercially owned, proprietary packet-switched network, e.g., a proprietary cable or fiber-optic network, and the like, or any combination thereof. In addition, the wireless

network may be, for example, a cellular network and may employ various technologies including enhanced data rates for global evolution (EDGE), general packet radio service (GPRS), global system for mobile communications (GSM), Internet protocol multimedia subsystem (IMS), universal mobile
 5 telecommunications system (UMTS), etc., as well as any other suitable wireless medium, e.g., worldwide interoperability for microwave access (WiMAX), Long Term Evolution (LTE) networks, code division multiple access (CDMA), wideband code division multiple access (WCDMA), wireless fidelity (Wi-Fi), wireless LAN (WLAN), Bluetooth®, Internet Protocol (IP) data casting,
 10 satellite, mobile ad-hoc network (MANET), and the like, or any combination thereof.

[0043] Although the present specification describes components and functions that may be implemented in particular embodiments with reference to particular standards and protocols, the invention is not limited to such standards and
 15 protocols. For example, standards for Internet and other packet switched network transmission (e.g., TCP/IP, UDP/IP, HTML, HTTP, HTTPS) represent examples of the state of the art. Such standards are periodically superseded by faster or more efficient equivalents having essentially the same functions. Accordingly, replacement standards and protocols having the same or similar
 20 functions as those disclosed herein are considered equivalents thereof.

[0044] In a preferred example embodiment, the autonomous system components perform various tasks in co-ordination with each other. All the autonomous system components generate data that is ultimately necessary to execute the painting activity. The execution of painting activity starts with the
 25 scanning unit collecting data. Working of the scanning unit is explained in Fig. 2.

[0045] FIG 2 illustrates a diagram of the scanning unit of the autonomous system, according to one embodiment of the invention. The scanning unit may comprise a support base (201) supporting a rotatable head (203) which carries

an imaging device (203) and a range finder (not shown). The support base (201) includes but not limited to a tripod, monopod, pedestal or any other stable base capable of supporting the other components of the scanning unit (101). The rotatable head (203) includes an actuator (not shown) such as stepper motor,
 5 capable of rotating the head (203) around 360°.

[0046] In some example embodiments, the scanning unit (101) may obtain topographical data for a geography where the painting activity need to be executed. The topographical data of the geography may be captured as video images as the head (203) of the scanning unit (101) rotates. Further, the
 10 processor associated with the scanning unit (101) generates a primary scanning report based on the topographical data. The primary scanning report may comprise details of the painting activity to be executed. Details of the painting activity may include but not limited to, region where coloring needs to be performed, specific area for performing sanding, placement of objects (i.e.
 15 windows) on the geography associated with the painting activity etc.

[0047] In a preferred embodiment, the imaging device (205) includes one or more charge coupled device (CCD) sensors or complementary metal-oxide-semiconductor (CMOS) sensors capable of capturing visible light images, to capture the topographical data. Alternatively, the imaging device (203) may
 20 include one or more sensors capable of capturing non-visible radiation images such as infrared images, ultrasound images, etc. For example, the imaging device (203) may capture non-visible light images of rough patches on a wall.

[0048] The range finder is a laser-based or ultrasound-based range finder for measuring a distance between the scanning unit (101) and a task location. For
 25 example, once a rough patch on a wall surface is identified from an image, the range finder determines a distance between the scanning unit and the identified patch.

[0049] In some example embodiment, the primary scanning report may be transmitted to a remote device (109) to generate a secondary scanning report.

The remote device may be a user operated system, wherein the primary scanning report may be processed by the processor associated with the remote device (109). The primary scanning report may be processed based on one or more verification parameters. The one or more verification parameters may include
 5 analysis of the video images by the user based on a procedural protocol, identification of irregularities in patterns obtained using the infrared and/or the ultrasound images. In some example embodiments, the scanning unit (101) may further comprise a GPS sensor to associate a position data with the topographical data. Additionally, the communication unit of the scanning unit
 10 (101) may communicate with the mobile unit (103) and the central control unit (105). In some example embodiment the scanning unit (101) may be a drone.

[0050] In some example embodiment, the user may also provide some additional data associated with the painting activity, such as color selection, pattern selection etc to the primary scanning report, using the remote device
 15 (109). Further, FIG. 3 explains transmission of one or more generated tool reports by the one or more mobile units (103), towards the central control unit (105) to generate the action report and there by execute the painting activity.

