

METHOD FOR READING AND WRITING DATA WIRELESSLY FROM SIMULATED MUNITIONS

BACKGROUND OF THE INVENTION

[0001] Weapon simulation systems are commonly used for combat training and/or shooting practice. Such systems are designed to simulate the effects of a specific weapon type with a specific computer-generated target. There are numerous different types of munitions that are compatible with any one weapon, such as a 40mm grenade launcher (manufacturer independent). Some of these round types include high explosive, airburst, star cluster, flare, smoke, and practice. Because of this, there have been many attempts by firearms simulation manufacturers to create a method for simulating different types of munitions to be used in weapon simulation systems and be able to monitor the type of munition used in the weapon simulation system.

[0002] One method for reading different round types on a mortar launcher was using different color charge rings and a compatible color sensor to detect which charge ring is installed on the mortar. The mortar would then communicate via contacts on the mortar and launcher once the mortar had come to rest. This system was limited in many ways. The largest problem was sunlight causing large offsets and incorrect readings with the color sensor. Another issue is the ability to pick up a difference in color. Because the colors had to have a significant difference in wavelength in order to detect each one with no errors, the round types were limited to less than ten. Additionally, communicating via electrical contacts proved to be unreliable due to corrosion and mechanical bounce. Lastly, there was no ability to store any other data on the round such as a serial number or

usage data. Other methods for determining different round types suffer from very similar limitations.

[0003] Another example of a previous method for detecting round type is described in patent number 5,201,658. This implementation uses frequency resonance to detect different round types. There are a few disadvantages to using this type of detection. The most notable disadvantage is the inability to convey more information than just the round type. Additionally the round frequency is set by hardware design and cannot be changed without disassembling the round and replacing the resonant circuit.

SUMMARY OF THE INVENTION

[0004] A system and method for reading and writing data wirelessly from simulated munitions during a weapon simulation scenario includes a simulated weapon that is in electrical connection with a primary simulation computer and an instructor computing station. The simulated weapon includes an insert which will receive a simulated munition. The insert includes an antenna that is connected to an RFID transceiver, with the transceiver further being connected to a weapon controller. An RFID tag is installed within the simulated munition, with the RFID tag storing information about the simulated munition and transmitting that information to the weapon controller via the RFID transceiver when the simulated munition passes the antenna. The weapon controller will further transmit the simulated munition information to the primary simulation computer for proper identification in the weapon simulation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Figure 1 is a block diagram of the components of a weapon simulation system incorporating a simulated munition having wireless transmissions with a controller of a simulated weapon;

[0006] Figure 2a is a side sectional exploded view of one embodiment of the simulated munition used in the simulated weapon;

[0007] Figure 2b is a side sectional view of the assembled simulated munition illustrated in Figure 2a;

[0008] Figure 3a is a perspective view of a first embodiment of an insert;

[0009] Figure 3b is a perspective view of a second embodiment of the insert;

[0010] Figure 4 is a composite side sectional view of the simulated munition illustrated in Figure 2b combined with the insert illustrated in Figure 3 in a simulated weapon;

[0011] Figure 5 is a composite side sectional view of the simulated munition combined with the insert as illustrated in Figure 4, the antenna having an extended wrap around the insert; and

[0012] Figure 6 is an exploded side sectional view of the simulated munition with respect to the insert, the antenna extending around the edge of the insert.

DESCRIPTION OF THE INVENTION

[0013] A system and method for reading and writing data wirelessly from simulated munitions **24** is illustrated in the attached Figures 1-6. Looking first to Figure 1, a weapons simulation system **10** is shown having a simulated weapon **12** that is in electrical connection with a primary simulation computer **14**, such as with a serial or

wireless (e.g., Bluetooth) connection **15**. The primary simulation computer **14** generates an electronic simulation scenario displayed on a screen or monitor to train a user in the use of the simulated weapon **12**, and monitors the use of the simulated weapon **12** in the scenario. The primary simulation computer **14** is further in electrical communication with an instructor computing station **16**, again such as with a serial or wireless (e.g., Bluetooth) connection **17**. The instructor computing station **16** may be any computer or similar device that allows the instructor to further monitor the user's interaction and control the weapon simulation.

[0014] The simulated weapon **12** has the appearance of an actual weapon, and includes a weapon controller **18** that monitors the operation of various sensors that are used with the simulated weapon **12**, such as a magazine present sensor, a trigger sensor, a safety sensor, a hammer position sensor, as well as others as conventionally used with various simulated weapons **12**. The weapon controller **18** may be a conventional microcontroller or microprocessor that is able to control operation of the simulated weapon **12**, and it is additionally in electrical communication with a radio-frequency identification (RFID) transceiver **20** that is housed in the simulated weapon **12**. As discussed further herein, the RFID transceiver **20** is connected with an antenna **28**, which will communicate with an RFID transponder tag **26** housed in the simulated munition **24** when the simulated munition **24** is used with the simulated weapon **12**.

