

IDENTIFICATION TAG

Cross Reference to Related Application(s)

- 5 The present disclosure claims the benefit of Singapore Patent Application No. 10202001679T filed on 25 February 2020, which is incorporated in its entirety by reference herein.

Technical Field

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The present disclosure generally relates to an identification tag. More particularly, the present disclosure describes various embodiments of an identification tag, as well as computer system and a computerized method for identifying the identification tag.

15 Background

Many articles or objects are usually tagged with an identification tag for identifying the objects, such as during various steps of fabrication or manufacturing processes. For example as shown in Figure 1, metallic objects or parts such as a pipe spool 100 is
20 tagged with an existing identification tag 110 to identify the pipe spool 100 during the various steps of fabrication. Further as shown in Figure 2A, the identification tag 110 has identification markings 112 that may be engraved, dot-peened, punched, or perforated on or through the identification tag 110. Alternatively, the identification markings 112 may be printed on a paper-based material and attached to the
25 identification tag 110. The identification tag 110 may be embedded with electronic components such as an RFID chip.

The identification tag 110 is attached to the pipe spool 100 and subjected to harsh treatment processes, particularly sandblasting and galvanizing processes. The
30 identification tag 110 would be eroded during the sandblasting process. For example, identification markings 112 that are engraved or dot-peened would be defaced during the sandblasting process. The sandblasting process would also damage the RFID chip and render it unreadable.

The identification tag 110 would be further damaged during the galvanizing process. More specifically, during the galvanizing process, the identification tag 110 would be immersed in molten zinc at around 450 °C. Electronic components such as the RFID
5 chip are not suitable to be treated by the galvanizing process, because standard heat resistant RFID chips can operate up to only around 200 °C to 230 °C. In some cases, extreme and ultra-high temperature RFID chips can operate up to only around 300 °C to 400 °C, which is still below the temperature of the molten zinc. Moreover, zinc coatings may form on the RFID chip and render it completely unreadable or
10 significantly reduce its reading range due to the Faraday Cage effect. Identification markings 112 that are hole punched or perforated would be covered during the galvanizing process and become illegible.

Although some forms of identification markings 112, such as by laser marking or
15 engraving, might be able to withstand sandblasting or shotblasting, the identification markings 112 would still be defaced and coated with zinc during galvanization, rendering them illegible. Identification markings 112 printed on a paper-based material also cannot withstand the sandblasting and galvanizing processes. After treatment by the sandblasting and galvanizing processes, the identification tag 110 would need to
20 be brushed to thin the zinc coating formed by the galvanization. Even after brushing, the identification markings 112 are often not clearly visible due to the remaining zinc coating and the significant erosion from the sandblasting.

The identification markings 112 on current identification tags 110 would be damaged
25 by these abrasive treatment processes and rendered illegible post-treatment, such as shown in Figure 2B. An identification tag 110 with illegible identification markings 112 cannot be reliably used to identify the object which the identification tag 110 is attached to, such as the pipe spool 100. When the pipe spool 100 is received after the treatment processes, the identification markings 112 can be expected to become partially or
30 wholly illegible.

Therefore, in order to address or alleviate at least one of the aforementioned problems and/or disadvantages, there is a need to provide an improved identification tag.

Summary

According to a first aspect of the present disclosure, there is a computerized method
5 for identifying an identification tag after treatment thereof. The method comprises:
obtaining a post-treatment image of the identification tag; finding, in the post-treatment
image, a number of serrated edges of the identification tag, each serrated edge
comprising a plurality of serrations formed thereon; determining characters from the
10 respective serrations of each serrated edge, each serration representing a set of
characters; and deriving, for each serrated edge, a tag identifier from the respective
characters of the serrated edge, wherein the identification tag is identifiable by the tag
identifier.

According to a second aspect of the present disclosure, there is a computerized
15 method for registering an identification tag before treatment thereof. The method
comprises: obtaining a pre-treatment image of the identification tag; finding, in the pre-
treatment image, a number of serrated edges of the identification tag, each serrated
edge comprising a plurality of serrations formed thereon; determining characters from
the respective serrations of each serrated edge, each serration representing a set of
20 characters; deriving, for each serrated edge, a tag identifier from the respective
characters of the serrated edge; and storing the pre-treatment image on an image
database, wherein the pre-treatment image is identifiable by the tag identifier.

According to a third aspect of the present disclosure, there is an identification tag
25 comprising: a body comprising a number of serrated edges; and each serrated edge
comprising a plurality of serrations formed thereon, each serration representing a set
of characters, wherein each serrated edge represents a tag identifier derived from the
respective characters of the serrated edge; and wherein the identification tag is
identifiable by the tag identifier.

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An identification tag according to the present disclosure are thus disclosed herein.
Various features, aspects, and advantages of the present disclosure will become more
apparent from the following detailed description of the embodiments of the present

disclosure, by way of non-limiting examples only, along with the accompanying drawings.