[0051] FIG.3 illustrates an operational scenario of executing the painting activity, in accordance with an example embodiment of the invention. As seen
 20 in Fig. 2, the scanning report (i.e. primary scanning report and/or the secondary scanning report) is transmitted to the central control system (105)

[0052] Further, in some example embodiments, each of the mobile units (103A to 103D as shown in Fig. 3) may perform the same action, associated with the painting activity. Throughout the disclosure, each of the mobile units (103A to
 25 103D) may be collectively referred with reference numeral (103). In some other example embodiment, each of the mobile units (103) may perform different action, associated with the painting activity. Before execution of the painting activity, the processor associated with each of the one or more mobile units (103) generate the respective tool reports based on status of respective one or

more tools, the status of the respective one or more tools include location data and resources data. In some example embodiments, the tool report may also include information on type of the tool carried by the respective mobile unit of the one or more mobile units (103). Parts of the one more mobile units (103) responsible for fetching the respective location data and resources data is explained in further parts of the disclosure.

[0053] In some example embodiment, the generated one or more tool reports are transmitted to the central control system (105). Further, the central control system (105) generates the action report based on the secondary scanning report and the one or more tool reports. In some example embodiment, the central control system (105) transmits the action report to the one or more mobile units (103) to control movements of the one or more mobile units (103) and thereby execute one or more tasks associated with the painting activity. In some example embodiments, the generation of the scanning reports and the one or more tool reports may occur in parallel at their respective autonomous system components.

[0054] Consider an example scenario, where the painting activity needs to be executed at 4th floor of a building Here the painting activity may include sanding operation and coloring operation. Initially, a scanning report is generated and transmitted to the central control system (105), by the scanning unit (101). In this case the scanning unit (101) may be a drone and the scanning report may also include information provided by a user (i.e. information on color selection, pattern selection etc). Parallely, the tool reports of the respective mobile units (103) are generated and sent to the central control unit (105). The central control system (105) transmits the action reports to the respective mobile units (103) to execute specific tasks. In this case, there are two mobile units, which are called sanding robot and painting robot.

[0055] Further, the execution of the painting activity may closely be monitored by the scanning unit (101) and obtain multiple video images during the execution of the painting activity. This may be referred as quality control data.

Further, the quality control data may be processed by the central control system (105) to generated feedback data. The feedback data may be transmitted to the respective mobile unit of the one or more mobile units (103) to rectify errors in case some errors have been occurred during the painting activity. For example,
 5 the errors may be discontinuous painting operation or sanding operation etc.

[0056] In some example embodiment, The central control system (105) may be a desktop computer, portable computer, smartphone or server located near the environment or at a remote location. Alternatively, the central control system (105) may also be a cloud server. The central control system (105) includes an
 10 image processing model for processing the images captured by the scanning unit (101). The image processing model is an artificial intelligence (AI)-based model, preferably a machine learning model.

[0057] Before loading the image processing model into the central control system (105), the image processing model is trained using a training dataset
 15 comprising a set of manually labeled images, wherein the images are manually analyzed and classified by one or more experts based on one or more tasks to be performed within a location captured in the corresponding image.

[0058] In some example embodiment, the data received from the scanning unit (101) and the one or more mobile units (103) may also include but not limited to
 20 power requirements for performing an assigned task and power availability, which enable the central control system (101) to optimize the plan accordingly, so that the tasks are completed without any interruption due to power failure in any of the one or more mobile units (103) or scanning unit (101). In some example embodiment, the central control system (105) may divide a task into
 25 multiple sub-tasks to be executing the painting activity. For example, sanding operation on a 10 sq/ft * 10 sq/ft area may be divided into two sanding robots to execute the activity faster. Further, this also enables a high degree of flexibility to execute the painting activity.

[0059] In some example embodiments, the action report generated by the central control system (105) comprises instructions for each of the one or more mobile units (103) to perform multi-planar movements and thereby execute a specific task. The multi-planar movements and the specific tasks executed by the one or more mobile units (103), based on the action report is explained in the Figs. 4-5.

[0060] FIGs. 4A-4B illustrates construction and assembly of the one or more mobile units (103), associated with execution of the painting activity. Further, Fig. 4A shows a top-view of one of the one or more mobile units (103A) based on general construction and assembly. Throughout the disclosure, the one or more mobile units (103) may be referred as wall climbing robots. Further, the mobile unit (103) comprises a multi-part casing (401) housing a dual suction mechanism (403) connected by a linear drive (405). Further, a task specific tool (407) is placed on the casing (401) and a power source (not shown).

[0061] In some example embodiments, dual suction mechanism includes at least two vacuum impellers, supported by respective DC/BLDC motor. The at least two vacuum impellers further comprise a suction cup respectively. Further, each of the suction cups are made of microfiber or rubber, such that surface on which the vacuum impellers are placed, affected by movement of the mobile unit (103A). The mobile unit (103A) may be a wall climbing robot, which may be placed vertically on the wall against gravity using the vacuum impellers enabled suction cups. During ON state (i.e. both the vacuum propellers are on), the mobile unit (103) may withstand natural resistances such as wind and/or rain etc.

