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(54) AN APPARATUS AND A METHOD FOR SELECTING A POSITION FOR A MINING VEHICLE

(57) Example embodiments provide an apparatus for selecting a position for a mining vehicle in a mine for drilling. The apparatus comprises at least one processor and at least memory, the at least one memory comprising instructions which, when executed by the at least one processor, cause the apparatus to select a drill plan associated with a tunnel line for a tunnel to be excavated; select a position of a navigation plane for the drill plan with respect to the tunnel line; determine a first position for the mining vehicle based on the drill plan and the position of the navigation plane; obtain information on a plurality of predefined variations of the first position; determine a plurality of second position for the mining vehicle based on the first position and the information on the plurality of variations; and select, from the plurality of second positions, a target position for the mining vehicle based on the first position and at least one criterion.

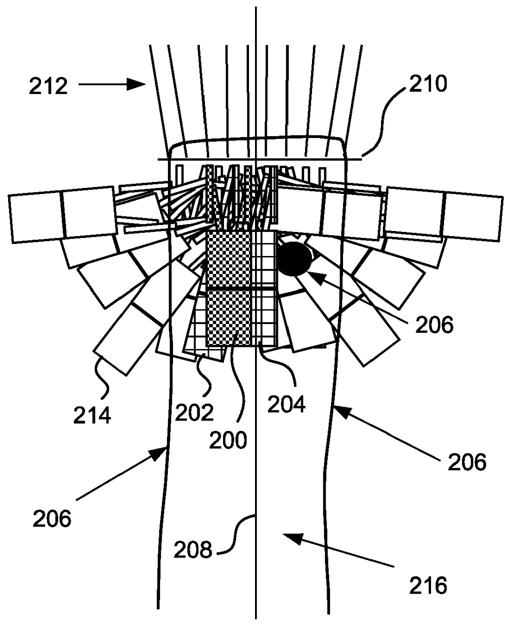

FIG. 2

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Description

TECHNICAL FIELD

[0001] The present application generally relates to a mining vehicle. In particular, some example embodiments of the present application relate to selecting a position for a mining vehicle.

BACKGROUND

[0002] In development drilling and tunnelling in mines, tunnels change all the time and advance after every blast. It may be challenging to operate a mining vehicle in the changing conditions in mines. Further, selecting an optimal depth location for a relative drilling pattern and selecting an optimal location for a drill rig to drill the pattern are challenging and effect the effectiveness of the tunneling process.

SUMMARY

[0003] 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 to limit the scope of the claimed subject matter.

[0004] Example embodiments may enable automatically selecting a position of a mining vehicle in a tunnel. The position may be selected such that the mining vehicle may be able to drive at the selected position and be placed there. Further, selection of a drill plan and a position of a navigation plane may be automated to improve efficiency and accuracy of drilling by the mining vehicle.

[0005] According to a first aspect, there is provided an apparatus for selecting a position of a mining vehicle in a mine for drilling, the apparatus comprising at least one processor and at least memory, the at least one memory comprising instructions which, when executed by the at least one processor, cause the apparatus to select a drill plan associated with a tunnel line for a tunnel to be excavated; select a position of a navigation plane for the drill plan with respect to the tunnel line; determine a first position for the mining vehicle based on the drill plan and the position of the navigation plane; obtain information on a plurality of predefined variations of the first position; determine a plurality of second positions for the mining vehicle based on the first position and the information on the plurality of predefined variations; and select, from the plurality of second positions, a target position for the mining vehicle based on the first position and at least one predefined criterion.

[0006] In an embodiment, selecting the drill plan comprises identifying a profile of the tunnel to be excavated and selecting the drill plan based on the profile.

[0007] In an embodiment, in addition or alternatively, the at least one memory further comprises instructions which, when executed by the at least one processor, cause the apparatus to identify the profile of the tunnel to be excavated based on a depth of the already excavated tunnel and direction of the tunnel to be excavated.

[0008] In an embodiment, in addition or alternatively, selecting a position of the navigation plane for the drill plan comprises varying a position of the navigation plane in tunnel depth direction until a number of starting points of drill holes in the drill plan located inside the excavated tunnel exceeds at least one predefined limit.

[0009] In an embodiment, in addition or alternatively, the plurality of predefined variations comprises a change in at least one of a position, a heading or an articulation of the mining vehicle in relation to the first position.

[0010] In an embodiment, in addition or alternatively, the at least one predefined criterion comprises information on at least one obstacle located at the first position or at least one of the plurality of second positions.

[0011] In an embodiment, in addition or alternatively, the at least one predefined criterion comprises that each drill hole of the drill plan is reachable for drilling by the mining vehicle.

[0012] In an embodiment, in addition or alternatively, the at least one criterion comprises that each drill hole of the drill plan is drillable by the mining vehicle based on locations, depths and directions of the drill holes of the drill plan, and dimensions of the machine parts.

[0013] In an embodiment, in addition or alternatively, the at least one criterion comprises a priority order for the plurality of second positions.

[0014] In an embodiment, in addition or alternatively, the priority order for the plurality of second positions is determined based on distance from the first position.

[0015] In an embodiment, in addition or alternatively, the at least one predefined criterion comprises space required by the mining vehicle.

[0016] In an embodiment, in addition or alternatively, the at least one memory further comprises instructions which, when executed by the at least one processor, cause the apparatus to determine a new target position in response to determining, based on floor map data, that the mining vehicle is unable to drive to the target position.

[0017] According to a second aspect, there is provided a computer-implemented method for selecting a position of a mining vehicle in a mine for drilling. The method comprises selecting a drill plan associated with a tunnel line for a tunnel to be excavated; selecting a position of a navigation plane for the drill plan with respect to the tunnel line; determining a first position for the mining vehicle based on the drill plan and the position of the navigation plane; obtaining information on a plurality of predefined variations of the first position; determining a plurality of second positions for the mining vehicle based on the first position and the information on the plurality of predefined variations; and selecting, from the plurality of second positions, a target position for the mining vehicle based on the first position and at least one predefined criterion.

[0018] According to a third aspect, there is provided a computer-program product comprising instructions which, when executed by a computer, cause the computer to carry out the method according to the second aspect.

[0019] Many of the attendant features will be more readily appreciated as they become better understood by reference to the following detailed description considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The accompanying drawings, which are included to provide a further understanding of the example embodiments and constitute a part of this specification, illustrate example embodiments and together with the description help to explain the principles of the example embodiments. In the drawings:

FIG. 1 illustrates an example of an apparatus configured to practice at least one example embodiment;
FIG. 2 illustrates an example of selecting a target position for a mining vehicle in a mine by an apparatus for drilling according to an example embodiment;
FIG. 3 illustrates another example of selecting a target position for a mining vehicle in a mine by an apparatus according to an example embodiment;
FIG. 4 illustrates an example of a plurality of tunnels having a plurality of profiles and associated drill plans, according to an example embodiment;
FIG. 5 illustrates an example of selecting a position of a navigation plane for a drill plan by an apparatus according to an example embodiment;
FIG. 6 illustrates an example of a method for selecting a position of a mining vehicle in a mine for drilling, according to an example embodiment.

[0021] Like references are used to designate like parts in the accompanying drawings.

DETAILED DESCRIPTION

[0022] Reference will now be made in detail to example embodiments, examples of which are illustrated in the accompanying drawings. The detailed description provided below in connection with the appended drawings is intended as a description of the present examples and is not intended to represent the only forms in which the present examples may be constructed or utilized. The description sets forth the functions of the example and a possible sequence of operations for constructing and operating the example. However, the same or equivalent functions and sequences may be accomplished by different examples.

[0023] Predefining a location for a mining vehicle to drive to for drilling may be difficult. Driving the mining vehicle to a wrong position for drilling may mean that booms of the mining vehicle cannot reach to drill all drill holes planned in a drill plan. Further, the drilling may be caused to be more difficult than needs to be due to the wrongly selected position of the mining vehicle. A human driver of the mining vehicle may estimate the best location to start drilling and test manually for reach of the booms to drill the drill holes. If the mining vehicle cannot reach to drill all drill holes, the mining vehicle may need to be moved which means lost time and effort.

[0024] For example, there may be something in a tunnel that prevents the mining vehicle from being able to park in a desired position such as the center of the tunnel. The center of the tunnel may be a desired position for drilling. An obstacle preventing the mining vehicle from parking to the desired position can be as simple as muck remaining from a mucking phase of the blast or there may be a hole on the floor of the tunnel, for example.