Brief Description of the Drawings

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Figure 1 is an illustration of a pipe spool tagged with an existing identification tag.

Figure 2A and Figure 2B are illustrations of the identification tag of Figure 1 before and after treatment.

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Figure 3A and Figure 3B are illustrations of an identification tag, before and after treatment, according to embodiments of the present disclosure.

Figure 4 to Figure 6 are other illustrations of the identification tag according to
15 embodiments of the present disclosure.

Figure 7 is an illustration of a system for registering and identifying the identification tag, according to embodiments of the present disclosure.

20 Figure 8 is a flowchart illustration of a computerized method for identifying the identification tag, according to embodiments of the present disclosure.

Figure 9 is a flowchart illustration of a computerized method for registering the identification tag, according to embodiments of the present disclosure.

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Figure 10A to Figure 10C are illustrations of various geometries of the identification tag, according to embodiments of the present disclosure.

Figure 11 is a flowchart illustration of a method for identifying the identification tag,
30 according to embodiments of the present disclosure.

Detailed Description

For purposes of brevity and clarity, descriptions of embodiments of the present disclosure are directed to an identification tag, in accordance with the drawings. While aspects of the present disclosure will be described in conjunction with the embodiments provided herein, it will be understood that they are not intended to limit
5 the present disclosure to these embodiments. On the contrary, the present disclosure is intended to cover alternatives, modifications and equivalents to the embodiments described herein, which are included within the scope of the present disclosure as defined by the appended claims. Furthermore, in the following detailed description, specific details are set forth in order to provide a thorough understanding of the present
10 disclosure. However, it will be recognized by an individual having ordinary skill in the art, i.e. a skilled person, that the present disclosure may be practiced without specific details, and/or with multiple details arising from combinations of aspects of particular embodiments. In a number of instances, well-known systems, methods, procedures, and components have not been described in detail so as to not unnecessarily obscure
15 aspects of the embodiments of the present disclosure.

In embodiments of the present disclosure, depiction of a given element or consideration or use of a particular element number in a particular figure or a reference thereto in corresponding descriptive material can encompass the same, an equivalent,
20 or an analogous element or element number identified in another figure or descriptive material associated therewith.

References to “an embodiment / example”, “another embodiment / example”, “some embodiments / examples”, “some other embodiments / examples”, and so on, indicate
25 that the embodiment(s) / example(s) so described may include a particular feature, structure, characteristic, property, element, or limitation, but that not every embodiment / example necessarily includes that particular feature, structure, characteristic, property, element or limitation. Furthermore, repeated use of the phrase “in an embodiment / example” or “in another embodiment / example” does not
30 necessarily refer to the same embodiment / example.

The terms “comprising”, “including”, “having”, and the like do not exclude the presence of other features / elements / steps than those listed in an embodiment. Recitation of

certain features / elements / steps in mutually different embodiments does not indicate that a combination of these features / elements / steps cannot be used in an embodiment.

- 5 As used herein, the terms “a” and “an” are defined as one or more than one. The use of “/” in a figure or associated text is understood to mean “and/or” unless otherwise indicated. The term “set” is defined as a non-empty finite organization of elements that mathematically exhibits a cardinality of at least one (e.g. a set as defined herein can correspond to a unit, singlet, or single-element set, or a multiple-element set), in
10 accordance with known mathematical definitions. The recitation of a particular numerical value or value range herein is understood to include or be a recitation of an approximate numerical value or value range.

In representative or exemplary embodiments of the present disclosure, there is an
15 identification tag 200 as shown in Figure 3A. The identification tag 200 includes a body 210 comprising a number of, i.e. one or more, serrated edges 220. As used herein, a serrated edge 220 is an edge of the body 210 that has a jagged, notched, or toothed profile.

- 20 The identification tag 200 is preferably ruggedized so that it can withstand or tolerate harsh treatment processes like sandblasting and galvanizing. Preferably, the body 210 is made of a material that is less or not vulnerable to damage when the identification tag 200 is subjected to harsh, abrasive, or chemical treatments or conditions. Additionally, the material used, such as a metallic material, allows the shape of the
25 body 210, especially the serrated edges 220, to remain sufficiently intact after such treatments or conditions.

Each serrated edge 220 of the body 210 has a plurality of serrations 230 formed thereon. A serration 230 may be defined as a notch or toothlike protrusion or groove
30 formed along the serrated edge 220. A serration 230 may also be a straight or linear portion of the serrated edge 220. The identification tag 200 may optionally include identification markings 240 formed on the body 210 that can be used to identify the identification tag 200. The identification markings 240 may be formed on the

identification tag 200 by various means, such as by engraving, dot-peening, punching, or perforating on or through the body 210. In the example as shown in Figure 3A, the identification tag 200 has identification markings 240 showing "01010110". The identification markings 240 may be in the form of alphanumeric characters, such as
5 binary numbers as shown in Figure 3A. The identification markings 240 may also be in the form of an optical code or data matrix code, such as a barcode or QR code.