[0015] As a bit of background, RFID is an automatic identification method, relying on storing and remotely retrieving data using the RFID tags **26** or transponders. The RFID tag **26** is an object that can be applied to or incorporated into a product or item for the purpose of identification using radio waves. Some RFID tags **26** can be read from a

very close proximity of the transceiver **20**, while others may be meters away and beyond the line of sight of the reader, and still others may be accessible hundreds of meters away. Most RFID tags **26** contain at least two parts. The first part is an integrated circuit for storing and processing information, modulating and demodulating a radio frequency (RF) signal, and other specialized functions. The second component is an antenna for receiving and transmitting the signal to the transceiver **20**.

[0016] Referring back to Figure 1, the RFID transceiver **20** is connected with the antenna **28** via an impedance matching circuit **22**. The impedance matching circuit **22** which is used to match the resistance of the transceiver **20** with the simulated munition **24** for efficient operation. The RFID transponder tag **26** as described above is placed inside of the simulated munition round **24** to store information about what type of munition is being simulated in the system **10**. This intelligent simulated munitions round **24** is used in the simulated weapon **12**. The RFID tag **26** also stores other data including serial numbers, usage data, service history, and other information useful for either the customer or the manufacturer. The RFID tag **26** is read by the RFID transceiver **20** that is connected with the simulated weapon **12**, the transceiver **20** being added on or supported in the simulated weapon **12**. The communications between the RFID tag **26** and the RFID transceiver **20** are accomplished using an antenna **28**. The RFID transceiver **20** and the antenna **28** are connected through the impedance matching circuit board **22** and a coaxial cable **23**. The RFID tag **26** is read by the RFID transmitter **20** when the simulated munition **24** is inserted into the simulated weapon **12** and after the simulated munition **24** has been seated into the barrel **54** or launch tube of the simulated weapon **12**. After the RFID tag **26** is read, the weapon controller **18** will make decisions

based on what type of simulated munitions round was read from the RFID tag **26**. The data read from the RFID tag **26** is communicated to the primary simulation computer **14** and then to the instructor's computing station **16** so that instructor's computing station **16** may visually and audibly display the information to the user.

[0017] Continuing to view Figure 1, the block diagram of the system **10** shows the data flow and processing blocks of the system **10**. The instructor's computing station **16** is used to control, monitor, and update the simulation being run in real-time by a course instructor. That is, the instructor's computing station **16** will generate the graphics and scenarios being used to interact and train the user of the simulated weapon **12**. During the simulation, the primary simulation computer **14** receives data and commands from both the instructor's computing station **16** and the weapon controller **18**. The primary simulation computer **14** makes simulation decisions based on its programming and displays feedback to the trainee via visual means such as a projector onto a screen or using a television or monitor (not illustrated).

[0018] There are two separate processing blocks within the simulated weapon **12** which can run independent of one another. The weapon controller **18** is responsible for controlling all weapon timing of outputs, the reading of various sensors associated with the simulated weapon **12**, and communication with the primary simulation computer **14**. The RFID transceiver **20** executes commands to the RFID tag or transponder **26** via the antenna **28** and reads the responses from the RFID tag **26**. The RFID transceiver **20** packetizes the data received from the RFID tag **26** and sends the data via a serial bus **19** or another electrical connection to the weapon controller **18**. The weapon controller **18** reads the data in from the serial bus **19** and interprets the data from the RFID tag **26** as

just another sensor. The weapon controller **18** will make decisions on how to fire the simulated weapon **12** based on the data from the RFID tag **26** along with other weapon sensors associated with the simulated weapon **12**. The data from the RFID tag **26** gets re-packetized in a different format and sent to the primary simulation computer **14** where it is used for visual feedback to the trainee using the simulated weapon **12**.

[0019] As an example, if the simulated munition **24** was designed to have a round type such as "Smoke," then, when the simulated weapon **12** is fired, the primary simulation computer **14** will display smoke on screen corresponding to where the round was fired. However, if the round type of the simulated munition **24** is a high explosive grenade, then the primary simulation computer **14** will display an explosion on screen. Thus, various simulated munitions **24** may be incorporated into the training of the user. The data from the RFID tag **26** is also available to be viewed by the instructor on the instructor's computing station **16**. It should further be noted that all of the parts of the system **10** used for RFID (seen within the dotted line in Figure 1) are interchangeable with other simulated weapons **12**. In addition, note that mechanical changes made be required to meet space constraints for various simulated weapons **12**.