[0025] In an example embodiment, an apparatus is configured to automatically select a target position for the mining vehicle based on a first position, at least one second position and at least one criterion. The apparatus may be further configured to provide navigation instructions for the mining vehicle to arrive at the selected target position from a current position of the mining vehicle. The target position of the mining vehicle may be selected automatically in a tunnel based on an up-to-date mapping result of a mine model and a drill plan. The target position may be accessible to the mining vehicle and not limited by ground conditions, obstacles or height restrictions in the tunnel. Hence, it may be enabled that the mining vehicle reaches to drill the drill holes of the drill plan in a desired way. In case of an automated or autonomous mining vehicle, the mining vehicle may be provided with instructions to drive to the selected target position. Alternatively, the instructions to arrive to the target position may be provided for a human driver of the mining vehicle.

[0026] FIG. 1 illustrates an example of an apparatus 100 configured to practice at least one example embodiment.

[0027] The apparatus 100 may comprise at least one processor 102. The at least one processor 102 may comprise, for example, one or more of various processing devices, such as for example a co-processor, a microprocessor, a controller, a digital signal processor (DSP), a processing circuitry with or without an accompanying DSP, or various other processing devices including integrated circuits such as, for example, an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), a microcontroller unit (MCU), a hardware accelerator, a special-purpose computer chip, or the like.

[0028] The apparatus 100 may further comprise at least one memory 104. The memory 104 may be configured to store, for example, computer program code 106 or the like, for example, operating system software and application software. The memory 104 may comprise one or more volatile memory devices, one or more nonvolatile memory devices, and/or a combination thereof. For example, the memory may be embodied as magnetic storage devices (such as hard disk drives, magnetic tapes, etc.), optical magnetic storage devices, or semiconductor memories (such as mask ROM, PROM (programmable ROM), EPROM (erasable PROM), flash ROM, RAM (random access memory), etc.).

[0029] The apparatus 100 may further comprise a communication interface 108 configured to enable the apparatus 100 to transmit information to and/or receive information from other devices. The apparatus may be configured to receive information, for example, from a positioning system of a mining vehicle. Information may comprise, for example, data relating to operation of the mining vehicle. The apparatus 100 may be configured to receive data from a server storing at least one of a mine model, a floor map or a plurality of drill plans. The apparatus 100 may be configured to transmit data, for example, to a control device of the mining vehicle.

[0030] The communication interface 108 may be configured to provide at least one wireless radio connection, such as for example a 3GPP mobile broadband connection (e.g. 3G, 4G, 5G). However, the communication interface 108 may be configured to provide one or more other type of connections, for example a wireless local area network (WLAN) connection such as for example standardized by IEEE 802.11 series or Wi-Fi alliance; a short range wireless network connection such as for example a Bluetooth, NFC (near-field communication), or RFID connection; a wired connection such as for example a local area network (LAN) connection, a universal serial bus (USB) connection or an optical network connection, or the like; or a wired Internet connection. The communication interface 108 may comprise, or be configured to be coupled to, at least one antenna to transmit and/or receive radio frequency signals. One or more of the various types of connections may be also implemented as separate communication interfaces, which may be coupled or configured to be coupled to a plurality of antennas.

[0031] When the apparatus 100 is configured to implement some functionality, some component and/or components of the apparatus 100, such as for example the at least one processor 102 and/or the memory 104, may be configured to implement this functionality. Furthermore, when the at least one processor 102 is configured to implement some functionality, this functionality may be implemented using program code 106 comprised, for example, in the memory 104.

[0032] The functionality described herein may be performed, at least in part, by one or more computer program product components such as software components. According to an embodiment, the apparatus 100 comprises a processor 102 or processor circuitry, such as for example a microcontroller, configured by the program code 106 when executed to execute the embodiments of the operations and functionality described. Alternatively, or in addition, the functionality described herein can be performed, at least in part, by one or more hardware logic components. For example, and without limitation, illustrative types of hardware logic components that can be used include Field-programmable Gate Arrays (FPGAs), application-specific Integrated Circuits (ASICs), application-specific Standard Products (ASSPs), System-on-a-chip systems (SOCs), Complex Programmable Logic Devices (CPLDs), Graphics Processing Units (GPUs).

[0033] The apparatus 100 may comprise for example a server device, a client device, a mobile phone, a tablet computer, a laptop, or the like. In an embodiment, the apparatus 100 may comprise a mining vehicle. Although the apparatus 100 is illustrated as a single device it is appreciated that, wherever applicable, functions of the apparatus 100 may be distributed to a plurality of devices.

[0034] The apparatus 100 comprises means for performing at least one method described herein. In one example, the means comprises the at least one processor 102, the at least one memory 104 including program code 106 configured to, when executed by the at least one processor 102, cause the apparatus 100 to perform the method.

[0035] FIG. 2 illustrates an example of selecting a target position 200 for a mining vehicle in a mine by an apparatus, according to an example embodiment. The target position 200 may be determined, for example, by the apparatus 100. The target position may refer to a most suitable position of the mining vehicle in a mine for performing a certain task. A mining vehicle may be configured to perform drilling, bolting and/or tunnelling tasks in a mine. For example, drilling may be performed by a rock drilling rig. A rock drilling rig is an example of a mining vehicle. The rock drilling rig may comprise at least one boom for drilling, such as 1 to 3 booms. The booms may be mounted on a carrier of the rock drilling rig. The apparatus 100 may comprise the rock drilling rig.

[0036] The apparatus 100 may be configured to select a drill plan 212 associated with a tunnel line 208 for a tunnel to be excavated.

[0037] A drill plan comprises drill hole information on holes to be drilled. Drill hole information may comprise, for example, a number of holes, locations of the holes, directions and/or lengths of holes to be drilled. A drill plan may define, for example, a starting point, a length and direction in a three-dimensional coordinate system for holes included in the drill plan. As another example, a drill plan may define a starting point and an end point for holes included in the drill plan. A drill plan may comprise information on selected holes or each hole to be drilled. A hole comprised in a drill plan may be called a drill hole.

[0038] A tunnel line may refer to a planned line of a tunnel. A tunnel design may determine a tunnel line to be excavated in a project coordinate system of a mine. Since a tunnel is excavated in rounds, a drill plan may be designed in advance for each round. A tunnel may refer to an excavated portion of a tunnel line. Although illustrated as a center line of a tunnel 216 in FIG. 2, the tunnel line 208 could be located at an edge of the tunnel 216 or even outside the tunnel 216. A tunnel line 208 may illustrate a reference line in a space relative to which excavation of the tunnel 216 may be done. A mine may be associated with a plurality of drill plans for the tunnel line 208. The plurality of drill plans may be associated with a plurality of tunnel profiles. A tunnel profile may indicate characteristics of a tunnel at a certain depth, such as an outline of the tunnel, a shape of the tunnel and/or a cross-sectional area of the tunnel.

[0039] In an embodiment, selecting a drill plan comprises identifying a profile of the tunnel to be excavated and selecting the drill plan based on the profile.

[0040] In an embodiment, the apparatus 100 is configured to identify the profile of the tunnel to be excavated based on a depth of the already excavated tunnel and direction of the tunnel to be excavated.

[0041] For example, the apparatus 100 may be configured to determine based on the tunnel line, what kind of a tunnel profile is associated to a detected depth. The apparatus 100 may be then configured to select a drill plan that has a matching profile with the tunnel profile associated with the detected depth. The apparatus 100 may be configured to prefer a drill plan comprising a name of the tunnel line in the drill plan if there exist multiple drill plans with the matching profile. The apparatus 100 may be configured to select a latest drill plan if there exist multiple drill plans comprising the name of the tunnel line.

[0042] The apparatus 100 may be configured to select the drill plan 212 from the plurality of drill plans, for example, based on at least one of a tunnel profile associated with the drill plan, a time stamp associated with a drill plan such as a latest drill plan for the tunnel line 208, a position of the mining vehicle with respect to the tunnel line 208, or a depth of the tunnel line 208.

[0043] The apparatus 100 may be further configured to select a position of a navigation plane 210 for the drill plan 212 with respect to the tunnel line 208. A navigation plane may comprise an imaginary plane comprising starting points of holes included in a drill plan. Lengths of the holes are defined based on the starting points of holes. The navigation plane may be also referred to as a start profile of the drill plan 212. The apparatus 100 may further be configured to obtain a mine model. The apparatus 100 may be configured to obtain the position of the navigation plane 210 in a coordinate system of the mine model.