Each serrated edge 220 is formed on the body 210 such that it represents a tag identifier that can be used to identify the identification tag 200. Additionally, each
10 serration 230 of the serrated edge 220 represents a set of characters, i.e. one or more characters. Each character can be defined as any letter, number, space, punctuation mark, or symbol that is used in computer and/or machine-based telecommunications terminology. In the example as shown in Figure 3A, the identification tag 200 has one
15 serrated edge 220 representing the tag identifier. Additionally, each serration 230 of the serrated edge 220 represents a character such that the tag identifier is derived from the respective characters of the serrated edge 220. The tag identifier may be identical or correspond to the identification markings 240 or may alternatively be used to derive the identification markings 240.

20 The serrations 230 can be of various shapes and sizes to form a coded pattern of serrations 230 that can be used to derive the tag identifier. In the example as shown in Figure 3A, the pattern of serrations 230 may include notches of similar dimensions and straight portions. The notches may be adjacent to each other or spaced apart by a straight portion to form a sequence of notches and straight portions. Each of these
25 serrations 230 (notches and straight portions) represents a character such as a binary character, i.e. "0" or "1". The sequence of serrations 230 thus form a binary sequence that represents the tag identifier or unique identification code of the identification tag 200. As shown in Figure 3A, a notch has a semi-circular shape and represents the binary character "0", and a straight portion (i.e. the space or uncut portion between
30 notches) represents the binary character "1". The string of binary characters represented by the serrations 230 is thus "01010110", representing the tag identifier and corresponding to the identification markings 240.

The identification tag 200 can be used to attach to an asset such as another article or object. For example, the identification tag 200 is attachable to an asset such as the pipe spool 100 commonly used in the ship building and repair industry, wherein the pipe spool 100 is identifiable based on the tag identifier. During the pipe spool
5 fabrication processes, the pipe spool 100 is sent for various harsh, abrasive, or chemical treatments. After these treatments, the identification markings 240 can be expected to become partially or wholly illegible as shown in Figure 3B. The pipe spool 100, which the identification tag 200 is attached to, cannot be identified by the identification markings 240 as they have become damaged from the harsh treatments.

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However, the edges of the identification tag 200, particularly the serrated edge 220 and its serrations 230, remain sufficiently intact after the treatments despite the harshness of such treatments. While the surface profile of the serrations 230 may be slightly damaged by the treatments, the overall geometries of the serrations 230
15 remain sufficiently intact to derive the tag identifier. As the serrated edge 220 represents the tag identifier derived from the string of characters represented by the serrations 230, the identification tag 200 and consequently the pipe spool 100 can be identified by the serrated edge 220 and tag identifier.

20 In another example of the identification tag 200 as shown in Figure 4, the pattern of serrations 230 includes notches and straight portions, each serration 230 representing a binary character. A notch has a semi-circular shape and represents the binary character "1", and a straight portion represents the binary character "0". The string of binary characters represented by the serrations 230 is thus "1011010111". The
25 identification markings 240 may include the string of binary characters "1011010111". The identification markings 240 may include another identification code 250, such as "727" as shown in Figure 4. The identification markings 240 may optionally include other details associated with the identification tag 200 and/or pipe spool 100. The identification tag 200 and pipe spool 100 can be identified by the tag identifier
30 represented by the serrated edge 220, wherein the tag identifier is derived from the string of characters.

In some embodiments, the identification tag 200 has a plurality of serrated edges 220 and various edge patterns can be used to represent the tag identifiers. In one embodiment as shown in Figure 5, the identification tag 200 has a first serrated edge 222 and a second serrated edge 224. Each serrated edge 222,224 has a corresponding series of serrations 230 including notches and straight portions, each serration 230 representing a binary character. A notch has a semi-circular shape and represents the binary character "1", and a straight portion represents the binary character "0". The first serrated edge 222 and its string of binary characters represent a first tag identifier "11001001", such as shown as first identification markings 242.

5 The second serrated edge 224 and its string of binary characters represents a second tag identifier "10101101", such as shown as second identification markings 244. The first tag identifier may refer to an item identification code of the identification tag 200 and the second tag identifier may refer to a batch identification code of the identification tag 200. Having two or more different tag identifiers for an identification

10 tag 200 may be useful if item identification codes are recycled across different batches, each batch having a unique batch identification code.

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Each serration 230 can be of various shapes and sizes and using a combination of varying serrations 230 can allow for higher order edge patterns to be formed in the serrated edges 220. In one embodiment as shown in Figure 6, the identification tag 200 has a first serrated edge 222 and a second serrated edge 224. Each serrated edge 222,224 has a corresponding series of serrations 230 including notches and straight portions, each serration 230 representing a binary character. A semi-circular-shaped notch represents a pair of binary characters "1 1", a saw-tooth-shaped notch represents a pair of binary characters "1 0", a square-shaped-notch represents a pair of binary characters "0 1", and a straight portion represents a pair of binary characters "0 0". The first serrated edge 222 and its string of binary characters represent a first tag identifier "11001001", such as shown as first identification markings 242. The second serrated edge 224 and its string of binary characters represents a second tag identifier "10101101", such as shown as second identification markings 244.

