

"An electronic shooting game apparatus"

The invention relates to an apparatus for an electronic shooting game played in an arena.

- 5 Possibly, the most important aspects of such apparatus are firstly the ease with which players can familiarise themselves with the game, and secondly the provision of challenging features which help maintain a players' interest over many games. The difficulty lies in addressing both aspects together - provision of either aspect alone is relatively simple.
- 10 Heretofore, most improvements in such apparatus have been quite specific, for example, improving accuracy of shooting. They seldom affect the overall, general nature in which the game is played and are thus of limited benefit in providing sufficient game challenges
- 15 to maintain a player's interest.

It is therefore an object of the invention to provide an apparatus which provides a major and general improvement in the manner in which games are played.

Statements of Invention

- 20 Accordingly there is provided an electronic shooting game apparatus comprising:
- a controller for controlling the course of a game in an arena;
 - at least one mobile player unit;
 - 25 a game communication means for communication of data in the apparatus; and
 - means for sensing the position of a player unit in the arena.
- 30 Advantageously this allows for the introduction of location information into the game. This information

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may be used in a wide variety of ways to add to user enjoyment of the game.

5 Preferably the apparatus comprises at least one zone control unit comprising means for defining a game playing zone within the arena. Thus, game operators may assign special game attributes to various zones throughout the arena. These attributes may apply to all or selected zones and given zones may be defined in different ways for different players. Therefore in 10 addition to using the location information for player tracking throughout the arena the information may also be used to for player handicapping.

15 In one embodiment, the zone control unit comprises a zone communication means for transmitting data to define a zone, and each mobile player unit comprises means for receiving said data. This is a particularly effective means of defining a zone and combines the functions of defining a zone and communication in one operation. It is of course possible to keep these functions separate 20 by, for example, providing a sensor which senses entry of a player unit into the zone and a transmitter to communicate sensing data to the game communication means.

25 In one embodiment the zone control unit comprises a zone controller. The zone control unit may comprise means for transmitting a unique zone identifier in said data under control of the zone controller. In one embodiment the zone communication means comprises a radiation transmitter activated by the zone controller. These 30 features provide for simple and effective transmission of location data. Further, the size of the zone may be easily altered by changing the spread of the radiation field.

35 In one embodiment a plurality of zone control units are provided, each for defining a zone within the arena in which the game may be played and for transmitting location information from each zone control unit to the mobile player units located within the zone associated with the zone control unit. This allows the system to

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accurately record a players location during the course of a game, it further allows the apparatus to keep track of a player's movements, this is useful for many game scenarios as well as providing a safety feature by
5 determining if a player is moving too quickly.

Ideally the radiation transmitter is an infra-red transmitter. Thus, the zone is defined in a relatively simple manner and may be readily altered by changing the spread of the infra-red field.

10 In one arrangement the zone communication means comprises means for transmitting status data to each mobile player unit. Thus, the zone control unit may also be used to transmit game information.

15 Preferably the zone communication means has a status receiver for receiving status data from a mobile player unit. Thus, the zone control unit may be used to receive game information.

Preferably the zone communication means comprises a transceiver.

20 Preferably the zone identification means is non-volatile and comprises a number of dip-switches for setting the zone identifier. This obviates the need for a specially programmed unit by allowing the code to be configured when the unit has been installed and a players location
25 information may be updated as soon as the zone is entered by receiving the zone identifier from the dedicated zone control unit.

Ideally the zone controller comprises a microcontroller with associated memory and timing means. Thus, the zone
30 information may be transmitted in a pulse mode reducing power requirements by using the microcontroller timer.

In one arrangement the zone communication means has a data communication means for communication with the central processor. This allows information to be passed
35 to and from the controller through the zone unit. Advantageously this allows for the provision of zones

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whose characteristics may be changed as the game progresses. These might include no entry zones or safe zones for example.

5 Preferably the game communication means comprises a
mobile player unit communication means on the mobile
player unit for wireless communication with the
controller in real time during a unique time slot period
for each mobile player unit. In this way the game
10 information relating to shots and hits as well as the
additional information relating to location within the
arena may be efficiently communicated to the controller
in real time. This communication is achieved without
requiring multiple communication channels and without
the necessity for the controller to poll each of the
15 mobile player units advantageously, minimising cost and
permitting real time communication of information
without the risk of communication interference.

20 Preferably the controller comprises a central processor
and at least one control device with an associated
player unit communication means, the control device
being mounted in the arena for controlling communication
between the central processor and each mobile player
unit. This allows the control devices to be
strategically positioned throughout the game playing
25 arena and if required to be easily moved.

Preferably the mobile player unit communication means
has a receiver and a transmitter advantageously,
allowing the player unit to receive and transmit game
status information.

30 Ideally the receiver has a zone receiver for receiving
location data from the zone control unit. Thus, the
game information received by the player unit is
efficiently communicated to the mobile player unit
processor.

35 Preferably the zone receiver has decoding means for
decoding location data and for detecting a safe zone.

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In this way zones may be defined that are safe for players to rest in as they can neither shoot or be shot.

5 Ideally the decoding means incorporates disabling means for preventing changes in game information. Thus, the game status information of each player unit may not be changed while in the safe zone except by the controller.

10 Preferably the receiver is a two part radiation receiver a control receiver for receiving radio frequency signals and a zone receiver for receiving infra-red signals. Thus, by combining common features of the two receivers the size and weight of the receiver unit is reduced.

15 Preferably the apparatus comprises at least two mobile player units each having independently operable mobile player unit communication means for communication with the controller during a unique time slot. Thus, each mobile player unit may transmit in turn obviating the need to be polled for game information by the controller thereby improving game response.

20 Preferably the mobile player unit incorporates an identification means for identifying the mobile player unit to the controller. Thus, the controller recognises source of the game information received and may compile it with information from other player units to provide team status information. Further it allows for a number of games between a number of teams to take place in the same game arena simultaneously without interacting.