[0062] Further, Fig. 4B illustrates a side-view of the mobile unit (103A). The side-view explicitly shows suction cups (403B) associated with the respective vacuum impellers of the dual suction mechanism (403A). In some example embodiments, the casing 401 may cover a multi-part locking mechanism, where the first part of the casing covers one of the vacuum impellers and other second

part of the casing may cover the other vacuum impeller, to enable dynamic assembly of the parts (not shown). In some example embodiment, the casing (401) may be comprise machined metal parts, 3D printed parts and carbon fiber.

- [0063]** In some example embodiment, the mobile unit (103A) receives an action report, which requires the mobile unit (103A) to move up by two units and move right by one unit. In some example embodiment, one unit may be two centimeters. Consider the vacuum impeller near to the task specific tool (407) be referred as top suction and the vacuum impeller farther away from the task specific tool (407) be referred as bottom suction.
- [0064]** In some example embodiment, assume the top suction mechanisms and the bottom suction mechanisms (collectively referred as dual suction mechanism 403A) are connected by an extendable linear drive (405), which is controlled by a first actuator (i.e. .DC motor). The linear drive enabled dual suction mechanism executes caterpillar based movement to move up/ move down and move right/ move left. To move up by one unit from the default position, the top suction is disabled and only the bottom suction is enabled. The linear drive (405) extends to push up the top suction. Once the top suction reaches the predetermined point, it engages and the bottom suction is disabled. Further the linear drive pulls up the bottom suction. This is continued till the desired point is reached. In the present case the desired point is two units. Hence, the process may be executed two. In some other example embodiment, converse of the above process may be performed to move left by one unit.

- [0065]** In some example embodiment, to move right by one unit the bottom suction is engaged and the top suction is released. Further, by using a worm gear (not shown) the top suction is pivoted by 90 degrees clockwise. Furthermore, the top suction is on the right of the bottom suction, and the mobile unit (103A) is parallel to the ground. To move right, the top (i.e. right) suction is engaged, and the bottom (i.e. left) suction is disengaged and pulled to the right. Further, the bottom (i.e. left) suction is engaged & the top (i.e. bottom) suction

disengaged. The linear drive is pushed to the right. This constitutes one step. Converse of the move right step is performed to move left.

[0066] The above mentioned steps enable the multi-planar movement of the mobile unit (103A). In some example embodiment, the mobile unit (103A) may
 5 comprise a camera to detect and avoid obstacles. In some other example embodiments the action report comprises the path of travel to reach specified destination by avoiding all possible obstacles.

[0067] In some of the example embodiments, the mobile unit (103A) comprises
 10 inertial measurement unit (IMU) sensors (not shown) to know the altitude of the mobile unit (103A) and a location device such as global positioning system (GPS) (not shown) sensor for capturing location of the mobile unit (103A). These sensors may be placed in periphery of the casing (401). In some example embodiment, the mobile unit (103A) may comprise one or more sensors to
 15 tracks available resources, for example paint. The processor associated with the mobile unit (103A) generates tool report based on the above parameter. Further, the mobile unit (103A) may communicate with the central control system (105) and/or the scanning unit (101) to execute the painting activity. Throughout the disclosure, the one or more mobile units (103) are wall climbing robots, which
 20 perform such action based on the linear drive (405), enabled vacuum impellers (403). Further, throughout the disclosure the wall associated with the wall climbing robots, may be considered as a vertical surface and action of wall climbing may be considered as anti-gravity movement. Throughout the disclosure, the suction mechanism comprising vacuum impeller (403A and/or 403B) may collectively be referred with reference numeral (403) .Furthermore,
 25 execution of the painting activity by the mobile unit (103), such as sanding and/or coloring are explained in the Fig. 5

[0068] **FIGs.5A-5B** illustrates the one or more mobile units comprising specific tools to execute the specific tasks associated with the painting activity, in accordance with an example embodiment. In some example embodiment,

consider a coloring task needs to be performed on a specific region. In that case, as per Fig. 5A a mobile unit (103A) comprising a roller tool receives an action report, by the central control system (105). Assume based on discussion of Fig. 4, the mobile unit (103A) reaches the destination. In some example
 5 embodiments, the action report for the mobile unit (103A) comprising a roller tool (501A) (i.e. coloring robot) may further comprise instructions to determine the rate at which the paint is supplied into the roller through a pipe (503) in real time basis variables by a modular supply unit, pumping paint from the ground level. The action report may further comprise instructions to determine the
 10 length of each roller stroke, and the speed of each stroke and send alerts when the paint container (i.e. modular supply unit) is empty or below safety stock levels.