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Notably, in the embodiments as shown in Figure 5 and Figure 6, the first tag identifiers are the same and the second tag identifiers are also the same. However, in the

embodiment as shown in Figure 6, the same tag identifier can be represented with fewer serrations 230 by using different shapes. This allows the size of the identification tag 200 of Figure 6 to be smaller than the one of Figure 5.

5 In representative or exemplary embodiments of the present disclosure, there is a system 300 for registering and identifying an identification tag 200 as shown in Figure 7. The system 300 includes the identification tag 200 and an object which the identification tag 200 is attached to, such as the pipe spool 100. The system 300 further includes an imaging device 310 for capturing images of the identification tag
10 200. The imaging device 310 may be a camera or a handheld scanner. The system 300 further includes an electronic device 320 for obtaining the captured images of the identification tag 200 from the imaging device 310. In some embodiments, the imaging device 310 is a separate device from the electronic device 320 and communicatively connected to the electronic device 320. In some embodiments, the imaging device
15 310 is integrated with the electronic device 320. The electronic device 320 may be, but is not limited to, a mobile phone or tablet device.

The system 300 further includes an image database 330 for storing images of identification tags 200. The electronic device 320 is communicative with the image
20 database 330 for sending and receiving images to and from the image database 330. In some embodiments, the image database 330 is hosted in an internal data storage module of the electronic device 320. In some embodiments, the image database 330 is hosted on a remote server communicatively connected to the electronic device 320. The remote server may be based on a centralized model, decentralized model, or
25 hybrid model. As used herein, a server is a physical or cloud data processing system on which a server program runs. The server may be implemented in hardware or software, or a combination thereof. Some non-limiting examples of the server include computers, laptops, mini-computers, mainframe computers, any non-transient and tangible machines that can execute a machine-readable code, cloud-based servers,
30 distributed server networks, and a network of computers.

The electronic device 320 may communicate with the remote server across a communication network which is a medium or environment through which content,

notifications, and/or messages are communicated among various components. Some non-limiting examples of the communication network include a virtual private network (VPN), wireless fidelity (Wi-Fi) network, light fidelity (Li-Fi) network, local area network (LAN), wide area network (WAN), metropolitan area network (MAN), satellite network, Internet, fiber optic network, coaxial cable network, infrared (IR) network, radio frequency (RF) network, and any combination thereof. Various components in the communication network may connect to it in accordance with various wired and wireless communication protocols, such as Transmission Control Protocol / Internet Protocol (TCP/IP), User Datagram Protocol (UDP), 2nd to 5th Generation (2G to 5G) communication protocols, Long Term Evolution (LTE) communication protocols, and any combination thereof. Each component to the communication network includes a data communication or transceiver module to communicate and transmit / receive data over the communication network. Some non-limiting examples of a transceiver module include an antenna module, a radio frequency transceiver module, a wireless transceiver module, a Bluetooth transceiver module, an Ethernet port, a Universal Serial Bus (USB) port, or any other module / component / device configured for transmitting and receiving data.

With reference to Figure 8, there is a computer-implemented or computerized method 400 performed in the system 300 for identifying the identification tag 200 after treatment 340 of the identification tag 200. More specifically, the method 400 is performed by the electronic device 320 for identifying the identification tag 200 that has been damaged by various treatment processes 340, such as sandblasting and galvanizing.

The method 400 includes a step 402 of obtaining an image 350 of the identification tag 200. As the identification tag 200 has been treated, this image 350 may be referred to as a post-treatment image 350. For example, the imaging device 310 captures the post-treatment image 350 and sends it to the electronic device 320. Alternatively, the electronic device 320 is integrated with the imaging device 310 and directly captures the post-treatment image 350.

The identification tag 200 may have identification markings 240 on its body 210 but these identification markings 240 would have been damaged or defaced by the treatment 340. The damaged identification markings 240 could not be relied on to identify the identification tag 200 post-treatment.

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The method 400 further includes a step 404 of finding, in the post-treatment image 350, a number of serrated edges 220 of the identification tag 200, each serrated edge 220 having a plurality of serrations 230 formed thereon. Optionally, the method 400 includes isolating the identification tag 200 in the post-treatment image 350 before
10 finding the serrated edges 220. Optionally, the method 400 includes performing corrective actions on the post-treatment image 350 before finding the serrated edges 220, such as aligning and/or cropping the post-treatment image 350. Optionally, the method 400 includes performing refinement actions on the post-treatment image 350 to improve its properties such as brightness, contrast, and/or resolution.