30 Preferably the mobile player unit incorporates a position indicating means for receiving location information from mobile player units in the arena and for displaying the relative positions of other mobile player units. Thus, a tracking device or player radar is provided to track fellow team members and or opposing team members during the course of the game.

35 Ideally the position indicating means has a filter means for removing the location information of selected mobile player units. Thus information about players of a

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different game happening in the same arena at the same time is not shown preventing unwanted interaction.

5 Preferably the position indicating means is provided by a liquid crystal display communicating with the mobile player unit communication means. Thus, the information received is displayed in a simple and efficient manner.

Ideally each control device comprises a sound emitter.

10 Thus, the control device may transmit to its associated player units in real time.

15 Preferably the player communication means has a transmitter having an associated transmission field within the arena in which the game may be played, for transmitting game information from the control device to each mobile player unit located within the transmission field. Thus, each mobile player unit will receive game information from the control device transmission field in which it is located.

20 Preferably each control device incorporates a timing means for determining a unique control device transmit period for the player communication means associated with the control device. Thus, the control devices may transfer information in turn without the risk of transmission interference between adjacent control devices. This feature further allows a number of mobile player units to communicate without requiring additional channels necessitating increased bandwidth.

30 Ideally a plurality of control devices are provided, each control device having an associated transmission field for defining a transmission region within the arena and for transmitting game information from the control device to the mobile player units located within the transmission field of the control device. Thereby, ensuring that all mobile player units within the arena will receive the game information in real time.

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Preferably the transmitter is a radio frequency transmitter thus, the transmission is provided in a simple and efficient manner.

5 Preferably each player communication means has a player communication controller and a device identification means for controlling the player communication means. Advantageously, allowing each individual control device to be configured to operate in a predefined manner and further allows the control device to be easily re-
10 configured even during the course of a game.

Ideally the player communication means has a receiver for receiving signals from the mobile player unit. Thus, the control device may receive game status information from the mobile player unit, this
15 information may be either be acted on locally or communicated to the central processor. In this way the shape or size of the game arena may be altered without adversely affecting game communications.

20 In one arrangement the transmitter and receiver are combined as a transceiver thereby reducing the number of components required.

Preferably the control device has a host communication means for communicating with the central processor. Thereby, allowing game status information to be
25 communicated to the central processor.

Preferably the host communication means has a host communication controller, a data buffer and a communication link for connection to the central processor and the data buffer. Thus, constant access to
30 the central processor is obtained eliminating the possibility of delay in communications additionally the capabilities of the apparatus may be easily expanded to accommodate increasing numbers of players by increasing the processing power or number of central processors.

35 Preferably the host communication controller and the player communication controller are integrally formed as

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a device communication controller thereby reducing component requirements by combining functionality.

5 Ideally the device communication controller is a microcontroller with associated memory and timing means for controlling communication between the control device and the central processor and between the control device and the mobile player unit. Beneficially, using standard components thereby reducing cost.

10 In one arrangement at least one of the control devices is remote from the central processor and is mounted in an arena in which the game may be played. Beneficially allowing obstacles to be used in the game arena without hindering communication. These obstacles may be naturally occurring features of the game arena such as
15 walls or obstacles included to enhance reality and player enjoyment.

Ideally each mobile player unit communication means has a processor with associated memory means for controlling the mobile player unit communication means.
20 Advantageously, this allows processing to be conducted locally within the player unit.

Preferably the mobile player unit communication means has a player unit transmitter for transmitting game information from the mobile player unit to the control
25 device. Thus, information may transferred in real time between the mobile player unit and the controller.

Ideally the player unit receiving means has a control receiver for receiving status data from the controller thereby, establishing a communications link with the
30 central processor.

Preferably the control receiver includes means for receiving status data from another mobile player unit. Thus, team status information may be shared further enhancing the players enjoyment of the game by allowing
35 the players to develop tactics.

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In one arrangement the control receiver and the player unit transmitter are formed as a mobile player unit transceiver. Thus, the number of components required is reduced thereby minimising the weight and cost of the unit.

Ideally each mobile player unit incorporates a timing means for determining a unique transmit period associated with the mobile player unit. Thus, each player unit may communicate game information within the arena without the risk of transmission interference.

In one arrangement the controller comprises means for assigning a unique time slot period to each mobile unit and control device node by storing relationships between fixed or real node identifiers and alias identifiers, the alias identifiers identifying the unique time slot period.

Preferably the controller comprises means for transmitting signals re-configuring the apparatus by re-assigning alias identifiers with real identifiers in real time.

Ideally the controller comprises means for re-configuring the apparatus by transmitting a reconfiguration signal comprising a reference followed by a series of real identifiers in successive time slots, and each node comprises means for identifying its real identifier and storing an indication of the position of said identifier in the reconfiguration signal to set its alias identifier as a configuration.

Preferably the controller comprises means for assigning alias identifiers to only a portion of the nodes of the apparatus at any particular time.

Preferably the controller comprises means for transmitting synchronisation signals which include a synchronisation frame for synchronisation of clocks in the nodes, followed by a series of time slots within which nodes can respond in the relevant appropriate time

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slot, each node determining its time slot according to its current alias identifier.

5 In one embodiment the controller comprises means for including an auxiliary time slot for random use by nodes such as de-activated nodes.

Ideally each node comprises means for storing a configuration for later retrieval, the configuration being identified by a unique reference.

10 In a preferred arrangement the apparatus comprises infra-red communication means comprising transmitters and receivers programmed to communicate at a high sequence change rate.

Ideally the rate has a frequency of greater than two seconds.

15 In a preferred embodiment the transmitter comprises means for encoding part of a transmitted signal, and changing the encoding method for a subsequent transmission.

20 Preferably the code is encoded by use of an encoding byte retrieved from an indexed table, a successive byte in the table being used for each successive transmission.