[0044] In an embodiment, selecting a position of the navigation plane for the drill plan comprises varying a position of the navigation plane in tunnel depth direction until a number of starting points of the holes in the drill plan located inside the excavated tunnel exceeds at least one predefined limit.

[0045] The number of starting points may comprise, for example, an absolute number or a proportional number such as a percentage of the holes.

[0046] Varying a position of the navigation plane in tunnel depth direction may be referred to as navigation plane depth adjustment. In an embodiment, an aim of navigation plane depth adjustment is that the hole end points are inside unexcavated rock based on the up-to-date 3D mine model and that as many hole start points are inside the tunnel in the already excavated volume. This enables drilling holes to target length while maximizing advance.

[0047] The apparatus 100 may be configured to determine a first position 204 for the mining vehicle based on the drill plan 212 and the position of the navigation plane 210.

[0048] The first position may comprise, for example, an initial position of the mining vehicle, a default position of the mining vehicle, or the like. For example, the apparatus 100 may be configured to determine a center point and a heading of the drill plan 212 with respect to the tunnel line 208. The center point and the heading may be determined based on drill hole information obtained from the drill plan 212. The apparatus 100 may be configured to determine the first position 204 to be, for example, in align to the center point and the heading of the drill plan 212. The first position 204 may be aligned with the center point according to the heading of the drill plan 212. Hence, the first position 204 may be located in a same axis as the center point of the drill plan 212 and positioned to have the same heading as the drill plan 212. The heading of a drill plan may comprise a depth direction of the navigation plane. The depth direction may refer to a drilling direction. The apparatus 100 may be configured to determine the position of the navigation plane 210 with respect to a depth direction of the tunnel 216. The position of the navigation plane 210 may be defined as a peg number. The peg number may indicate a distance along the tunnel 216 to the navigation plane location 210.

[0049] The apparatus 100 may be further configured to determine the first position 204 based on dimensions of the mining vehicle and the position of the navigation plane 210. Based on the dimensions of the mining vehicle, the apparatus 100 may be configured to determine a distance between the position of the navigation plane 210 and a position of the mining vehicle such that each drill hole of the drill plan 212 is reachable for drilling by the mining vehicle. The dimensions of the mining vehicle may comprise at least one of dimensions of one or more carriers of the mining vehicle, dimensions of a boom base of the mining vehicle or a length of one or more booms of the mining vehicle. The boom base may be a part of the booms from which part the booms are attached to the carrier. The length of the booms may be determined from the attachment point of the boom base to the carrier to a drill bit of the booms in an extreme position. The extreme position may refer to a position where the booms are adjusted to a a minimum length. Hence, the apparatus 100 may be configured to determine the first position 204 to be located within the distance from the position of the navigation plane 210.

[0050] Alternatively, the apparatus 100 may be configured to use a default distance to a tunnel face for determining the first position 204. The apparatus 100 may be configured to obtain the default distance to tunnel face, for example, based on the dimensions of the mining vehicle. The default distance may comprise the length of one or more booms of the mining vehicle with an added margin. Different mining vehicles may have booms of different lengths, such as from 5 to 15 metres long booms. The margin may be, for example, 0,1 - 1,5 metres, such as 0,2 metres, 0,5 metres, 0,7 metres, or 1 metre. The lengths and the margin are an example, and the values may depend on the used mining vehicle. The tunnel face may refer to an end wall of a tunnel.

[0051] In an embodiment, the apparatus 100 is configured to obtain information on a plurality of predefined variations of the first position.

[0052] Information on a plurality of predefined variations in position may comprise, for example, a list of predefined variations in position of the mining vehicle in relation to at least one of the center point and heading of the drill plan 212 or the first position 204.

[0053] The plurality of predefined variations may comprise, for example, a change in at least one of a position, a heading or an articulation of the mining vehicle in relation to the default first position.

[0054] The apparatus 100 may be configured to compare the first position 204 to at least one second position 202 of the mining vehicle. The at least one second position may comprise, for example, at least one candidate position for the mining vehicle. A candidate position may comprise a predefined position for the mining vehicle.

[0055] The apparatus 100 may be configured to determine at least one second position 202 based on the first position 204. In an embodiment, the apparatus 100 is configured to determine a plurality of second positions 202 for the mining vehicle based on the first position 204 and the information on the plurality of variations.

[0056] The apparatus 100 may be configured to determine the at least one second position 202 based on the list of predefined variations in position of the mining vehicle in relation to at least one of the center point and heading of the drill plan 212 or the first position 204. The predefined variations in position may comprise at least one change in at least one of a position, a heading, or an articulation of the first position 204. For example, the apparatus 100 may be configured to determine the at least one second position by varying information on the position of the mining vehicle in relation to the first position 204 to at least one of to the left, right, or back with respect to the center point of the drill plan 212, the heading of the drill plan 212 and/or the position of the navigation plane 210 based on the predefined variations of position. The apparatus 100 may be further configured to determine the at least one second position 202 by varying at least one of heading or articulation of the mining vehicle in relation to the center point and heading of the drill plan 212 based on the predefined variations of position.

[0057] The apparatus 100 may be configured to determine a target position 200 for the mining vehicle based on the first position 204, the at least one second position 202 and/or at least one criterion. The target position 200 may indicate a most suitable position for drilling from a plurality of position options comprising the first position 204 and the at least one second position 202. The apparatus 100 may be configured to discard one or more position options based on the at least one criterion, such as one or more unsuitable second positions 214.

[0058] In an embodiment, the apparatus is configured to select, from the plurality of second positions, a target position for the mining vehicle based on the first position and at least one predefined criterion.

[0059] In an example embodiment, the at least one criterion relates to a suitability of the first position and/or the at least one second position of the mining vehicle for performing rock drilling based on the drill plan 212.

[0060] In an embodiment, the at least one predefined criterion comprises information on at least one obstacle located at the first position or at least one of the plurality of second positions.

[0061] For example, the at least one criterion may comprise information on one or more obstacles 206 located at the first position 204 or at the at least one second position 202. The apparatus 100 may be configured to obtain a floor map data of the mine model. Floor map data may comprise, for example, a traversability map comprising a floor map including additional information relating to height, floor slope, or the like. A traversability map may comprise, for example, data on a floor of the tunnel 216 with obstacle height, slope and roof height information coded into floor points. The apparatus 100 may be configured to determine if any of the first position 204 or the at least one second position 202 is located at a position of an obstacle 206 based on the traversability map. The obstacle 206 may comprise, for example, an obstacle on the floor, or a roof or a wall of the tunnel 216. The apparatus 100 may be also configured to determine a temporary traversability map based on a real-time data obtained from the mining vehicle, such as obstacles detected by the mining vehicle from surroundings of the mining vehicle.

[0062] In an embodiment, the at least one predefinend criterion comprises space required by the mining vehicle.

[0063] For example, the apparatus 100 may be configured to check position options in which the mining vehicle may be placed, for example, based on dimensions of the mining vehicle and the traversability map. For example, the apparatus 100 may be configured to obtain machine part envelopes of the mining vehicle. The machine part envelopes may comprise at least carrier envelopes. In general, an envelope is indicative of space required by a machine part or the mining vehicle in a current position. Space required by a machine part or the mining vehicle may comprise a margin added on outer dimensions of the machine part/mining vehicle. The apparatus 100 may be configured to discard the first position 204 or a second position 202, for example, when the machine part envelope contains space occupied by an obstacle having predetermined properties or when the machine part envelope is not located within the tunnel 216 based on the traversability map. The apparatus 100 may be configured to check, for example, if the machine part envelope is located at least partially inside walls of the tunnel 216 or overlapping with an obstacle or wall of the tunnel 216 at a second position 202 of the mining vehicle. Further, the apparatus 100 may be configured to check based on dimensions of the mining vehicle, for example, if there is an obstacle on the floor located below the machine part envelope and having a height above a predetermined limit or if the roof height prevents positioning the mining vehicle to the at least one second 202 or first position 204. Different parts of the mining vehicle (machine part envelopes of the complete machine envelope) may have different limitations in ground clearance/obstacle height or roof height requirements. The apparatus 200 may be configured to obtain the limitations associated with the dimensions of the mining vehicle.

[0064] In an embodiment, the at least one predefined criterion comprises that each drill hole of the drill plan is drillable by the mining vehicle based on locations, depths and directions of the holes of the drill plan, and dimensions of the machine parts.

[0065] In an embodiment, the at least one criterion may comprise a priority order. For example, the first position 204 may have a highest priority.