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The method 400 further includes a step 406 of determining characters from the respective serrations 230 of each serrated edge 220. As described above, each serration 230 represents a set of characters such as a binary number or combination of binary numbers. More specifically, the electronic device 320 identifies the serrations
20 230 as the region of interest and recognizes the geometries (e.g. shapes and/or sizes) of the serrations 230. The electronic device 320 compares the serration geometries using a predefined image recognition algorithm that matches each serration geometry to a predefined set of characters.

25 The method 400 further includes a step 408 of deriving, for each serrated edge 220, a tag identifier from the respective characters of the serrated edge 220. More specifically, the electronic device 320 derives, using the image recognition algorithm, the string of characters represented by the series of serrations 230 of the respective serrated edge 220. The string of characters represents the tag identifier and the
30 identification tag 200 is identifiable by the tag identifier. The tag identifier may correspond to the identification markings 240 which have been damaged by the treatment 340. However, the serrated edge 220 and its serrations 230 remain

sufficiently intact after the treatment 340, and so can be relied on to determine the tag identifier to identify the identification tag 200.

The method 400 may include retrieving, from the image database 330, another image
5 of the identification tag 200 using the tag identifier. This other image is captured before the identification tag 200 has been treated, and this other image may be referred to as a pre-treatment image 360. Notably, the pre-treatment image 360 shows the identification tag 200 that is still intact, including the identification markings 240 that have not yet been damaged by the treatment 340. For example, the tag identifier is
10 used to search the image database 330 for the pre-treatment image of the identification tag 200. Alternatively, the tag identifier may be converted to the identification code 250 to query the image database 330.

Pre-treatment images 360 of identification tags 200 are captured and stored in the
15 image database 330 to register the identification tags 200 for subsequent identification thereof using the method 400. With reference to Figure 9, there is a computer-implemented or computerized method 500 performed in the system 300 for registering the identification tag 200 before treatment 340 thereof. More specifically, the method 500 is performed by the electronic device 320 for registering the identification tag 200
20 that is still intact and has not been damaged by the treatment 340.

The method 500 includes a step 502 of obtaining a pre-treatment image 360 of the identification tag 200. For example, the imaging device 310 captures the pre-treatment image 360 and sends it to the electronic device 320. Alternatively, the electronic device
25 320 is integrated with the imaging device 310 and directly captures the pre-treatment image 360.

The method 500 further includes a step 504 of finding, in the pre-treatment image 360, a number of serrated edges 220 of the identification tag 200, each serrated edge 220
30 having a plurality of serrations 230 formed thereon. Optionally, the method 500 includes isolating the identification tag 200 in the pre-treatment image 360 before finding the serrated edges 220. Optionally, the method 500 includes performing corrective actions on the pre-treatment image 360 before finding the serrated edges

220, such as aligning and/or cropping the pre-treatment image 360. Optionally, the method 500 includes performing refinement actions on the pre-treatment image 360 to improve its properties such as brightness, contrast, and/or resolution.

- 5 The method 500 further includes a step 506 of determining characters from the respective serrations 230 of each serrated edge 220. The method 500 further includes a step 508 of deriving, for each serrated edge 220, a tag identifier from the respective characters of the serrated edge 220. It will be appreciated that the steps 506 and 508 are similar or analogous to the steps 406 and 408, and are not further described for
10 purpose of brevity.

The method 500 further includes a step 510 of storing the pre-treatment image 360 on the image database 330, wherein the pre-treatment image 360 is identifiable by the tag identifier. The pre-treatment image 360 that is stored on the image database 330
15 may have been modified by the corrective and/or refinement actions mentioned above. Thus, the pre-treatment image 360 can be identified and retrieved using the method 400 described above, even though the identification markings 240 have been damaged or defaced by the treatment 340.

- 20 In some embodiments, the methods 400 and 500 further include identifying the shape of the body 210 and determining a shape identifier based on the body shape. More specifically, the electronic device 320 recognizes the geometry of the body shape and compares it using the image recognition algorithm that matches the body shape to a predefined shape identifier. The shape identifier may complement the tag identifier for
25 identifying the identification tag 200 / pre-treatment image 360. This may be useful to identify different identification tags 200 having the different body shapes (e.g. rectangle and square) but having the same serrated edge 220 (e.g. on one side of the body 210).

- 30 As described above, the body 210 and serrations 230 can be of various geometries with different shapes and/or sizes to form varying body shapes and edge patterns of the serrated edges 220. Various non-limiting examples of edge patterns of a serrated edge 220 including its serrations 230 are shown in Figure 10A. Various non-limiting

examples of shapes of the body 210 are shown in Figure 10B. For example, the body shape may be polygonal or circular. Various non-limiting examples of the identification tag 200 having various geometries of the body 210 and serrations 230 are shown in Figure 10C. In some cases, the identification tag 200 has an inner serrated edge 220 and an outer serrated edge 220. It will be appreciated that the identification tag 200 may use any suitable geometry for the body 210 and serrations 230, depending on various considerations. These factors include, but are not limited to, ease and cost of manufacturing the identification tag 200, level of vulnerability of the serrations 230 to be damaged or distorted by the treatment 340 which include harsh or abrasive treatment processes, and the ability of the image recognition algorithm to recognize the serrations 230 and determine the tag identifier.