[0020] The RFID tags **26** used in the illustrated system **10** are passive, although it is foreseen that other types of RFID tags **26** may be implemented. That is, RFID tags are generally passive, active or semi-passive. Passive tags require no internal power source, so they are only active when a reader is nearby to power them. In contrast, semi-passive and active tags require a power source, such as a small battery. For passive RFID tags that have no internal power supply, the minute electrical current induced in the antenna by the incoming radio frequency signal provides just enough power for the integrated

circuit in the tag to power up and transmit a response. Passive tags have practical read distances ranging from about four inches up to a few almost 600 feet.

[0021] In comparison to passive RFID tags, active RFID tags have their own internal power source that is used to power the integrated circuit and to broadcast the response signal to the reader. Communications from active tags to readers is typically much more reliable than communications from passive tags. Due to their on board power supply, active tags may transmit at higher power levels than passive tags, allowing them to be more robust at longer distances and in different environments. Many active tags today have operational ranges of hundreds of meters, and a battery life of up to ten years. Active tags may include larger memories than passive tags, and may include the ability to store additional information received from the reader. Although the embodiments shown herein include passive RFID tags **26**, it is noteworthy that an active or semi-passive RFID tag **26** could be implemented for the user to achieve the desired results.

[0022] Referring to Figures 2-6, various embodiments of the simulated weapon **12** and simulated munition **24** are illustrated. In these embodiments, a simulated grenade launcher is able to fire a simulated munition **24** in the form of a 40mm grenade **40**. Although a grenade is illustrated, various types of munitions could be implemented. Nonetheless, the simulated grenade **40** is composed of two parts similar to an actual 40mm grenade, namely, a simulated projectile **42** and an aluminum cartridge case **44**. The simulated projectile **42** is created from a nylon rod turned down to match the profile of the live round. The inside of the projectile **42** is bored out and female threads **46** are cut into the diameter to mate with the cartridge case **44**, also known as the shell. The cartridge case **44** may be made from aluminum, and has an outer diameter closely

resembling that of a live round. The cartridge case **44** also has a smaller threaded diameter **47** that threads into the nylon projectile **42**. Once the cartridge case **44** is threaded completely into the projectile **42**, a small cavity **48** is defined for the placement of the RFID tag **26**. In many cases depending on the munition being simulated, the RFID tag **26** may not completely and snugly fit into the small cavity **48**. In such cases, a spacer **50**, such as a nylon spacer and/or one or more foam pads **49** may be included to secure the RFID tag **26** in place and help prevent malfunction of the RFID tag **26** from unnecessary physical activity. Looking to Figures 2b and 4, the RFID tag **26** is supported by the foam pads **49a**, **49b**, with one foam pad **49b** abutting the spacer **50**.

[0023] Looking to Figure 3a, a thin walled insert **52** is designed to snugly fit into or abut an inner surface of the simulated weapon **12**, such as the inner surface of the barrel **54** of the simulated weapon **12** (although the insert **52** may be positioned relative to other components of the simulated weapon **12** as appropriate to the operation of the weapon). Looking to Figure 4, the barrel insert **52** is designed to fit into the barrel **54** of a simulated launcher or firearm, and may be affixed to the barrel **54** or launcher using any conventionally known method, such as glue, a press fit, or a screw or other connector extending through the barrel **54** and the insert **52**. The barrel insert **52** has a longitudinal groove cut **56** that is used to house the coaxial cable **23** connecting the transceiver board with the antenna. A relief cut **58** in the barrel insert **52** extends along the groove cut **56**, and is used to support the antenna impedance matching circuit board. Looking to Figures 3a and 3b, the barrel insert **52** may additionally have at least one lateral groove cut **60** at one end of the longitudinal groove cut **56** around the circumference of the barrel insert **52** to receive the coil antenna **28** for the RFID transceiver **26**. In the embodiment shown in