Ideally the checksum of a transmit signal is encoded.

25 Ideally the mobile player unit includes an electronic gun.

Ideally the player unit includes a body unit.
Thus, the player unit may be worn by the player during the course of the game.

30 In a preferred arrangement the body unit has a body armour shell with integral indication means to indicate that a player has been shot. Thus, information received locally or from the game controller may be indicated to the player using lights, buzzers or solenoids.

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5 Preferably the controller includes a real time communication controller. Thus removing the need for the players to pass control points and allowing information to be distributed in a fast and efficient manner.

According to one aspect of the invention there is provided an electronic shooting game apparatus comprising:-

10 a controller for controlling the course of a game in an arena;

at least one mobile player unit;

a plurality of zone control units, each having means for defining a unique zone within an arena in which the game may be played; and

15 a game communication means for controlling communication between the zone control units, the mobile player units and the controller in real time.

20 Advantageously the electronic shooting game apparatus allows each mobile player unit to interact with the other mobile player units in real time. Real time in this context is taken to be less than one second being the maximum acceptable time in which responses to game events may issue without reducing game enjoyment.

25 Detailed Description

The invention will be more clearly understood from the following description of some embodiments thereof, given by way of example only, with reference to the accompanying drawings, in which:

30 Fig. 1 is a block diagram of an electronic shooting game apparatus according to the invention;

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Fig. 2 is a plan view from above of a game arena divided into zones;

Fig. 3 is a side view of a zone identification unit in operation;

5 Fig. 4 is a block diagram of a single zone identification unit;

Fig. 5 is a elevational view of a player unit;

Fig. 6 is a diagrammatic view of a body unit shown in Fig 5;

10 Fig. 7 is a block diagram of a game arena control device forming part of the invention;

Fig. 8 is a timing diagram of an electronic shooting game apparatus according to the invention;

15 Fig. 9 is a block diagram of an alternative electronic shooting game apparatus according to the invention; and

Fig. 10 is a plan view of an alternative arena shown in Fig. 9, divided into zones.

20 Referring to the drawings and initially to Figs. 1 to 7 there is illustrated an electronic shooting game apparatus 1. The apparatus 1 has a controller for controlling the course of a game in an arena. The controller comprises a central processor 2 and number of control devices 3. The apparatus 1 also has a number of
25 mobile player units 4 worn by players, and means for sensing the position of a player unit 4 in the arena provided by a number of zone control units 5, each for defining a zone 6 within a game playing arena 7.

30 Each zone control unit 5 has a data transmitter for transmitting location data within its zone 6 provided by an infra red transmitter 8 mounted on the zone control

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unit 5. The zone control unit 5 also has a zone identification means provided by a bank of dip-switches 9 and a zone microcontroller 10 with an integral timer 11 for controlling the infra red transmitter 8. The dip switches 9 of each control unit 5 define a unique binary location code which is transmitted through the infra-red transmitter 8 to define each zone 6. The range and spread of the infra-red field defines the boundaries of the zone 6 and the binary location code is received by the mobile player unit 4 as the player enters the zone 6.

Referring specifically to Figs. 5 and 6, the mobile player unit 4 has an electronic gun 12 and a body unit 13. The body unit 13 has a body armour shell 14 with an indicator 15 to indicate a players game condition using a numbers of buzzers 15a and lights 15b. The body armour shell 14 also has communication means provided by a player unit communicator 16 for communication with the central processor 2 in real time. The player unit communicator 16 has a memory chip 17 connected to a microprocessor 18 and associated timer 18(a) for controlling communication to and from the player unit communicator 16. The microprocessor 18 in turn is connected to an infra-red receiver 19 and a radio frequency transceiver formed by a radio frequency receiver 20, a radio frequency transmitter 21 and an aerial 22.

Referring specifically to Fig. 7, the control device 3 has a device communication microcontroller 23 with internal memory 24 and a timer 25. The device communication microcontroller 23 is connected to the central processor 2 through a data buffer 26 and a network cable 27. The device communication microcontroller 23 is also connected to a device transceiver 28 in turn connected to a device aerial 29.

Referring now to Fig. 8 there is illustrated a timing diagram 30 showing the communication timing structure between the central processor 2, four control devices 3 and six mobile player units 4. The diagram 30 shows a synchronisation pulse 31, four control device transmit

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periods 3(a), 3(b), 3(c), 3(d), a system settle pulse 32 and six mobile player unit transmit periods 4(a), 4(b), 4(c), 4(d), 4(e) and 4(f).

5 In use, the central processor 2 sends a synchronisation pulse 31 on the network cable 27 to each control device 3. Upon receipt of the synchronisation pulse 31 through the data buffer 26, the device communication microcontroller 23 retrieves a value stored in internal memory 24 and sets the device timer 25 with this value
10 and initiates the count. When the device timer 25 has completed this count the identity of the control device 3 also stored in the internal memory 24 is transmitted to the mobile player units 4 through the transceiver 28 and the device aerial 29.

15 The value stored in the internal memory 24 for each control unit 3 is different, being preset in the unit to correspond to one of the transmit periods 3(a) to 3(d). This allows each control unit 3 to transmit in turn without transmission interference.

20 As the mobile player unit 4 moves around the arena 7 the signal containing the identity of the control device 3 is received through the radio frequency receiver 20 and aerial 22 and is passed to the microprocessor 18.

When the microprocessor 18 receives the signal it stores
25 it in the timer 18(a). The microprocessor 18 then uses the information received to determine when the system settle pulse 32 occurs by counting down from the value received. When the system settle pulse 32 begins the microprocessor 18 resets the timer 18(a) to a pre-set
30 value stored in the memory chip 17, to determine the correct transmit period associated with that mobile player unit 4. Each mobile player unit 4 has a unique transmit period corresponding to one of the transmit periods 4(a) to 4(f). In this way each mobile player
35 unit 4 may transmit the selected status information to the central processor 2 through the control devices 3 and the other mobile player units 4 in turn without transmission interference. The status information is received by the mobile player units 4 in the same way as

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timing information is received from the control devices 3.