[0066] In an embodiment, the at least one predefined criterion comprises a priority order for the plurality of second positions. In an embodiment, the priority order for the plurality of second positions is determined based on distance from the first position. For example, the apparatus 100 may be configured to prioritize at least one second position 202 based on proximity of a second position 202 to the first position 204. For example, the apparatus 100 may be configured to prioritize a second position closer to the first position 204 higher than another second position that is farther away from the first position. In addition, or alternatively, the apparatus 100 may be configured to prioritize the first position 204 and the at least one second position 202 based on obstacles 206 located at or near the respective positions. For example, the apparatus 100 may be configured to prioritize a position with less obstacles near the position higher than a position with a lot of obstacles near the position. The apparatus 100 may be further configured to prioritize the first position at the at least one second position based on properties of an obstacle 206 at the first position and/or the second position. The properties of the obstacle 206 may comprise, for example, dimensions or a position of the obstacle 206 obtained from the traversability map by the apparatus 100. For example, a second position 202 located on top of a relatively small hole on the ground but close to the first position 204 may be prioritized over a second position 202 located right next to a wall of the tunnel 216.

[0067] In an embodiment, the at least one predefined criterion comprises that each drill hole of the drill plan 212 is reachable for drilling by the mining vehicle. For example, the apparatus 100 may be configured to determine that each drill hole of the drill plan 212 is reachable for drilling by at least one boom of the mining vehicle. The apparatus 100 may be configured to determine which second positions 202 are located, for example, within the default distance to the tunnel face. For example, the apparatus 100 may be configured to determine a distance between boom base coordinates of the mining vehicle in the second position 202 and coordinates of the drill holes of the drill plan 212 based on the position of the navigation plane 210. Thereafter, the apparatus 100 may be configured to compare the distance with the default distance. Instead of the default distance, the distance between the second position 202 and the drill holes based on the position of the navigation plane 210 may be compared, for example, with the length of the one or more booms of the mining vehicle. The apparatus 100 may be configured to discard the second positions 202 which are not within the default distance or within the boom length. Hence, it may be determined that the one or more booms of the mining vehicle can reach to drill the planned drill holes using the associated boom length.

[0068] The apparatus 100 may be configured to select the target position 200 among the first position 204 and the at least one second position 202 based on the at least one criterion. For example, the apparatus 100 may be configured to select the first position 204 as the target position 200 unless the traversability map indicates that the first position 204 is not suitable for the mining vehicle. The apparatus 100 may be configured to select the at least one second position 202, for example, when the first position 204 is not suitable for the mining vehicle. The apparatus 100 may be configured to select one second position 202 as the target position 200, for example, based on proximity of the second position 202 to the first position 204. Alternatively, the apparatus 100 may be configured to select the target position 200, for example, based on the priority order such that positions in which the mining vehicle fits in the tunnel 216 based on the traversability map have a higher priority than position in which the mining vehicle does not fit in the tunnel 216.

[0069] In cross cutting, or other cases where the drilling is not performed in a forward moving direction of the mining vehicle, position selection for the mining vehicle may be difficult to optimize reachability by the booms for drilling. FIG. 3 illustrates an example, where the first and second positions 204, 202 are determined by the apparatus 100 for cross cutting. The apparatus 100 may have discarded the first position 204 and a plurality of unsuitable second positions 214 in which positions the mining vehicle does not fit in the tunnel 216 due to obstacles 206, such as a side wall and an end wall of the tunnel 216. The apparatus 200 may be configured to then select the target position 200 among the remaining second positions 202, for example, based on the priority order. The apparatus 100 may be configured to determine the priority order, for example, based on a capability of the mining vehicle to drill according to the drill plan 212 and the position of the navigation plane 210 from the second position. Hence, the apparatus 100 may enable to find a most suitable position for the mining vehicle for drilling in different circumstances based on the determined first position 204 and at least one second position 202 and the at least one criterion.

[0070] In an embodiment, the apparatus 100 may be configured to determine a route for the mining vehicle to the target position 200. The apparatus 100 may be configured to obtain a current location of the mining vehicle. Thereafter, the apparatus 100 may be configured to determine the route from the current location to the target position 200 based on the traversability map. Hence, it may be determined that the target position 200 is also accessible to the mining vehicle. For example, the target position 200 might not be accessible to the mining vehicle if the wall of the tunnel 216 was too close to rear of the mining vehicle such that it is not possible for the mining vehicle to arrive in that particular target position. The apparatus 100 may be configured to, upon determining the route to the target position, take into account obstacles included in the traversability map along the route. Further, the apparatus 100 may be configured to add margins for dimensions of the mining vehicle to determine that the mining vehicle fits to drive to the target position 200.

[0071] The apparatus 100 may be configured to determine a new target position when the selected target position 200 is not accessible to the mining vehicle.

[0072] In an embodiment, the apparatus 100 is configured to determine a new target position in response to determining, based on floor map data, that the mining vehicle is unable to drive to the target position. The new target position may be determined, for example, among remaining second positions 202 based on the priority order.

[0073] The apparatus 100 may be configured to cause the mining vehicle to drive automatically to the target position 200 when the apparatus 100 has determined the target position 200 is accessible to the mining vehicle. Alternatively, the apparatus 100 may be configured to provide information on the target position 200 as well as the route to the target position 200 to a driver of the mining vehicle.

[0074] Mining vehicles, such as underground development and tunnelling rigs, may need information on a tunnel line and a drill plan to be able to perform rock drilling automatically. In addition, the information on a tunnel line may be needed for displaying booms in relation to the drill plan to the operator of the rig. The tunnel lines and drill plans both may comprise a theoretical profile. The profile may change along the length of a tunnel. For example, consider a railway tunnel where most of the tunnel is small but at the stations the tunnel is wider. The tunnel in the mine may thus require different kinds of drill plans at different depths of the tunnel. In mining tunnels, the profile may change, for example, in passing bays. FIG. 4 shows an example of a plurality of tunnels 400. A tunnel 216 of the plurality of tunnels 400 may have different profiles and associated drill plans 212 along a length of the tunnel216. For example, a tunnel in the mine may start larger and then get narrower towards the end. In addition, the different drill plans 212 may be updated over time. Hence, before starting rock drilling, the the tunnel profile at a correct drilling position may need to be determined as well as a correct drill plan.

[0075] For example, an operator may select a tunnel line for a tunnel from amongst all tunnel lines based on the information available about the tunnels in the mine. The operator may accidentally select an old tunnel line even though information on an updated one would be available. The tunnel line may have changed for example due to mine planning. Excavation based on a wrong tunnel line may cause delays. The operator may select the drill plan manually from amongst information on all drill plans. For example, the operator may accidentally select a wrong one for the depth in the tunnel and cause the profile to be excavated wrong. Wrong selection of the drill plan may further cause underbreak or overbreak causing delay in a project and additional work to fix it. The operator may also accidentally choose an older pattern even though an updated one would be available, causing suboptimal blast result.

[0076] The apparatus 100 may be configured to receive information on a plurality of tunnel lines in a mine. The apparatus 100 may be configured to select a correct tunnel line for drilling from the plurality of tunnel lines. Thereafter, the apparatus 100 may be configured to select a profile based on a depth in the tunnel and a direction of the tunnel. The depth in the tunnel may correspond to a depth of a deepest excavated point of the tunnel projected to the tunnel line. The tunnel and a tunnel line may comprise a plurality of profiles from which a correct profile may be determined by the apparatus 100 based on the depth. For example, the apparatus 100 may be configured to detect a deepest point in the tunnel by comparing a mapped mine to the selected tunnel line. Lastly, the apparatus 100 may be configured to select a drill plan that matches the chosen profile.

[0077] In an embodiment, the apparatus 100 may be configured to obtain information from a position system of the mining vehicle. For example, the mining vehicle may drive to an end of a tunnel. The apparatus 100 may then select the correct tunnel line based on at least one of a location or a heading of the mining vehicle at the end of the tunnel. A rough positioning may be sufficient for determining the location and heading. For example, a positioning system with a meter-level error may be sufficient for the purpose.

[0078] The apparatus 100 may be configured to obtain a latest data of the tunnel line associated with at least one of the location or the heading of the mining vehicle. For example, different data on tunnel lines may have a same identifier, such as a name of the tunnel line. Also, some of the tunnel lines may overlap. Hence, the apparatus 100 may be configured to select the tunnel line having the same heading as the mining vehicle. The apparatus 100 may be configured to obtain the latest data, for example, based on an edited date or other content indicating which is the latest version of the data.