Therefore, the identification tag 200 of the present disclosure is tolerant and less vulnerable to damage by harsh or abrasive treatment processes 340, and is capable of being identified after the treatment processes 340. The identification tag 200 has a number of serrated edges 220 each with a series of serrations 230 that represent unique tag identifiers. By using serrated edges 220 instead of holes or perforations through the body 210 to represent the tag identifier, the identification tag 200 avoids covering of the holes or perforations by the galvanizing process. The galvanizing process would make the holes or perforations illegible as identifiers (e.g. the identification markings 112 of an existing identification tag 110) and recognizing them would be very difficult or even impossible.

The identification tag 200 of the present disclosure can be readily image captured, image processed, recognized, and decoded for determining the tag identifier. The imaging device 310 and electronic device 320 are configured to capture the post-treatment image 350 of the identification tag 200 and to automatically determine the tag identifier to identify the identification tag 200. The serrated edges 220 are tolerant to harsh and abrasive treatment processes 340 and can be relied on to identify the identification tag 200, as have been described above. Moreover, the image recognition algorithm employed by the electronic device 320 is kept simple to ensure fast image processing and decoding, especially if the electronic device 320 has limited computing capacity.

The electronic device 320 includes a processor, memory devices, and an image processing module to process the post-treatment image 350 to determine the tag identifier. The processor executes instructions, codes, computer programs, and/or
5 scripts which it accesses from the memory devices. The processor includes suitable logic, circuitry, and/or interfaces to execute such instructions. Some non-limiting examples of the processor include an application-specific integrated circuit (ASIC) processor, a reduced instruction set computing (RISC) processor, a complex instruction set computing (CISC) processor, a field-programmable gate array (FPGA),
10 and the like. One or multiple processors may be present. Thus, while instructions may be discussed as executed by a processor, the instructions may be executed simultaneously, serially, or otherwise executed by one or multiple processors (e.g. in a multi-core configuration).

15 The memory devices may include storage devices (such as flash memory, disk drives, or memory cards), read-only memory (ROM), and random-access memory (RAM). The memory devices store non-transitory instructions operative by the processor to perform various operations or steps of the methods 400,500 according to various embodiments of the present disclosure. The memory devices may be referred to as
20 computer-readable storage media and/or non-transitory computer-readable media. Non-transitory computer-readable media include all computer-readable media, with the sole exception being a transitory propagating signal per se.

The processor cooperates with various modules / components of the electronic device
25 320, particularly the image processing module, for performing steps of the methods 400,500. The image processing module is configured for performing the image processing of the images 350,360 in cooperation with the processor, as described above in the methods 400,500.

30 As used herein, the terms "component", "module", and the like are generally intended to refer to a computer-related entity, either hardware, a combination of hardware and software, software, or software in execution. For example, a component or a module 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 controller and the controller can be a component / module. One or more components / modules may reside within a process and/or thread of execution. A component / module may be localized on one computer
5 and/or distributed among a plurality of computers.

The methods 400 and 500 respectively describe identifying and registering the identification tag 200 using the electronic device 320. In some cases, the identification tag 200 can be identified manually by a human person. With reference to Figure 11,
10 there is a method 600 for identifying the identification tag 200. Notably, the method 600 is performed manually instead of by the electronic device 320 or any computer.

The method 600 includes a step 602 of getting a physical form of the identification tag 200. For example, the physical form of the identification tag 200 may include the identification tag 200 itself and/or a photograph thereof. The physical form may also
15 be an electronic device that is able to display a digital image of the identification tag 200.

The method 600 further includes a step 604 of finding, in the physical form of the identification tag 200, a number of serrated edges 220 of the identification tag 200,
20 each serrated edge 220 having a plurality of serrations 230 formed thereon. The method 600 further includes a step 606 of determining characters from the respective serrations 230 of each serrated edge 220. The method 600 further includes a step 608 of deriving, for each serrated edge 220, a tag identifier from the respective characters
25 of the serrated edge 220.

The method 600 may be performed by a human person to identify the identification tag 200, which has been treated by the treatment processes 340, based on the tag identifier. Moreover, the method 600 may include recording the tag identifier to register
30 the identification tag 200 before treatment thereof. For example, the tag identifier may be recorded manually on a physical record to enable subsequent identification using the tag identifier. The tag identifier may also be input into the image database 330.