5 The status information transmitted in this way is received and prioritised by the microprocessor 18 before being stored in the memory chip 17 prior to transmission. The status information includes details of shots fired and hits received from other mobile player units. The player scores a hit by firing the electronic gun 12 at the body unit 13 of an opponent.
10 These hits are indicated to the player by activation of the buzzers 15(a) and lights 15(b).

In addition to the status information, location information is similarly transmitted. The location information is received from the zone control units 5.

15 The zone control unit 5 has a binary code encoded in the dip-switches 9. This code is transmitted through the infra-red transmitter 8 of each control unit to define each zone 6. The frequency of transmission of this binary code is determined by the value stored in the
20 integral timer 11 of the zone microcontroller 10. The range and spread of the infra-red field defines the boundaries of the zone 6. This location information is received by the infra red receiver 19 on the mobile player unit 4 as the player enters each zone. This
25 location information is again passed to the microprocessor 18 prior to transmission in the next one of the transmit periods 4(a) to 4(f).

30 As the game progresses the information being transmitted in real time around the arena 7 in this way may include hit status, remaining shots, location, timing signals and similar electronic shooting game related information.

35 In more detail, the real time communication between the various communication circuits is achieved using a technique referred to in this specification as time slot multiplexing (TSM). Brief mention has already been made of the fact that each zone controller and mobile unit has a unique time slot for communication, thereby

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allowing a single channel to be used by a large number of nodes without any interference. It has also been mentioned that the micro-processor 18 of the player unit communicator 16 retrieves a value from its memory 17 and that the microcontroller 23 at each control device 3 also retrieves a value from its memory 24. This value may be referred to as an alias identifier or alias ID as it identifies the unique time slot which any particular node has at any time. A very important aspect of the invention is the fact that each node (player unit communicator 16 or control device 3) has a fixed or real identifier, hereinafter referred to as a real ID. A master node (the controller 2) dynamically relates an alias ID with the real ID of each node being utilised at any particular time. It transmits reconfiguration signals at the start of a session, which signals achieve the following:-

- (a) They set the number of nodes to be operational and therefore set the length of the cycle to cater for that number of nodes without any redundant or unused time slots.
- (b) They set an alias ID for each operational node. Therefore, each operational node knows its alias ID, which as described above is the particular time slot for that session.

After the reconfiguration signal, the master node sends synchronisation signals at very frequent intervals, in one embodiment every second. These synchronisation signals are used for synchronisation of the clocks in the nodes so that the transmission of data from the nodes is accurately located in the correct time slot.

To describe this in more detail, each node can determine its unique time slot according to the following formula:-

$$\begin{aligned} \text{TSM slot time} \\ = (\text{Slot_Period} \times \text{Alias ID}) \end{aligned}$$

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...where

TSM slot time is a delay in time that occurs after the receipt of a TSM Request "synchronisation signal" (i.e. base time 0)

5 *Slot_Period* is a predefined time duration (can be dynamically redefined as needed).

Alias ID being a non-zero positive integer.

An initial configuration table stored in the master node (controller 2) may be as follows:-

10	Node Real ID	ALIAS ID
	A	1
	B	2
	C	3
	E	4
15	F	5
	G	6
	H	7
	I	8
	J	9
20	K	10

To broadcast this information to the nodes, the controller transmits a reconfiguration signal which includes the real ID in each successive time slot according to the order given in the above table. This order can be dynamically redefined at any time by the master node by transmitting a reconfiguration message prior to issuing information requested. For example, the order can be reversed by transmission of the following reconfiguration signal:-

30	Alias	1	2	3	4	5	6	7	8	9	10
	Config	J	I	H	G	F	E	D	C	B	A

Upon receipt of such a signal, each node identifies its own real ID and its location in the reconfiguration signal and therefore sets its alias ID (in memory) according to the following table:-

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	Node Real ID	ALIAS_ID
	A	10
	B	9
	C	8
5	D	7
	E	6
	F	5
	G	4
	H	3
10	I	2
	J	1

Alternatively, the master node can activate a subset of nodes that are eligible for a particular session by transmitting a reconfiguration similar such as:-

15	Alias	1	2	3
	Config	J	A	B

Upon receipt of such a signal, the nodes will change their memory contents to reflect the alias ID's of the following table:-

	Node Real ID	ALIAS_ID	Comment
20	A	2	
	B	3	
	C	-	not active
	D	-	not active
25	E	-	not active
	F	-	not active
	G	-	not active
	H	-	not active
	I	-	not active
30	J	1	

A very important point to note is that after this reconfiguration signal, nodes C to I inclusive are redundant as alias ID's have been assigned only for nodes A, B and J. Thereafter, each multiplexing cycle will involve only three time slots, thereby providing for a much faster data capture.

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From then on, the master node will transmit synchronisation signals every second to request information from the active nodes. Each active node reads the synchronisation signal and uses the
 5 synchronisation frame to reset its clock. It then uses its alias ID to count on each successive time slot until it recognises its own time slot and then transmits its information. This synchronisation would take the following:-

10 Req
 SYN Slot_J Slot_A Slot_B
 0-----TIME----->

Please note that in the above signal each time slot following the synchronisation frame represents a time
 15 period for transmission of information from a node to the master node. For example, node J transmits information in the first time slot. The notation SLOT_J in the first time slot does not indicate that the real ID J appears in this time slot, it is simply a time
 20 frame during which node J can transmit information.