[0079] Hence, the tunnel line selection may be performed automatically by the apparatus 100. Alternatively, the selection may be done by the operator of the mining vehicle. In an embodiment, the apparatus 100 may be configured to analyze all tunnel line information for unique identifiers. The operator may indicate the correct tunnel line for the apparatus 100 by selecting from a list of the unique identifiers extracted from all tunnel line information by the apparatus 100.

[0080] In an embodiment, the apparatus 100 may be configured to determine the depth and direction of the excavated portion of the selected tunnel line based on the information received from the positioning system. For example, the apparatus 100 may be configured to obtain a position of a drill bit of the mining vehicle. Further, the apparatus 100 may be configured to obtain the heading of the mining vehicle in the tunnel line indicating a direction of excavation. The apparatus 100 may be configured to compute the position of the drill bit based on the position of mining vehicle in the mine. For example, a three-dimensional (3D) point of the drill bit position may be projected to a tunnel line spline by the apparatus 100. A tunnel line may be defined as a series of points and depths that the tunnel line goes through. Interval of the points may be, for example 5 or 10 meters. The tunnel in between the defined points can be extrapolated by a spline, line or an arc. Thereafter, the apparatus 100 may be configured to extract the depth of the tunnel from the projected 3D point.

[0081] In an embodiment, the apparatus 100 may be configured to compare the mine model to the selected tunnel line to determine the deepest excavated point in the respective tunnel. For example, the apparatus 100 may extract a subset of a point cloud from the mine model that is close to the tunnel line. For example, all points at a threshold distance to the selected tunnel line may be picked up by the apparatus 100. The points of the point cloud may be projected to the tunnel line by the apparatus 100. For example, all the selected points may be projected to the spline formed by the tunnel line. Thereafter, the apparatus 100 may be configured to identify a deepest excavated point in the tunnel based on the projection. The apparatus 100 may then extract the depth from the projected point. For example, the apparatus 100 may compute a peg number indicating the depth of the projected points. The apparatus 100 may be configured to select the largest peg number and corresponding depth. The apparatus 100 may use, for example, outlier removal or clustering to reduce faulty results.

[0082] The tunnel line information may include the theoretical profile for each peg number and, respectively, depth in the tunnel. The apparatus 100 may be configured to extract and select a profile associated to a depth closest to the indicated position of the mining vehicle or the drill bit in the tunnel. The apparatus 100 may be configured to obtain available drill plan information for a matching tunnel line identifier (for example, included in a IREDES drill plan format) once the profile is extracted. If a matching tunnel line identifier is not found, the apparatus 100 may be configured to select a drill plan comprising a matching profile with the selected tunnel profile. The apparatus 100 may be configured to select the latest drill plan associated with the matching profile and optionally the tunnel line identifier. The selected drill plan may be provided by the apparatus 100 to the mining vehicle for navigation of the one or more booms.

[0083] An example embodiment may improve selection of correct information for operating a mining vehicle in a mine. For example, the operator may not have to know what specific file to use to obtain a correct drill plan. File naming may not matter, only the data content of the drill plan. The apparatus 100 may enable to ensure that the latest available data is used, for example after automatic synchronization to a planning program. This makes it possible to automate a navigation of the mining vehicle by only having to select the tunnel line by the operator. Alternatively, also the correct tunnel line may be automatically selected by the apparatus 100.

[0084] However, drill plans are not usually designed in mine coordinates. The drill plans may comprise a relative drilling pattern that is repeated in the mine in an actual excavation situation. As mentioned, a start of drill holes of a drill plan may be called a navigation plane or a start profile. The start profile may be smaller than a profile at the end of drill holes. The end of drill holes may be also called an end of round. The difference between the profiles at the start and at the end may define a lookout angle. The lookout angle may be used to fit drilling feeds and rock drills of mining vehicles into the tunnel. It may be difficult to drill holes directly next to a wall of a tunnel with a zero angle to the tunnel direction. For this reason, selection of a navigation plane depth, or depth of the start profile, may be important for the drilling result.

[0085] For example, if the position of the navigation plane is too deep in the tunnel, the mining vehicle may not be able to fully reach a designed length of the drill holes in the drill plan. When the position of the navigation plane is located too deep in the tunnel line, it may lead to a rounded and a malformed tunnel face because the targeted hole depth may be too deep for the lengths of a drill rod to drill. In addition, if the position of the navigation plane is too deep in the tunnel line, the position of the navigation plane may lead to failed blasting. For example, underbreak on a tunnel profile behind the start profile may be caused due to a lookout angle extrapolated back from the position of the navigation plane to an actual rock surface of the tunnel.

[0086] On the other hand, if the navigation plane is not positioned deep enough in the tunnel, this may lead to insufficient round length. The insufficient round length may cause extended project time and increased cost to a tunnel excavation project. Further, drilling may be difficult since the drill holes may eventually start from the side walls of the tunnel and not from the tunnel face. If the drilling is started from a too steep angle, this may lead to the drill bit sliding in the wall instead of impacting the wall.

[0087] FIG. 5 illustrates an example of selecting a position of the navigation plane 210 for a drill plan 212 by an apparatus, according to an example embodiment. The selection may be performed, for example, by the apparatus 100.

[0088] As mentioned, a mine may comprise multiple tunnel lines and associated tunnels. The apparatus 100 may obtain the mine model in a same coordinate system as the tunnel lines. The apparatus 100 may be configured to position a selected drill plan 212 into the tunnel line coordinates using, for example, navigation curve calculation. In a navigation curve calculation, the tunnel line is determined by means of a curve table which contains points and their coordinate information, such as peg numbers, spaced at predetermined distances from one another. A depth in the tunnel line 208, such as a peg number, may be varied in the navigation curve calculation. For example, the apparatus 100 may be configured to iterate the peg number with fixed steps from a planned end of the tunnel line 208 to the direction of a start of the tunnel line 208. Alternatively, the apparatus 100 may iterate the peg number with the fixed steps from an identified deepest excavated point 500 in the tunnel line 208 opposite to the direction of excavation.

[0089] The drill plan 212 may comprise locations of start points 502 of the drill holes. The start points of the drill holes may be provided in a three-dimensional format. The apparatus 100 may be configured to analyze the locations of the 3D start points 502 in comparison to the mine model mapped with the tunnel lines. The apparatus 100 may be configured to continue the iteration by moving the drill plan 212 backwards along the tunnel line 208 until a predefined number of the start points 502 are located inside the tunnel 216. In an embodiment, the predefined number may comprise having all start points 502 of the drill holes inside the tunnel 216. The apparatus 100 may be configured to determine that the predefined number of the start points are located inside a measured model of the tunnel 216. The model may be a 3D model of the tunnel 216 or a simplified 2D wall model indicating an advance of the tunnel 216 at the moment. In other words, at least the predefined number of drill holes of the navigation plane may be determined by the apparatus 100 to start inside the excavated portion of the tunnel line 208 based on the up-to-date model of the tunnel 216. In an embodiment, the predefined number may comprise having a certain percentage of the start points 502 inside the excavated portion of the tunnel 216. In an embodiment, the predefined number may comprise having all but profile or contour drill holes inside the excavated portion of the tunnel 216. The profile or contour drill holes may comprise at least the outermost drill holes of the drill plan 212.

[0090] The apparatus 100 may be configured to stop the iteration and store the peg number when the predefined number of the start points 502 are located inside the tunnel 216. The apparatus 100 may then determine the position of the navigation plane 210 based on the stored peg number/depth of the tunnel line 208. The position of the navigation plane 210 may be further used by the apparatus 100 to determine a final drill plan placement for drilling navigation.

[0091] By determining the position of the navigation plane 210 and/or the final drill plan placement based on the predefined number of start points 502 locating inside the tunnel 216, a balance between an advance per round, a tunnel face end shape after blast and drillability by the mining vehicle may be achieved. A maximal advance in relation to the tunnel face shape after blast may be achieved since at least most drill holes may be drilled to a target depth. Further, a minimal underbreak may be achieved due to the drill plan not being located too far back. Selecting the position of the navigation plane 210 in the tunnel line 208 based on the predefined number of start points 502 locating inside the tunnel 216 may enable optimizing tunnel face shape after blast to a planned flat shape, making the following rounds easier to drill and load.

[0092] FIG. 6 illustrates an example of a method 600 for selecting a position of a mining vehicle in a mine for drilling, according to an example embodiment.

[0093] At an operation 602, the method may comprise selecting a drill plan associated with a tunnel line for a tunnel to be excavated. The drill plan may be selected, for example, based on a depth and direction of a tunnel line selected for drilling.

