In the case where a mechanical fastening part is a bolt, the tool head section R~~H~~T<u>H</u>n may be a torque wrench for which it is possible to mount various types of sockets RTSn corresponding to a bolt size or bolt type to the head section RTHn of the tool RTn, or may have various torque wrench shapes such as a spanner shape or an adjustable wrench shape. In addition, in a case where a mechanical fastening part is a rivet, the tool head section R~~H~~T<u>H</u>n may be a site that includes a nose housing for grasping the rivet.

[0026]

A display section in the communication display unit RTT which is also provided in the tool RTn is provided with functionality for teaching a fastening target torque value (Tr_Set) to a worker, and communicating to the worker information that the worker has fastened a bolt at greater than or equal to a target torque value (Tr_Set) and less than or equal to a fastening upper-limit torque value (Tr_Max), information that fastening work has completed with a predetermined fastening torque value, etc. It is also possible to have a configuration in which these items of information are, for example, displayed on the transmissive screen 14 or displayed by a display unit in a different wearable terminal equipped to a wrist, etc. of a worker.

In addition, in a case where the mechanical fastening part is a rivet, the communication display unit RTT may be configured to connect to a nose housing that grasps the rivet, and transmit and receive an on/off signal for a trigger provided in a handle corresponding to the tool handle section RTEn.

[Network server 26]

[0027]

The network server 26 is a server for storing a production work instruction document in which production content for a product (a railway vehicle, an automobile, etc.) is described, a maintenance work instruction document in which content for maintenance work is described, etc. In addition, the network server 26 is provided with functionality for, in response to a request by the augmented reality server 12, extracting only necessary data from stored data and providing the necessary data to the augmented reality server 12.

[0028]

In addition, the network server 26 is provided with functionality for performing image analysis such as edge processing on an image of a base and a component (for example, a base RD1~~RD2~~ and a component RD2 ~~RD1~~ illustrated in FIG. 2), the tool RTn, the socket RTSn, etc., the image having been captured by the camera 10, to thereby extract a

for the bolt RBn is disposed in an aspect that goes straight in an x-y plane formed by an x axis in the horizontal direction within the paper surface and a y axis in a normal direction for the paper surface, a position (coordinates) ORTHn for the tool head RTHn and the axis for the cylindrical socket RTSn overlap with a z axis (axis in vertical direction within the paper surface).

[0040]

Letting the thickness (dimension in z direction) of the tool head RTHn be D1n and the height dimension following the z axis for the socket RTSn be D2n, a tool dimension h1 (hereinafter, may be simply written as dimension h1) for from the representative position (coordinates) ORTHn for the tool head RTHn to the position ORBn of the bolt RBn is the sum of the tool head thickness dimension D1n and a socket length dimension D2n.

Note that a marker that is used in image analysis after being captured by the camera 10 is attached to a side surface of the tool head RTHn and a side surface of the socket RTSn, which are illustrated in FIG. 5.

<Description of situation in which bolt fastening torque observed by the tool RTn arises>

[0041]

Next, with reference to FIG. 6, description is given regarding change in fastening torque observed when

fastening a bolt with a tool, according to an embodiment of the present invention.

[0042]

FIG. 6 is a schematic view that illustrates change in a fastening torque value (hereinafter may be simply written as torque) observed when fastening a bolt with a tool. Typically, it is desirable to manage a fastening state for a bolt by axial force arising in the bolt, such that bolt breakage due to excess fastening or looseness due to insufficient fastening do not arise for the bolt. However, because it is not easy to directly observe axial force for a bolt, in place of bolt axial force, the fastening state for a bolt is managed by fastening torque, which is proportional to the axial force for a bolt.

[0043]

The horizontal axis in FIG. 6 represents time, and the vertical axis represents fastening torque measured by the tool RTn when fastening a bolt RBn by the tool RTn. The display communication unit RTT that the tool RTn is provided with transmits and receives, to and from a network server (for example, the network server 26 illustrated in FIG. 1) via a network described above (for example, the network 5 illustrated in FIG. 1), fastening torque information (fastening torque time history data, fastening torque, etc.) obtained when fastening the bolt RBn by the

from the start of fastening for the bolt RB~~n~~1 to the completion of fastening for the bolt RB~~n~~4.

For the order (Seq), an order may be recorded for each of respective bolt fastening completion time t_E at which fastening of the bolts RBn (n = 1 to 4) completed, or the order (Seq) may be an order resulting from extracting and lining up in an order from oldest time to newest time the bolt fastening start time t_B or the bolt fastening completion time t_E, when fastening for all bolts has completed.

[0081]

Step 220 (S220): As illustrated in FIG. 18, after all of the bolts RBn (n = 1 to 4) are fastened, the server captures and saves an image resulting from writing a work result (worker ID, work date, work time, fastening complete torque value Tr_rslt, work instruction document, etc.) near the bolts RBn (n = 1 to 4) in the augmented reality space which includes fastening work target objects. By saving this captured image, even in a case where some data in the data table illustrated in FIG. 17 in which the bolt fastening work by the first worker has been recorded is damaged or lost, it is possible to secure evidence (traceability) pertaining to bolt fastening work.

[0082]

In accordance with the mechanical fastening work

method provided with each of the steps described above, it is possible to provide a high-quality mechanical fastening work method having lower operating costs with which it is possible to confirm that bolt fastening work to be performed by a worker has been reliably performed without a work omission, and it is possible to ensure traceability by recording a result of work performed.

<Fastening work by second worker>

[0083]

Steps being the subsequent step 230 and thereafter pertain to bolt fastening work by the second worker who is taught work content using work instructions (a manual) generated on the basis of the work content by the first worker.

[0084]

Step 230 (S230): The ~~first~~ second worker mounts the wearable apparatus 7, turns the power supply on, and activates augmented space generation application software.

[0085]

Step 240 (S240): The server creates a second work table (data table illustrated in FIG. 19) that is for recording bolt fastening work by the second worker and results from removing data for the fastening complete torque Tr_rslt, the work date, and the work time from the first work table (FIG. 17) for the time at which the

a start point.

[0088]

Next, with reference to FIG. 20, description is given regarding bolt fastening work by the second worker, according to an embodiment of the present invention.

[0089]

FIG. 20 is a schematic view that illustrates positions for bolts to be fastened by the second worker, and is an image of an augmented reality space displayed by a transmissive screen for the second worker.

The server creates a data table (the second work table illustrated in FIG. 19) resulting from deleting only the fastening complete torque Tr_rslt, the work date, and the work time for work performed by the first worker from the data table (the first work table illustrated in FIG. 17) that recorded work history for the first worker who has completed their work, while keeping the bolt positions (Xn, Yn, Zn), the direction vector NV (in, jn, kn) indicating the direction in which the bolt RBn is positioned from the tool RTBn, and the fastening order. Afterwards, on the basis of this second work table, the server can display, on the transmissive screen 14 for the second worker, the bolt positions, the number of bolts, and the order for fastening the bolts, for which fastening is to be performed by the second worker.