The identification tag 200 can be a low-cost product that can be fabricated by various manufacturing methods, such as metal forming. For example, the body 210 is formed and the serrations 230 are punched out according to their unique edge patterns. The body 210 including the serrated edges 220 may be integrally formed, such as by
5 moulding. A metallic identification tag 200 typically costs around 10 cents each.

In some embodiments, the identification tag 200, or a product comprising it, may be formed by a manufacturing process that includes an additive manufacturing process. A common example of additive manufacturing is three-dimensional (3D) printing;
10 however, other methods of additive manufacturing are available. Rapid prototyping or rapid manufacturing are also terms which may be used to describe additive manufacturing processes.

As used herein, “additive manufacturing” refers generally to manufacturing processes
15 wherein successive layers of material(s) are provided on each other to “build-up” layer-by-layer or “additively fabricate”, a 3D component. This is compared to some subtractive manufacturing methods (such as milling or drilling), wherein material is successively removed to fabricate the part. The successive layers generally fuse together to form a monolithic component which may have a variety of integral sub-
20 components. In particular, the manufacturing process may allow an example of the disclosure to be integrally formed and include a variety of features not possible when using prior manufacturing methods.

Additive manufacturing methods described herein enable manufacture to any suitable
25 size and shape with various features which may not have been possible using prior manufacturing methods. Additive manufacturing can create complex geometries without the use of any sort of tools, moulds, or fixtures, and with little or no waste material. Instead of machining components from solid billets of plastic or metal, much of which is cut away and discarded, the only material used in additive manufacturing
30 is what is required to shape the part.

Suitable additive manufacturing techniques in accordance with the present disclosure include, for example, Fused Deposition Modelling (FDM), Selective Laser Sintering

(SLS), 3D printing such as by inkjets and laserjets, Stereolithography (SLA), Direct Selective Laser Sintering (DSLS), Electron Beam Sintering (EBS), Electron Beam Melting (EBM), Laser Engineered Net Shaping (LENS), Electron Beam Additive Manufacturing (EBAM), Laser Net Shape Manufacturing (LNSM), Direct Metal
5 Deposition (DMD), Digital Light Processing (DLP), Continuous Digital Light Processing (CDLP), Direct Selective Laser Melting (DSLM), Selective Laser Melting (SLM), Direct Metal Laser Melting (DMLM), Direct Metal Laser Sintering (DMLS), Material Jetting (MJ), NanoParticle Jetting (NPJ), Drop On Demand (DOD), Binder Jetting (BJ), Multi Jet Fusion (MJF), Laminated Object Manufacturing (LOM), and other known
10 processes.

The additive manufacturing processes described herein may be used for forming components using any suitable material. For example, the material may be metal, plastic, polymer, composite, or any other suitable material that may be in solid, liquid,
15 powder, sheet material, wire, or any other suitable form or combinations thereof. More specifically, according to exemplary embodiments of the present disclosure, the additively manufactured components described herein may be formed in part, in whole, or in some combination of materials suitable for use in additive manufacturing processes and which may be suitable for the fabrication of examples described herein.

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As noted above, the additive manufacturing process disclosed herein allows a single component to be formed from multiple materials. Thus, the examples described herein may be formed from any suitable mixtures of the above materials. For example, a component may include multiple layers, segments, or parts that are formed using
25 different materials, processes, and/or on different additive manufacturing machines. In this manner, components may be constructed which have different materials and material properties for meeting the demands of any particular application. In addition, although the components described herein are constructed entirely by additive manufacturing processes, it should be appreciated that in alternate embodiments, all
30 or a portion of these components may be formed via casting, machining, and/or any other suitable manufacturing process. Indeed, any suitable combination of materials and manufacturing methods may be used to form these components.

Additive manufacturing processes typically fabricate components based on 3D information, for example a 3D computer model (or design file), of the component. Accordingly, examples described herein not only include products or components as described herein, but also methods of manufacturing such products or components
5 via additive manufacturing and computer software, firmware or hardware for controlling the manufacture of such products via additive manufacturing.

The structure of the product may be represented digitally in the form of a design file. A design file, or computer aided design (CAD) file, is a configuration file that encodes
10 one or more of the surface or volumetric configuration of the shape of the product. That is, a design file represents the geometrical arrangement or shape of the product.

Design files can take any now known or later developed file format. For example, design files may be in the Stereolithography or "Standard Tessellation Language" (.stl)
15 format which was created for Stereolithography CAD programs of 3D Systems, or the Additive Manufacturing File (.amf) format, which is an American Society of Mechanical Engineers (ASME) standard that is an extensible markup-language (XML) based format designed to allow any CAD software to describe the shape and composition of any 3D object to be fabricated on any additive manufacturing printer. Further examples
20 of design file formats include AutoCAD (.dwg) files, Blender (.blend) files, Parasolid (.x_t) files, 3D Manufacturing Format (.3mf) files, Autodesk (3ds) files, Collada (.dae) files and Wavefront (.obj) files, although many other file formats exist.