[0094] At an operation 604, the method may comprise selecting a position of a navigation plane for the drill plan with respect to the tunnel line. The position of the navigation plane may be selected, for example, based on a depth of the tunnel, where at least a predetermined number of drill holes of the navigation plane is located inside the tunnel 216.

[0095] At an operation 606, the method may comprise determining a first position for the mining vehicle based on the drill plan and the position of the navigation plane.

[0096] At an operation 608, the method may comprise obtaining information on a plurality of predefined variations of the first position.

[0097] At an operation 610, the method may comprise determining a plurality of second positions for the mining vehicle based on the first position and the information on the plurality of predefined variations.

[0098] At an operation 612, the method may comprise selecting, from the plurality of second positions, a target position for the mining vehicle based on the first position and at least one predefined criterion. The at least one predefined criterion may comprise, for example, detected obstacles preventing positioning the mining vehicle to the first position or the at least one second position based on a traversability map of the mine.

[0099] It is obvious to a person skilled in the art that with the advancement of technology, the basic idea of the invention may be implemented in various ways. The invention and its embodiments are thus not limited to the examples described above, instead they may vary within the scope of the claims.

[0100] Further features of the methods directly result from the functionalities and parameters of the apparatus as described in the appended claims and throughout the specification and are therefore not repeated here. It is noted that one or more operations of the method may be performed in different order.

[0101] An apparatus may be configured to perform or cause performance of any aspect of the method(s) described herein. Further, a computer program may comprise instructions for causing, when executed, an apparatus to perform any aspect of the method(s) described herein. Further, an apparatus may comprise means for performing any aspect of the method(s) described herein. According to an example embodiment, the means comprises at least one processor, and memory including program code, the at one memory and the program code configured to, when executed by the at least one processor, cause performance of any aspect of the method(s).

[0102] Any range or device value given herein may be extended or altered without losing the effect sought. Also, any embodiment may be combined with another embodiment unless explicitly disallowed.

[0103] Although the subject matter has been described in language specific to structural features and/or acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as examples of implementing the claims and other equivalent features and acts are intended to be within the scope of the claims.

[0104] It will be understood that the benefits and advantages described above may relate to one embodiment or may relate to several embodiments. The embodiments are not limited to those that solve any or all of the stated problems or those that have any or all of the stated benefits and advantages. It will further be understood that reference to 'an' item may refer to one or more of those items.

[0105] The operations of the methods described herein may be carried out in any suitable order, or simultaneously where appropriate. Additionally, individual blocks may be deleted from any of the methods without departing from the scope of the subject matter described herein. Aspects of any of the embodiments described above may be combined with aspects of any of the other embodiments described to form further embodiments without losing the effect sought.

[0106] The term 'comprising' is used herein to mean including the method, blocks, or elements identified, but that such blocks or elements do not comprise an exclusive list and a method or apparatus may contain additional blocks or elements.

[0107] As used in this application, the term 'circuitry' may refer to one or more or all of the following: (a) hardware-only circuit implementations (such as implementations in only analog and/or digital circuitry) and (b) combinations of hardware circuits and software, such as (as applicable):(i) a combination of analog and/or digital hardware circuit(s) with software/firmware and (ii) any portions of hardware processor(s) with 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) hardware circuit(s) and or processor(s), such as a microprocessor(s) or a portion of a microprocessor(s), that requires software (e.g., firmware) for operation, but the software may not be present when it is not needed for operation. This definition of circuitry applies to all uses of this term in this application, including in any claims.

[0108] As a further example, as used in this application, the term circuitry also covers an implementation of merely a hardware circuit or processor (or multiple processors) or portion of a hardware circuit or processor and its (or their) accompanying software and/or firmware. The term circuitry also covers, for example and if applicable to the particular claim element, a baseband integrated circuit or processor integrated circuit for a mobile device or a similar integrated circuit in server, a cellular network device, or other computing or network device.

[0109] It will be understood that the above description is given by way of example only and that various modifications may be made by those skilled in the art. The above specification, examples and data provide a complete description of the structure and use of exemplary embodiments. Although various embodiments have been described above with a certain degree of particularity, or with reference to one or more individual embodiments, those skilled in the art could make numerous alterations to the disclosed embodiments without departing from scope of this specification.

Claims

1. An apparatus for selecting a position of a mining vehicle in a mine for drilling, the apparatus comprising at least one processor and at least memory, the at least one memory comprising instructions which, when executed by the at least one processor, cause the apparatus to:

select a drill plan associated with a tunnel line for a tunnel to be excavated;
select a position of a navigation plane for the drill plan with respect to the tunnel line;
determine a first position for the mining vehicle based on the drill plan and the position of the navigation plane;
obtain information on a plurality of predefined variations of the first position;
determine a plurality of second positions for the

mining vehicle based on the first position and the information on the plurality of predefined variations; and

select, from the plurality of second positions, a target position for the mining vehicle based on the first position and at least one predefined criterion.

2. An apparatus of claim 1, wherein selecting the drill plan comprises identifying a profile of the tunnel to be excavated and selecting the drill plan based on the profile.

3. An apparatus according to claim 2, wherein the at least one memory further comprises instructions which, when executed by the at least one processor, cause the apparatus to identify the profile of the tunnel to be excavated based on a depth of the already excavated tunnel and direction of the tunnel to be excavated.

4. An apparatus of any preceding claim, wherein selecting a position of the navigation plane for the drill plan comprises varying a position of the navigation plane in tunnel depth direction until a number of starting points of drill holes in the drill plan located inside the excavated tunnel exceeds at least one predefined limit.

5. An apparatus of any preceding claim, wherein the plurality of predefined variations comprises a change in at least one of a position, a heading or an articulation of the mining vehicle in relation to the first position.

6. An apparatus of any preceding claim, wherein the at least one predefined criterion comprises information on at least one obstacle located at the first position or at least one of the plurality of second positions.

7. An apparatus of any preceding claim, wherein the at least one predefined criterion comprises that each drill hole of the drill plan is reachable for drilling by the mining vehicle.

8. An apparatus of any preceding claim, wherein the at least one criterion comprises that each drill hole of the drill plan is drillable by the mining vehicle based on locations, depths and directions of the drill holes of the drill plan, and dimensions of the machine parts.

9. An apparatus of any preceding claim, wherein the at least one criterion comprises a priority order for the plurality of second positions.

10. An apparatus of claim 9, wherein the priority order for the plurality of second positions is determined based on distance from the first position.

11. An apparatus of any preceding claim, wherein the at least one predefined criterion comprises space required by the mining vehicle.

12. An apparatus according to any preceding claim, wherein the at least one memory further comprises instructions which, when executed by the at least one processor, cause the apparatus to determine a new target position in response to determining, based on floor map data, that the mining vehicle is unable to drive to the target position.

13. A computer-implemented method for selecting a position of a mining vehicle in a mine for drilling, the method comprising:

selecting a drill plan associated with a tunnel line for a tunnel to be excavated;

selecting a position of a navigation plane for the drill plan with respect to the tunnel line;

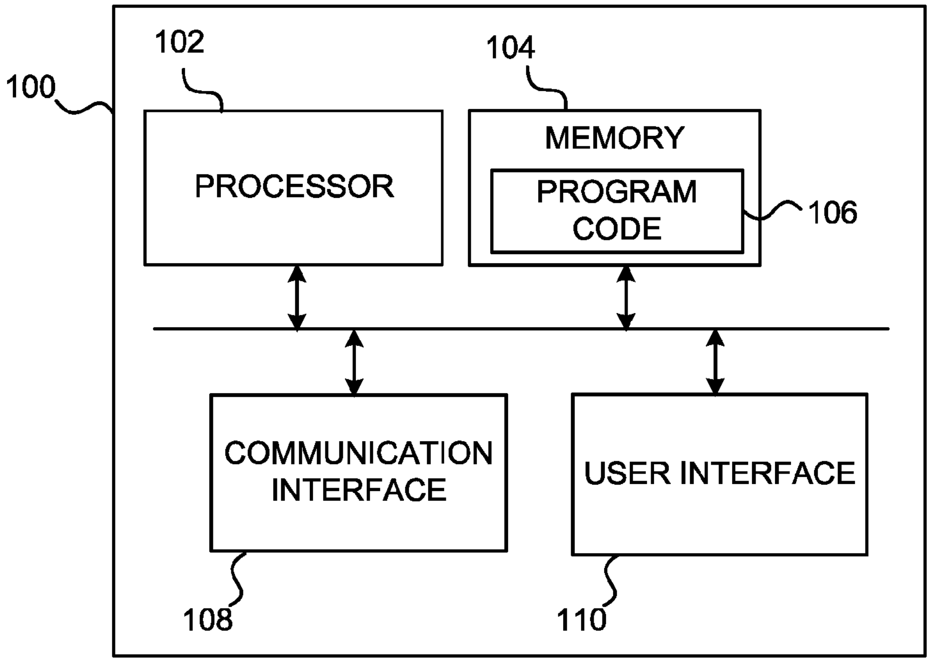
determining a first position for the mining vehicle based on the drill plan and the position of the navigation plane;

obtaining information on a plurality of predefined variations of the first position;

determining a plurality of second positions for the mining vehicle based on the first position and the information on the plurality of predefined variations; and

selecting, from the plurality of second positions, a target position for the mining vehicle based on the first position and at least one predefined criterion.