Another important aspect of the communication system is that an additional time slot may be included for auxiliary or random use. In one embodiment, this may be referred to as slot 0 in the following synchronisation
 25 signal:-

Req
 SYN Slot0 Slot_J Slot_A Slot_B
 0-----TIME----->

Slot 0 (which is not a valid alias ID) is shared with
 30 all nodes. The purpose of this slot is to allow during a single TSM sequence a de-activated node that has not been inadvertently or abnormally reset ID to dynamically request re-activation. For example, the response may be represented as follows:-

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	Node			
Req				
SYN	F	Slot_J	Slot_A	Slot_B
	0-----TIME----->			

- 5 It will be clear that node F responds during time slot 0 to request re-activation. Upon receipt of such a return signal, the master node immediately re-configures its table and transmits a reconfiguration signal as follows in order to give the following configuration:-

10	Config	J	A	BF
	Node Real ID	ALIAS_ID	Comment	
	A	2		
	B	3		
	C	-	not active	
15	D	-	not active	
	E	-	not active	
	F	4	**Active**	
	G	-	not active	
	H	-	not active	
20	I	-	not active	
	J	1		

Following this, subsequent synchronisation signals requesting information transmitted from the master node would be as follows:-

25	Node			
	Req			
	SYN	Slot_J	Slot_A	Slot_B Slot_F
	0-----TIME----->			

- 30 Another important aspect of the invention is the fact that each reconfiguration signal will include a unique header which may be used as a reference. The configuration settings instructed by the reconfiguration signal may be stored in non-volatile memory at each node and used subsequently if a request is transmitted from the master node to use the configuration associated with that reference.
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5 Regarding the hardware requirements to achieve the above operation, the communication circuits of the communicator 16 and the control devices 3 use an on-board microcontroller oscillator for timing. The timing reference for this oscillator uses an AT cut crystal oscillator which has the following characteristics:-

Basic Frequency: ± 20 ppm (parts per million) @ 25 degree C

10 Frequency Drift: ± 50 ppm per degree change in temperature (C)

Temperature Range: -10 to +60 degree C.

Base Frequency Tolerance Vs. Time: 40 uS / second Max

Frequency Drift: 3ms / second Max

15 From the characteristic above, any two crystal at 25°C will be within 40 ppm of one another (worst case). Therefore, two stand-alone oscillators using 1 MHz crystal could differ up to 40 uS (microseconds) in one second of time.

20 It is assumed that the normal operating environment will be within the temperature range of between +10 and +40°C. Therefore, there is a maximum temperature swing of 30 degrees.

25 It is also assumed that all crystal will drift in the same direction (up in frequency or down in frequency) with respect to a change in temperature. Therefore, for a temperature range of 30°C, any two crystal could deviate a maximum of:

30 $30 \times 100 = 3000$ ppm where 30 is degrees change in C and 100 is the maximum ppm change per degree C.

35 Then, any two stand-alone oscillators using 1 MHz crystals could differ up to 3000 uS (microseconds) in one second of time. Hence, in the course of once second (assuming the crystal characteristics stated above any two crystal would be within:

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$$\begin{aligned} &\text{Base_Tolerance} + \text{Maximum_Frequency_Drift} \\ &= 3040 \text{ uS / Sec or } 0.304\%. \end{aligned}$$

(+/-0.152% off centre frequency of the crystal).

- 5 The slot time for each node has a period of 15 ms. Up to 30 slot time periods follow each synchronisation signal. The maximum time to transmit an information request signal is:-

$$\begin{aligned} \text{TSM_CYCLE time} &= \\ &\text{TSM_REQ time} + 30 \times \text{slot_time_period}. \end{aligned}$$

- 10 In the above formula, TSM_CYCLE time is the total time for transmission of a single information request signal. TSM_REQ time represents a 15 ms synchronisation frame.

- 15 Only 46.5% of time within the period of 1 second is required for a TSM cycle. Since crystals could deviate as much as 0.304 milliseconds in one second, it can be seen that the maximum deviation, following TSM synchronisation could be:-

$$3.04 \text{ ms} \quad \text{or about} \quad 1.414 \text{ ms}$$

- 20 This is to say that any two nodes, at the end of a TSM_Cycle would not have deviated more than +1.4 ms (see below).

- 25 Serialised radio data messages being transmitted within slot time periods. This timing is initiated/synchronised by a TSM_REQ 'synchronising' radio frame. Taking into account distortion of the synchronising sync signal (envelope and/or amplitude) and microcontroller software timing resolution, an added delay of about +50 microseconds is possible.

- 30 Therefore the maximum deviation during a TSM_CYCLE is about 1.465 ms or about plus/minus 0.75 ms.

All serialised data that is sent within a slot time period is itself bit synchronised. By providing a preamble (header) at the beginning of a data frame (at

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least 3 characters at 4800 baud = 5ms) and assuring that the data frame time, in total, is:

Data_Frame time is less than or equal to slot_time_period minus 1.465 ms.

- 5 At the end of a TSM-Cycle (last slot time period), a node's interpretation of the slot's start could be early or late by as much as 0.75 ms.

10 If early, 0.75 milliseconds of preamble data would be sent during the previous slots trailing edge (as discussed above). This trailing slot time period is not used and no corruption or interference between adjacent slots time period data frames will occur.

If late, the frame would fall within 0.75 ms of the unused time at the trailing edge of a slot.

- 15 If a data frame is 0.75 ms late and the next slot is 0.75 ms early, still there is time at the end and beginning (i.e. preamble) to tolerate this maximum deviation.

20 Regarding the communication of infra-red (IR) signals, the techniques used greatly assist in overcoming the problem posed by possible use of universal learning IR devices (ULIRD). Such devices learn codes by detecting and storing codes, typically during a 2-3 second period.

25 In the apparatus 1, the IR transmitters are programmed to change the IR data transfer at least once every 2 seconds. A synchronising pulse based on an external common timer or an onboard oscillator achieves this. By changing the IR sequence at this rate, a ULIRD would not be capable of capturing the code. Further, the transmitters are programmed to modify the checksum before transmission by use of an encoding byte. The checksum is in one embodiment modified by applying an encoding byte using an XOR operation. The checksum is decoded at the IR receiver.