Design files can be produced using modelling (e.g. CAD modelling) software and/or
25 through scanning the surface of a product to measure the surface configuration of the product. Once obtained, a design file may be converted into a set of computer executable instructions that, once executed by a processor, cause the processor to control an additive manufacturing apparatus to produce a product according to the geometrical arrangement specified in the design file. The conversion may convert the
30 design file into slices or layers that are to be formed sequentially by the additive manufacturing apparatus. The instructions (otherwise known as geometric code or "G-code") may be calibrated to the specific additive manufacturing apparatus and may specify the precise location and amount of material that is to be formed at each stage

in the manufacturing process. As discussed above, the formation may be through deposition, through sintering, or through any other form of additive manufacturing method.

- 5 The code or instructions may be translated between different formats, converted into a set of data signals and transmitted, received as a set of data signals and converted to code, stored, etc., as necessary. The instructions may be an input to the additive manufacturing system and may come from a part designer, an intellectual property (IP) provider, a design company, the operator or owner of the additive manufacturing
10 system, or from other sources. An additive manufacturing system may execute the instructions to fabricate the product using any of the technologies or methods disclosed herein.

Design files or computer executable instructions may be stored in a (transitory or non-
15 transitory) computer readable storage medium (e.g., memory, storage system, etc.) storing code, or computer readable instructions, representative of the product to be produced. As noted, the code or computer readable instructions defining the product that can be used to physically generate the object, upon execution of the code or instructions by an additive manufacturing system. For example, the instructions may
20 include a precisely defined 3D model of the product and can be generated from any of a large variety of well-known CAD software systems such as AutoCAD®, TurboCAD®, DesignCAD 3D Max, etc. Alternatively, a model or prototype of the product may be scanned to determine the 3D information of the product. Accordingly, by controlling an additive manufacturing apparatus according to the computer
25 executable instructions, the additive manufacturing apparatus can be instructed to print out the product.

In light of the above, embodiments include methods of manufacture via additive manufacturing. This includes the steps of obtaining a design file representing the
30 product and instructing an additive manufacturing apparatus to manufacture the product according to the design file. The additive manufacturing apparatus may include a processor that is configured to automatically convert the design file into computer executable instructions for controlling the manufacture of the product. In

these embodiments, the design file itself can automatically cause the production of the product once input into the additive manufacturing apparatus. Accordingly, in this embodiment, the design file itself may be considered computer executable instructions that cause the additive manufacturing apparatus to manufacture the product.

- 5 Alternatively, the design file may be converted into instructions by an external computing system, with the resulting computer executable instructions being provided to the additive manufacturing apparatus.

Given the above, the design and manufacture of implementations of the subject matter
10 and the operations described in this specification can be realized using digital electronic circuitry, or in computer software, firmware, or hardware, including the structures disclosed in this specification and their structural equivalents, or in combinations of one or more of them. For instance, hardware may include processors, microprocessors, electronic circuitry, electronic components, integrated circuits, etc.
15 Implementations of the subject matter described in this specification can be realized using one or more computer programs, i.e., one or more modules of computer program instructions, encoded on computer storage medium for execution by, or to control the operation of, data processing apparatus. Alternatively or in addition, the program instructions can be encoded on an artificially generated propagated signal, e.g., a
20 machine-generated electrical, optical, or electromagnetic signal that is generated to encode information for transmission to suitable receiver apparatus for execution by a data processing apparatus. A computer storage medium can be, or be included in, a computer-readable storage device, a computer-readable storage substrate, a random or serial access memory array or device, or a combination of one or more of them.
25 Moreover, while a computer storage medium is not a propagated signal, a computer storage medium can be a source or destination of computer program instructions encoded in an artificially generated propagated signal. The computer storage medium can also be, or be included in, one or more separate physical components or media (e.g., multiple CDs, disks, or other storage devices).

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Although additive manufacturing technology is described herein as enabling fabrication of complex objects by building objects point-by-point, layer-by-layer, typically in a vertical direction, other methods of fabrication are possible and within the

scope of the present subject matter. For example, although the discussion herein refers to the addition of material to form successive layers, one skilled in the art will appreciate that the methods and structures disclosed herein may be practiced with any additive manufacturing technique or other manufacturing technology.

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In the foregoing detailed description, embodiments of the present disclosure in relation to the identification tag 200 are described with reference to the provided figures. The description of the various embodiments herein is not intended to call out or be limited only to specific or particular representations of the present disclosure, but merely to
10 illustrate non-limiting examples of the present disclosure. The present disclosure serves to address at least one of the mentioned problems and issues associated with the prior art. Although only some embodiments of the present disclosure are disclosed herein, it will be apparent to a person having ordinary skill in the art in view of this disclosure that a variety of changes and/or modifications can be made to the disclosed
15 embodiments without departing from the scope of the present disclosure. Therefore, the scope of the disclosure as well as the scope of the following claims is not limited to embodiments described herein.

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