14. A computer-program product comprising instructions which, when executed by a computer, cause the computer to carry out the method of claim 13.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COMMUNICATION INTERFACE
USER INTERFACE
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110

FIG. 1

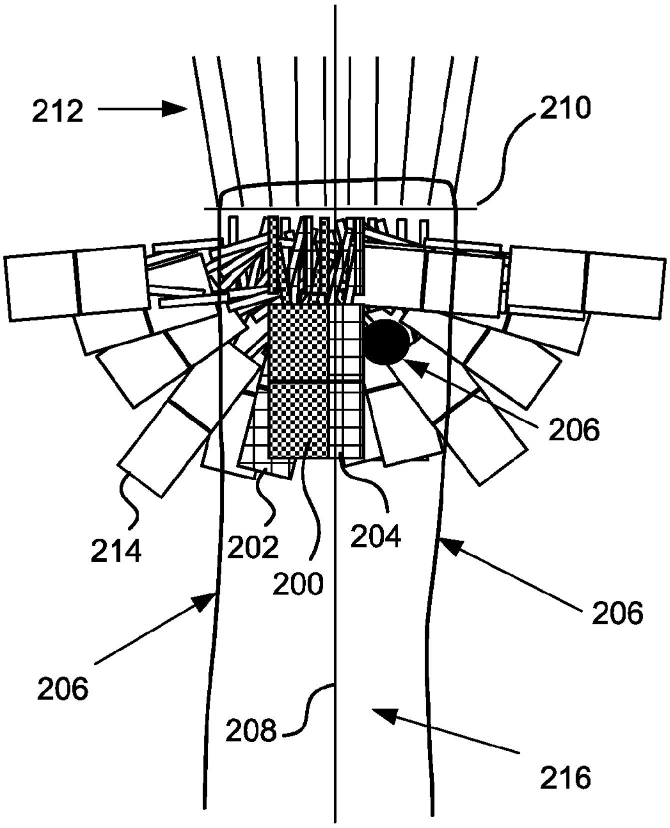
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FIG. 2