[0069] In some example embodiments, using a 3-D space map of the geography associated with the painting activity, the user may be able to mark out areas not
 15 to be painted, and to monitor completion of the painting activity, material usage, estimated time for completion, estimated paint refilling time etc, based on a remote device (109). In case of Fig. 5B, the mobile unit (103B) comprises a sanding tool. The central control system (105) may transmit the action report to the mobile unit (103B) comprises a sanding tool (i.e. sanding robot) to execute
 20 the process of sanding at a specific location.

[0070] In some example embodiments, the roller tool (501A) may be associated with a robotic arm (not shown), to execute the process of coloring. Further, the mobile unit (103A) controls the movement of the roller using the robotic arm. The roller tool may removeably attached to the robotic arm and furthermore, the
 25 robotic arm may removeably be attached to the casing (501). In some example embodiment, the sanding tool (501B) may be associated with a robotic arm (not shown), to execute the process of sanding. Further, the mobile unit (103B) controls the movement of the roller using the robotic arm. Here, the robotic arm associated with the coloring process and the sanding process may or may not
 30 have same functionalities, configurations and placement. In some example

embodiment, the robotic arm associated with the coloring process may be connected on top part of the casing and whereas the robotic arm associated with sanding process may be connected on lower part of the casing.

[0071] FIG. 6 illustrates one of the one or more mobile units (103A) to execute one of the specific tasks associated with the painting activity, in accordance with an example embodiment. Here, the specific task execute by the mobile unit (103A) is coloring, using the roller tool (601) associated with the robotic arm (605). Throughout the disclosure the robotic arm (605) is same as the robotic arm mentioned in the Fig.5. Also, the pipe (503) of Fig, 5 is same as the pipe (603) of the Fig, 6. Further, Fig. 6 may be considered as a preferred embodiment of the mobile unit (103A) in view of Fig. 5A. Furthermore, supply of one or more resources (e.g. paint), to the roller (601) is carried out using the supply pipe (603). Movement of the roller (601) is controlled by the robotic arm (605) enabled by a motor (607). In some example embodiment, based on the action report, the processor associated with the mobile unit (103A), performs movement of the roller (601), using the motor (607) enabled robotic arm (605), perpendicular to the axis (600). In some example embodiment, the motor (607) may be a DC motor, servo motor, BLDC motor and the like. In some example embodiment, the robotic arm (605) may comprise multiple degrees of freedom to achieve movement in multiple axis. The Multi-planar movement of the mobile unit (103A) is executed using the pair of BLDC motors (609A and 609B) enabled dual suction mechanism as shown in Fig. 4. Throughout, the disclosure dual suction mechanism includes at least two vacuum impellers (611a and 611b), supported by respective DC/BLDC motor (609a and 609b). The at least two vacuum impellers (611a and 611b) further comprise a suction cup (613a and 613b) respectively. The mobile unit (103A) comprises a multi part casing (615a, 615b and 615c), housing the above mentioned parts as shown in the Fig. 7. The linear drive and the worm gear are placed inside the multipart casing (615). The multipart casing (615) provides flexibility to assemble and

disassemble the parts, also to provides increased protect and/or stability to the above mentioned parts.

[0072] FIG. 7 illustrates a flowchart depicting a method for executing a painting activity, in accordance with an example embodiment. At **step 701**,
 5 generating, a primary scanning report of a geography based on topographical data by a scanning unit. The scanning unit comprises one or more sensors associated with an imaging device to obtain one or more category of images associated with the geography to obtain the topographical data

[0073] In accordance with an embodiment, **at step 703**, the method may include
 10 generating, a secondary scanning report based on one or more verification parameters. Further, the one or more verification parameters include procedural analysis of the primary scanning report to detect one or more anomalies, irregularities in patterns associated with the primary scanning report.

[0074] In accordance with an embodiment, **at step 705** the method may include
 15 generating; one or more tool reports based on status of the respective tools by one or more mobile units Further, the status of the respective one or more tools include location data and resources data.

[0075] In accordance with an embodiment, the method may further include **at step 707**, obtaining, the secondary scanning report and the tool report to
 20 determine an action report, by a central control system. Further, the action report comprises one or more instructions on multi-planar movement for the respective one or more mobile units to execute the painting activity by eliminating one or more obstacles.

[0076] In accordance with an embodiment, the method may further include **at step 709**, transmitting the action report to one or more mobile units to execute
 25 the painting activity. Further, the one or more mobile units comprise a plurality of vacuum impellers to enable anti-gravity motion of the one or more mobile units on a vertical surface.

[0077] The many features and advantages of the invention are apparent from the detailed specification, and thus, it is intended by the appended claims to cover all such features and advantages of the invention which fall within the true spirit and scope of the invention. Further, since numerous modifications and variations will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation illustrated and described, and accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.