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In more detail, the method of encoding used is as follows:

Data Frame**SOF,DAT1,DAT2,.....DATn,CHKSUM**

5 where SOF - Start of frame byte
 DATn - nth data byte
 CHKSUM - sum of SOF and all data
 bytes.

Transmitted Frame

10 SOF,DAT1,DAT2,.....DATn,(CHKSUM xor CODE)

A table of codes stored at both transmitting and receiving devices is indexed each time the code is to be changed. Until the next code changeover time, this code is XORed with the checksum of data frames for
15 transmission, and the same code is XORed with the checksum byte on reception.

Table of CODEs

Time1 CODE1

Time2 CODE2

20 " "

TimeN CODEN

The ULIRD will be able to learn one IR data transfer. However, when the ULIRD transmits the learned data, the
25 encoding byte will have changed and the learned data transfer will be invalid.

On each changeover time the table index is incremented. When the end of the table is reached, the index is reset to the start of the table and the process is repeated.
30 Therefore if one data transfer is learned by the ULIRD, this data will in time become valid again. The larger the table of codes is the more effective the protection against the ULIRD.

It will thus be appreciated that the electronic shooting
35 game apparatus provides for considerably improved player

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interest as it represents a new dimension in the interactivity of electronic shooting games. Role playing scenarios may be introduced by the inclusion of video walls or similarly interactive devices and by transmission of game instructions through the game controller in response to player status or certain game conditions. Handicapping systems may be introduced to make the game as competitive as possible. Team playing scenarios may be developed by ignoring the transmission of certain pieces of information to certain players or within parts of the arena. Players movement within the arena may also be controlled by punishing lack of movement when the same location is reported a number of times.

It will be appreciated that the real time communication features of the invention allow for very flexible communication with varying numbers of active nodes in a real time manner. This allows, for example, the team set-ups in a laser shooting game to be changed very frequently in a very simple manner. This is achieved by a simple transmission of a single configuration signal which resets all nodes, both hard-wired and wireless. This method of communication overcomes the problems of conventional time division multiplexing schemes whereby the numbers of time slots and nodes are fixed and there is very little flexibility. It also provides a considerable amount of flexibility by virtue of the fact that nodes can become re-activated during a game or at unusual times generally. This is achieved by use of the time slot 0. Additionally the controller can use this slot to broadcast game information to all of the player units using this time slot or to a single player unit or group of player units. The game information to be transmitted may be re-configuration information, passive game information to be stored in the player unit or active game information requiring immediate processing and subsequent action by the player unit.

The invention is not limited to the embodiment illustrated in Figs 1 to 8. Referring now to Figs. 9 and 10 there is illustrated an alternative construction

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of an electronic shooting game apparatus, indicated generally by the reference numeral 40. Parts similar to those described with reference to Figs. 1 to 8 are identified by the same reference numerals.

- 5 In this arrangement each alternate zone 6 is defined by the absence of a zone control unit 5 and thus the players movements may be monitored by storing the last location information of a mobile player unit until a new zone 6 is entered. Advantageously this reduces the
10 number of zone control units required.

It is envisaged that communication in the apparatus may be by way of a polling or any other suitable system instead of time slot multiplexing. The controller need not have separate control devices.

- 15 It is envisaged that the control unit microcontroller could be replaced by a microprocessor allowing more detailed processing to be carried out. It is further envisaged that the transceiver arrangement in the mobile player unit might be replaced by a transponder or
20 similar unit to respond to such a control unit. In this way the transponder in the mobile player unit could be activated by the control unit and the resulting game response be determined by the microprocessor.

- The apparatus of the invention need not necessarily
25 define zones in the arena. It could operate to sense players locations without relating location to zones. It is envisaged that the means for sensing player position in the arena may be provided using any suitable sensing technique, whether the arena is divided into
30 zones or not. Pressure, light, movement or sound sensitive devices may equally be used to sense a players position and the transmission of the information relating to the player may be achieved using any suitable transmission technique or transmission media.

- 35 It envisaged that the zone control units could incorporate a receiver for communication with the central processor. It is also envisaged that the zone control units could be configured to define a "no entry"

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zone by transmitting a signal to adversely affect the players status and that the location of such zones could be changed during the course of a game. One or more zone control units could also be configured to transmit a safe zone code to the mobile player units within the zone. A zone of this type could be used within the context of the game to define a neutral zone where a player could not shoot or be shot. Such a zone could also be moved by the central processor during the course of a game. It is further envisaged that the zone identification means either alone or in combination with the central processor could maintain a location history for the player to prevent the player revisiting a zone or to track a players progress throughout the game arena. In addition to tracking a players progress through the game arena it is envisaged that the information could be used to actuate a voice prompt unit, a visual or alternative indicator to relay a system message to the player. A unit of this type could be used to tell the player that he / she has entered a no entry zone and that a penalty was imminent or to warn a player not to run through the zones. A warning of this type would greatly improve the safety of the game.

It is envisaged that the mobile player units could be provided as powered vehicles such as battery or player powered carts. It is also envisaged that these mobile player units would have an appearance suitable to the electronic shooting game environment such as tanks or armoured vehicles. It is further envisaged that the units could be provided as airplanes travelling on rails above the game arena.

It is envisaged that the timing means of the player units could be located within the control device structure allowing the device controllers to request player units to transmit information either in a polled manner or randomly.

It is also envisaged that the central processor could control both mobile and stationary targets or hazards and that mobile player units could communicate with such targets.

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It is further envisaged that the unique identity of each mobile player unit may be easily modified. This allows for the minimum number of transmission periods to be obtained without the necessity of knowing which player unit transmits in which transmit period thus improving communication speeds.