Figure 3a and 4, the coil antenna **28** will wrap around the barrel insert **52** a limited number of times, such as three wraps around the barrel insert **52**. The number of wraps of the antenna **28** around the barrel insert **52** is inversely proportional to the frequency transmission. The fewer the wraps, the higher the frequency transmission.. However, it is noted that multiple wraps of the antenna **28** around the barrel insert **52** may be incorporated into the design. For example, in the embodiment shown in Figure 3b, the barrel insert **52** has three independent lateral groove cuts **60a**, **60b**, and **60c** that extend around the circumference of the barrel insert **52** at one end of the longitudinal groove cut **56**. As a result, in this embodiment, there will be three instances in which the RFID tag **26** will communicate with the antenna **28** as the simulated munition **24** is inserted into the barrel insert **52**. Further, referring to the embodiment shown in Figure 5, the antenna **28** may have multiple wraps around the insert **52**, with approximately 100 wraps of the antenna **28** being illustrated in this embodiment. Furthermore, referring to Figure 6, another embodiment illustrates the antenna **28** be disposed at the end of the insert **52**. In this embodiment, the RFID tag **26** will communicate with the RFID transceiver **20** as the simulated munition **24** is brought into range of the antenna **28**.

[0024] Once the simulated munition **20** is inserted into the barrel insert **52**, the RFID tag **26** will generally be positioned within the circumference of the antenna coil **28**. The position of the RFID tag **26** may vary according to the materials in the barrel **54** and the particular application of the simulated munition **26**, but it is desirable to have the RFID tag **26** positioned as close to the center of the circumference of the antenna **28** as possible. In the embodiment shown in Figure 4, it is estimated that the RFID tag **26** may be positioned 0.25 inches above or below the plane of the circumference of the antenna

28. The ends of the coil antenna **28** are attached to the impedance matching circuit board **22** that fits into the relief **58** also cut into the barrel insert **52**.

[0025] One end of the barrel insert **52** is a hollow recess **53** to receive the simulated 40mm grenade round **40** inside of the barrel insert **52**. The transceiver circuit board **20** that controls communication with the RFID tag **26** is located on the simulated weapon **12** where space allows. The coaxial cable **23** connects the antenna impedance matching circuit board **22** with the transceiver circuit board **20**. The transceiver circuit board **20** communicates with the weapon controller card **18** via an electronic connection, such as a serial data bus, to relay munitions data.

[0026] Utilizing radio-frequency identification for simulated munitions round type detection has many advantages. For example, the RFID tag **26** can be written to or read from at any time as long as it is within range of the antenna **28** connected to the transceiver **20**. This provides the advantage of allowing the same hardware to be used in all applications of simulated weapons **12** with only slight changes in the programming of the RFID tag **26**. If any data on the munitions round RFID tag **26** needs to be updated, it can be done at any time from a compatible RFID transceiver **20** without requiring an electrical connection to the RFID tag **26**. This includes the round type, service history, and usage data. Additionally, the RFID tag **26** may require no power (if passive, as discussed above) and is purchased as a commercial off the shelf part at a very small cost. This provides a large cost savings over custom applications throughout the life of the product. The RFID tags vary in memory capacity from 32Bytes to more than 256Bytes. As little as 32 Bytes would allow storage of 255 different round types and several bytes of service history and usage history. The round type could also be expanded larger

however more than 255 round types may be excessive. This amount of data storage provides a very large advantage over other round type detection methods. Lastly, due to the wireless and contact-less nature of RFID, there are no mechanical connections to brake or maintain. This allows for a nearly maintenance free product with high reliability.

[0027] Although the example of munitions described above was a grenade, it is to be noted that any other munition may be used in the system **10**. For example, the simulated munition **24** may take the form of a bullet, a missile, a warhead, or some other type of munition used in practicing the use of a weapon.

[0028] A first prototype RFID antenna **28** was built around a plastic tube **52** that allowed a round to be inserted into it for testing. A 40mm near-production simulated round was used with an RFID tag **26** installed. It had a read range of approximately 2.5 inches from the coil antenna **28** along the centerline of the plastic tube. To test a version closer to production assembly, the barrel insert **52** was made out of nylon with the relief cut **58** for the impedance matching circuit board **22** and the coil antenna **28**. This barrel insert **52** was placed into an aluminum tube with a 3/16 inch wall, which closely models a real barrel of a 40mm grenade launcher. Initially, the simulated aluminum barrel **54** was offsetting the resonate frequency of the antenna **28** enough for the RFID tag **26** to be unreadable. After retuning the antenna **28**, the system **10** was tested to have a read range of about three inches from the center of the coil antenna **28** along the centerline of the barrel **54**.

[0029] Having thus described exemplary embodiments of a METHOD FOR READING AND WRITING DATA WIRELESSLY FROM SIMULATED

MUNITIONS, it should be noted by those skilled in the art that the within disclosures are exemplary only and that various other alternatives, adaptations, and modifications may be made within the scope of the present invention. Accordingly, the invention is not limited to the specific embodiments as illustrated herein, but is only limited by the following claims.