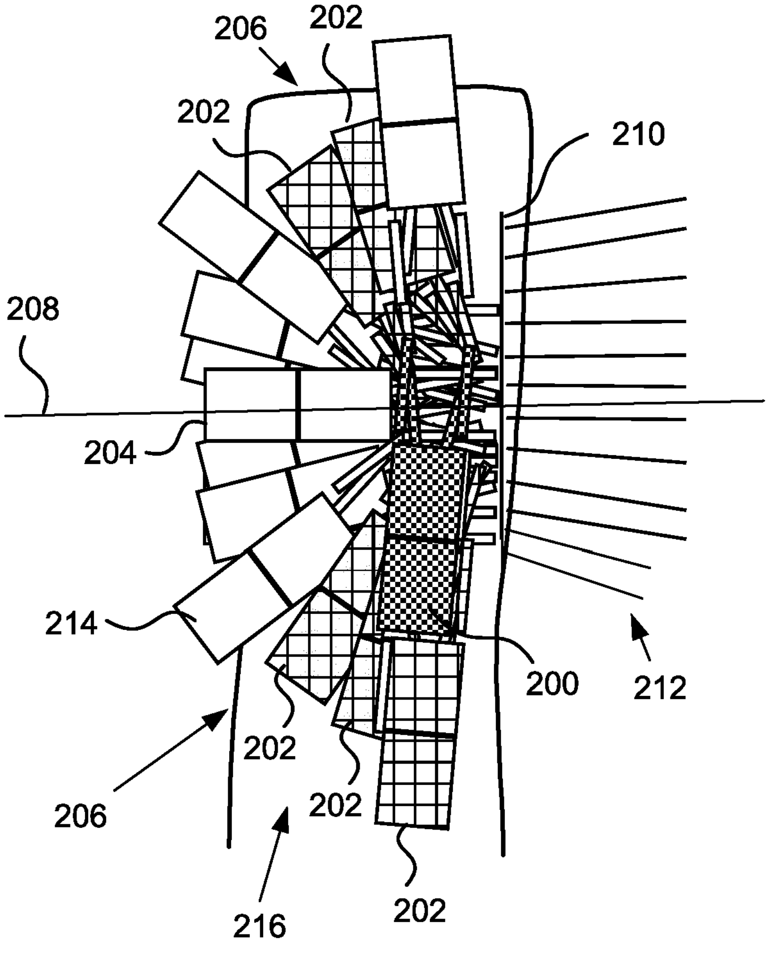

FIG. 3

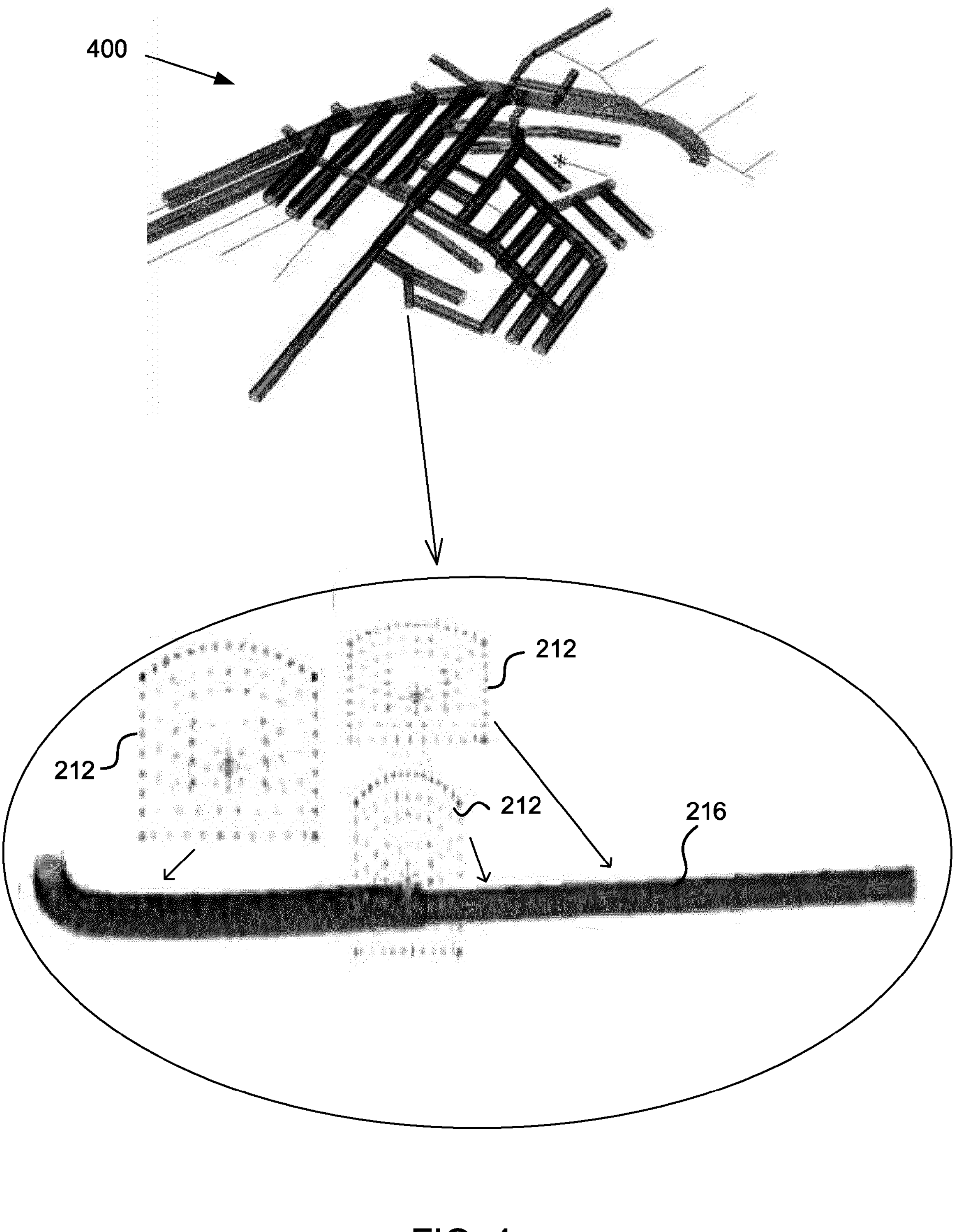

FIG. 4

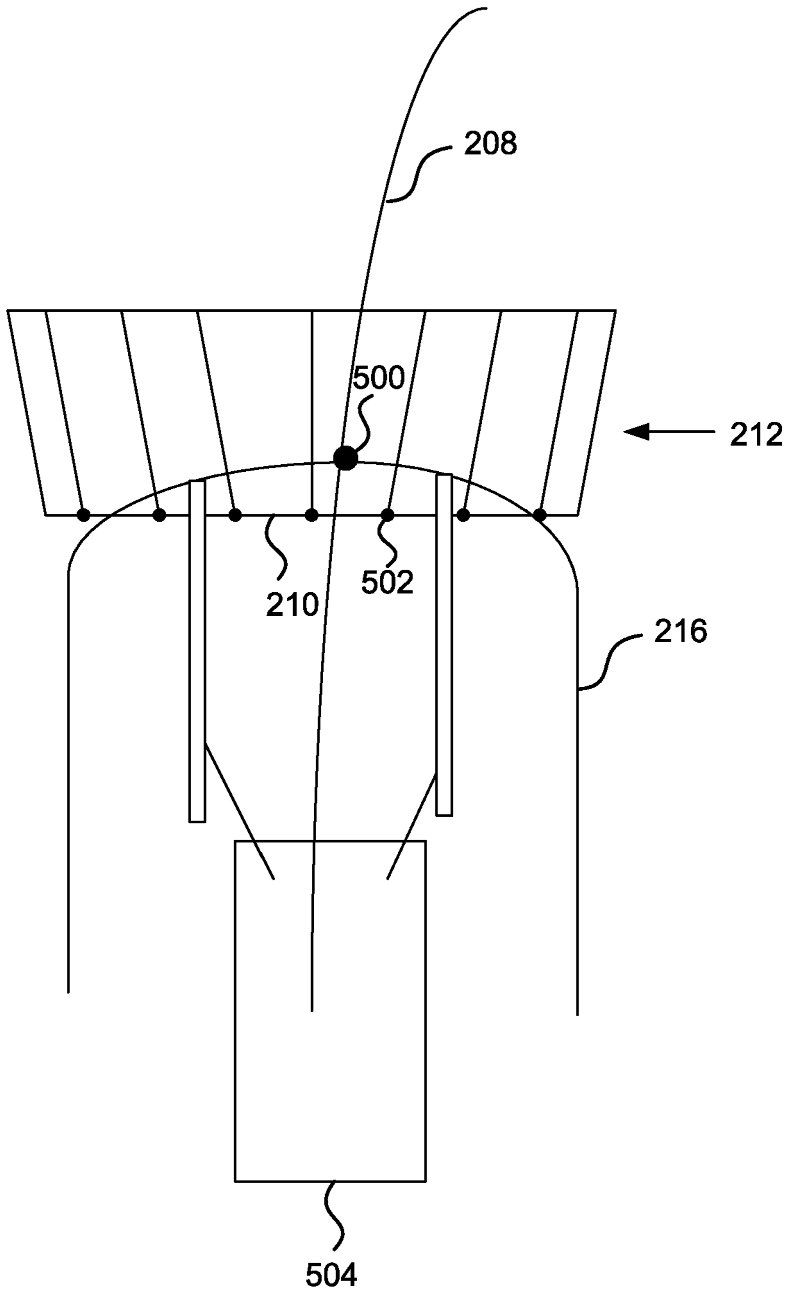

FIG. 5

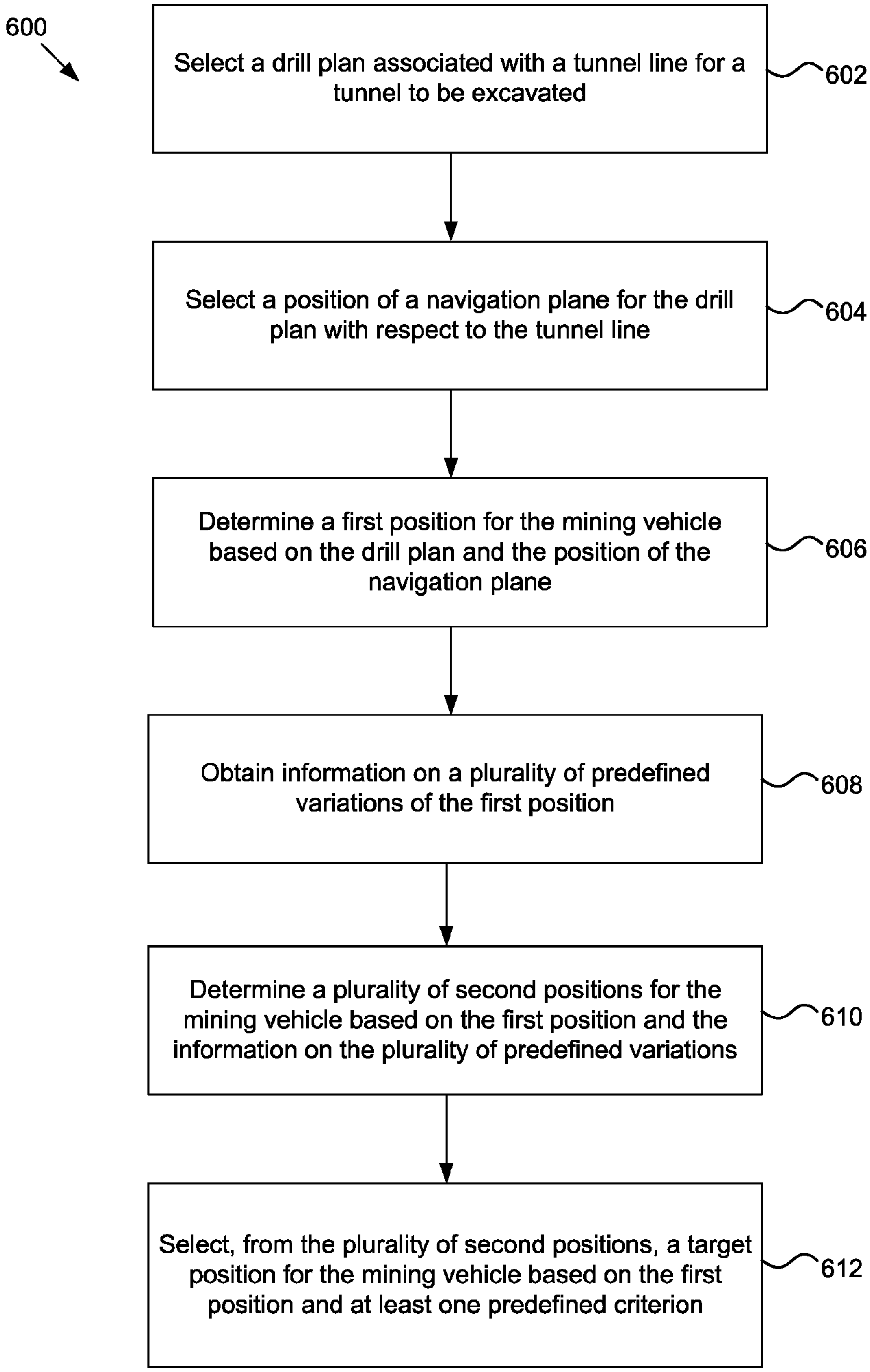
600
Select a drill plan associated with a tunnel line for a tunnel to be excavated
602
Select a position of a navigation plane for the drill plan with respect to the tunnel line
604
Determine a first position for the mining vehicle based on the drill plan and the position of the navigation plane
606
Obtain information on a plurality of predefined variations of the first position
608
Determine a plurality of second positions for the mining vehicle based on the first position and the information on the plurality of predefined variations
610
Select, from the plurality of second positions, a target position for the mining vehicle based on the first position and at least one predefined criterion
612

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 22 19 6993

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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E21C
E21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	16 February 2023	Morrish, Susan

1

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 19 6993

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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