It is envisaged that additional communications channels could be added, increasing band width. In this way a channel could be reserved for a particular team or additional players may be added without adversely affecting the real time communication of the system. It is further envisaged that certain communication channels be reserved for certain types of information. It is also envisaged that the transmission media be of any suitable type. It will be appreciated that the control device may include an additional microprocessor or microcontroller to control communication with the mobile player units in an efficient manner.

It is envisaged that the controller could communicate interactively with similar controllers in remote locations to form an arena network providing for inter game playing area games. Similarly, it is envisaged that the controller in a remote location could be provided by a personal computer either with or without a mobile player unit attached, allowing a remote player unit to interact with the game in real time. This remote player unit need not necessarily be located in an arena. It is also envisaged that the controller could incorporate elements of popular games or situations to enhance the role playing aspect of the game.

It will be appreciated that the combination of any of the aforementioned features may be used to sustain player interest.

Many other variations on the specific embodiments of the invention described will be readily apparent and accordingly the invention is not limited to the embodiments hereinbefore described which may be varied in both construction and detail.

**CLAIMS**

1. An electronic shooting game apparatus comprising:

a controller for controlling the course of
a game in an arena;

5 at least one mobile player unit;

a game communication means for
communication of data in the apparatus; and

means for sensing the position of a player
unit in the arena.
- 10 2. An electronic shooting game apparatus as claimed
in claim 1 comprising at least one zone control
unit comprising means for defining a game-playing
zone within the arena.
- 15 3. An electronic shooting game apparatus as claimed
in claim 2, wherein the zone control unit
comprises a zone communication means for
transmitting data to define a zone, and each
mobile player unit comprises means for receiving
said data.
- 20 4. An electronic shooting game apparatus as claimed
in claim 2 or claim 3, wherein the zone control
unit comprises a zone controller.
- 25 5. An electronic shooting game apparatus as claimed
in claim 4 wherein the zone communication means
comprises means for transmitting a unique zone
identifier in said data under control of the zone
controller.
- 30 6. An electronic shooting game apparatus as claimed
in claims 4 or 5, wherein the zone communication
means comprises a radiation transmitter activated
by the zone controller.



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- 5 7. An electronic shooting game apparatus as claimed in claim 6 wherein a plurality of zone control units are provided, each for defining a zone within the arena in which the game may be played and for transmitting location information from each zone control unit to the mobile player units located within the zone associated with the zone control unit.
- 10 8. An electronic shooting game apparatus as claimed in claim 6 or 7 wherein the radiation transmitter is an infra-red transmitter.
- 15 9. An electronic shooting game apparatus as claimed in any of claims 3 to 8 wherein the zone communication means comprises means for transmitting status data to each mobile player unit.
- 20 10. An electronic shooting game apparatus as claimed in any of claims 3 to 9 wherein the zone communication means has a status receiver for receiving status data from a mobile player unit.
11. An electronic shooting game apparatus as claimed in claim 10 wherein the zone communication means comprises a transceiver.
- 25 12. An electronic shooting game apparatus as claimed in any of claims 5 to 11 wherein the zone controller comprises a number of dip-switches for setting the zone identifier.
- 30 13. An electronic shooting game apparatus as claimed in any of claims 4 to 12 wherein the zone controller comprises a microcontroller with associated memory and timing means.
- 35 14. An electronic shooting game apparatus as claimed in claims 3 to 13 wherein the zone communication means has a data communication means for communication with the central processor.



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15. An electronic shooting game apparatus as claimed in any preceding claim wherein the game communication means comprises a mobile player unit communication means on the mobile player unit for wireless communication with the controller in real time during a unique time slot period for each mobile player unit.
- 5
16. An electronic shooting game apparatus as claimed in claim 15, wherein the controller comprises a central processor and at least one control device with an associated player unit communication means, the control device being mounted in the arena for controlling communication between the central processor and each mobile player unit.
- 10
17. An electronic shooting game apparatus as claimed in claim 16 wherein the mobile player unit communication means has a receiver and a transmitter.
- 15
18. An electronic shooting game apparatus as claimed in claim 17 wherein the player unit receiving means has a zone receiver for receiving location data from the zone control unit.
- 20
19. An electronic shooting game apparatus as claimed in claim 18 wherein the zone receiver has decoding means for decoding location data and for detecting a safe zone.
- 25
20. An electronic shooting game apparatus as claimed in claim 19 wherein the decoding means incorporates disabling means for preventing changes in game information.
- 30
21. An electronic shooting game apparatus as claimed in claims 19 or 20 wherein the receiver is a two part radiation receiver a control receiver for receiving radio frequency signals and a zone receiver for receiving infra-red signals.
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22. An electronic shooting game apparatus as claimed in any preceding claim having at least two mobile player units each having independently operable mobile player unit communication means for communication with the controller during a unique time slot.
23. An electronic shooting game apparatus as claimed in claim 22 wherein a mobile player unit incorporates an identification means for identifying the mobile player unit to the controller.
24. An electronic shooting game apparatus as claimed in claims 22 or 23 wherein a mobile player unit incorporates a position indicating means for receiving location information from mobile player units in the game arena and for displaying the relative positions of other mobile player units.
25. An electronic shooting game apparatus as claimed in claim 24 wherein the position indicating means has a filter means for removing the location information of selected mobile player units.
26. An electronic shooting game apparatus as claimed in claims 24 or 25 wherein the position indicating means is provided by a liquid crystal display communicating with the mobile player unit communication means.
27. An electronic shooting game apparatus as claimed in claims 24 to 26 wherein the position indicating means comprises a sound emitter.
28. An electronic shooting game apparatus as claimed in any of claims 16 to 27 wherein the player communication means has a transmitter having an associated transmission field within the arena for transmitting game information from the control device to each mobile player unit located within the transmission field.