CLAIMS

What is claimed is:

1. A method for identifying a simulated munition inserted into a simulated weapon in a weapon simulation system having a primary simulation computer generating a training scenario for a user, said method comprising the steps of:
 - a. storing information about the simulated munition in a radio frequency identification tag housed in the simulated munition;
 - b. placing the simulated munition into an insert in the simulated weapon;
 - c. transmitting the information from the radio-frequency identification tag to an radio-frequency identification transceiver housed in the simulated weapon;
 - d. transmitting the information from the RFID transceiver to a weapon controller of the simulated weapon; and
 - e. transmitting the information from the weapon controller to the primary simulation computer.
2. The method as described in claim 1, wherein step b) further comprises:
 - positioning the simulated munition fully in the insert for the radio-frequency identification tag to substantially align with an antenna wrapped around the insert; and
 - transmitting information from the radio-frequency identification tag to the radio-frequency identification transceiver via the antenna.
3. The method as described in claim 1, wherein prior to step a) including the steps of:
 - assembling the simulated munition by attaching a simulated projectile with a cartridge case to define a cavity between the simulated projectile and the cartridge case.

4. The method as described in claim 1 further comprising the step of:
placing the radio-frequency identification tag in the cavity and at least one spacer to protect the radio-frequency identification tag.
5. A weapon simulation system comprising:
a primary simulation computer generating a simulation scenario;
a simulated weapon having a weapon controller in electrical communication with the primary simulation computer;
a radio-frequency identification transceiver connected with the simulated weapon, the transceiver in electrical communication with the weapon controller;
an insert connected with the simulated weapon;
an antenna connected to the transceiver, the antenna being supported in the simulated weapon by the insert;
a simulated munition removeably engaging the insert in the simulated weapon;
a radio-frequency identification tag housed in the simulated munition, the tag being in electrical communication with the transceiver when the simulated munition is supported in the insert.
6. The weapon simulation system as described in claim 5 wherein said simulated munition further comprises a shell having a simulated projectile and a cartridge case defining a cavity to house the radio-frequency identification tag.
7. The weapon simulation system as described in claim 6 further comprising a nylon spacer housed in the cavity.

8. The weapon simulation system as described in claim 7 further comprising first and second foam pads surrounding the radio-frequency identification tag in the cavity, the second foam pad abutting the nylon spacer.
9. The weapon simulation system as described in claim 5, wherein said insert comprises a predetermined diameter and a lengthwise axis, with a portion of the antenna wrapping around the diameter of the insert to form a plane substantially normal to the lengthwise axis.
10. The weapon simulation system as described in claim 9, wherein the radio-frequency identification tag is substantially within the plane of the antenna wrapping around the diameter of the insert when the simulated munition is supported by the insert.
11. The weapon simulation system as described in claim 5 further comprising one or more grooves extending around the insert to receive the antenna.
12. A weapon simulation system for generating a training scenario for a weapon user, said system comprising:
 - a primary simulation computer generating the simulation scenario;
 - a simulated weapon housing a weapon controller in electrical communication with the primary simulation computer, the simulated weapon having a firearm barrel;
 - a radio-frequency identification transceiver housed in the simulated weapon, the transceiver in electrical communication with the weapon controller;
 - an insert connected with the barrel of the simulated weapon;
 - an antenna connected to the transceiver and surrounding the insert, the antenna being supported in the simulated weapon by the insert;
 - a simulated munition removeably engaging the insert in the simulated weapon;

a radio-frequency identification tag housed in the simulated munition and in electrical communication with the transceiver when the simulated munition is supported in the insert.

13. The weapon simulation system as described in claim 12 wherein said simulated munition further comprises a shell having a simulated projectile and a cartridge case defining a cavity to house the radio-frequency identification tag.

14. The weapon simulation system as described in claim 13 further comprising at least one spacer housed in the cavity.

15. The weapon simulation system as described in claim 14 further comprising first and second foam pads surrounding the radio-frequency identification tag in the cavity, the second foam pad abutting the spacer.

16. The weapon simulation system as described in claim 12, wherein said insert comprises a predetermined diameter and a lengthwise axis, with a portion of the antenna wrapped around the diameter of the insert to form a plane substantially normal to the lengthwise axis.

17. The weapon simulation system as described in claim 16, wherein the radio-frequency identification tag is substantially within the plane of the antenna wrapping around the diameter of the insert when the simulated munition is supported by the insert.

18. The weapon simulation system as described in claim 12, wherein the insert includes a first edge and a second edge, the antenna extending around the first edge of the insert.