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29. An electronic shooting game apparatus as claimed in claim 28 wherein each control device incorporates a timing means for determining a unique control device transmit period for the player communication means associated with the control device.
30. An electronic shooting game apparatus as claimed in claim 29 wherein a plurality of control devices are provided, each control device having an associated transmission field for defining a transmission region within the arena and for transmitting game information from the control device to the mobile player units located within the transmission field of the control device.
31. An electronic shooting game apparatus as claimed in claims 28 to 30 wherein the transmitter is a radio frequency transmitter.
32. An electronic shooting game apparatus as claimed in claims 27 to 31 wherein each player communication means has a player communication controller and a device identification means for controlling the player communication means.
33. An electronic shooting game apparatus as claimed in claims 27 to 32 wherein the player communication means has a receiver for receiving signals from the mobile player unit.
34. An electronic shooting game apparatus as claimed in claim 33 wherein the transmitter and receiver are combined as a transceiver.
35. An electronic shooting game apparatus as claimed in claims 16 to 34 wherein the control device has a host communication means for communicating with the central processor.
36. An electronic shooting game apparatus as claimed in claim 35 wherein the host communication means



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has a host communication controller, a data buffer and a communication link for connection to the central processor and the data buffer.

- 5 37. An electronic shooting game apparatus as claimed
 in claim 36 wherein the host communication
 controller and the player communication
 controller are integrally formed as a device
 communication controller.
- 10 38. An electronic shooting game apparatus as claimed
 in claim 37 wherein the device communication
 controller is a microcontroller with associated
 memory and timing means for controlling
 communication between the control device and the
15 central processor and between the control device
 and the mobile player unit.
39. An electronic shooting game apparatus as claimed
 in any of claims 16 to 38 wherein at least one of
 the control devices is remote from the central
 processor and is mounted in the arena.
- 20 40. An electronic shooting game apparatus as claimed
 in any preceding claim wherein the game
 communication means has a processor with
 associated memory means for controlling the
 mobile player unit communication means.
- 25 41. An electronic shooting game apparatus as claimed
 in claim 40 wherein the mobile player unit
 communication means has a player unit transmitter
 for transmitting game information from the mobile
 player unit to the control device.
- 30 42. An electronic shooting game apparatus as claimed
 in any of claims 17 to 41 wherein the player unit
 receiving means has a control receiver for
 receiving status data from the controller.
- 35 43. An electronic shooting game apparatus as claimed
 in claim 42 wherein the control receiver includes



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means for receiving status data from another mobile player unit.

44. An electronic shooting game apparatus as claimed in claim 43 wherein the control receiver and the player unit transmitter are formed as a mobile player unit transceiver.
45. An electronic shooting game apparatus as claimed in any of claims 15 to 44 wherein each mobile player unit incorporates a timing means for determining a unique transmit period associated with the mobile player unit.
46. An electronic shooting game apparatus as claimed in claim 45 wherein the controller comprises timing means for assigning a unique time slot period to each mobile unit and control device node by storing relationships between fixed or real node identifiers and alias identifiers, the alias identifiers identifying the unique time slot period.
47. An apparatus as claimed in claim 46 wherein the controller comprises means for transmitting signals re-configuring the apparatus by re-assigning alias identifiers with real identifiers in real time.
48. An apparatus as claimed in claim 47 wherein the controller comprises means for re-configuring the apparatus by transmitting a reconfiguration signal comprising a reference followed by a series of real identifiers in successive time slots, and each node comprises means for identifying its real identifier and storing an indication of the position of said identifier in the reconfiguration signal to set its alias identifier as a configuration.
49. An apparatus as claimed in claims 46 to 48 wherein the controller comprises means for



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assigning alias identifiers to only a portion of the nodes of the apparatus at any particular time.

50. An apparatus as claimed in any of claims 46 to 49 wherein the controller comprises means for transmitting synchronisation signals which include a synchronisation frame for synchronisation of clocks in the nodes, followed by a series of time slots within which nodes can respond in the relevant appropriate time slot, each node determining its time slot according to its current alias identifier.
51. An apparatus as claimed in any of claims 46 to 50 wherein the controller comprises means for including an auxiliary time slot for random use by nodes such as de-activated nodes.
52. An apparatus as claimed in any of claims 46 to 51 wherein each node comprises means for storing a configuration for later retrieval, the configuration being identified by a unique reference.
53. An apparatus as claimed in any preceding claim wherein the communication means comprises infra-red communication means comprising transmitters and receivers programmed to communicate at a high sequence change rate.
54. An apparatus as claimed in claim 53 wherein the rate has a frequency of greater than two seconds.
55. An apparatus as claimed in claims 53 or 54 wherein a transmitter comprises means for encoding part of a transmitted signal, and changing the encoding method for a subsequent transmission.
56. An apparatus as claimed in claim 55 wherein the code is encoded by use of an encoding byte



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retrieved from an indexed table, a successive byte in the table being used for each successive transmission.

- 5 57. An apparatus as claimed in claims 55 or 56 wherein a checksum of a transmit signal is encoded.
58. An electronic shooting game apparatus as claimed in any preceding claim wherein the mobile player unit includes an electronic gun.
- 10 59. An electronic shooting game apparatus as claimed in any preceding claim wherein the mobile player unit includes a body unit.
- 15 60. An electronic shooting game apparatus as claimed in claim 59 wherein the body unit has a body armour shell with integral indication means to indicate that a player has been shot.
61. An electronic shooting game apparatus as claimed in any preceding claim wherein the controller includes a real time communication controller.
- 20 62. An electronic shooting game apparatus comprising :-
- a controller for controlling the course of a game in an arena;
- at least one mobile player unit;
- 25 means for sensing the position of a player unit in the arena comprising a plurality of zone control units, each having means for defining a unique zone within an arena in which the game may be played; and
- 30 a game communication means for controlling communication between the zone control



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units, the mobile player units and the controller in real time.

63. An electronic shooting game apparatus substantially as hereinbefore described with reference to the accompanying drawings.