

TARGET LOCATION GUIDANCE SYSTEM

FIELD OF THE INVENTION

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This invention relates to a method and apparatus for guiding a self-propelled projectile, including a missile armed with a payload of explosives. The guidance method and apparatus does not require communication with satellites either for propulsion control or for obtaining coordinates under the
10 global position system (GPS).

BACKGROUND OF THE INVENTION

15 In the conventional land warfare, a military reconnaissance unit, which is more popularly known by its American military's designation of "Special Operation Force" (or in short, "Special Ops") may be deployed deep behind enemy lines or embedded deep into enemy territories to conduct reconnaissance and/or sabotage activities on selected enemy's targets.

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When these targets are identified, the Special Ops normally report to its command centre and provide the position coordinates through radio communication. The command centre calls out for the launching of artillery attacks or missiles to destroy the targets. The Special Ops wait and observe

at the perimeter for the strikes on target and report the outcome of such strikes before they return to their unit's base for debriefing or continue with another such mission.

5 There are several weaknesses with such modus operandi. The targets could be missed due to bad weather which may interfere with the guidance system especially when the visibility is poor or when there is strong wind. The targets could also be missed due to various decoying means set by the enemy or by the environment of the target.

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For example, decoys in the form of flares may be fired to confuse heat-seeking or light-seeking guidance systems of the missile. Environmental distractions such as a smoke screen may hamper accurate targeting. A burning oil field or a large flame near to the target may cause the flaming
15 source be hit by the missile instead of the target. An encampment may also be built hidden or camouflaged under a thick canopy of a forest which may be difficult to detect.

Often after a missed strike, Special Ops would call for another round of
20 fire in another communication attempt. It is known that such burst of communication signals may be detected or even intercepted by the enemy. Thus, any repeated or prolonged communications and length of mission time by staying back to observe the strike would lead to their presence being discovered and thus endangering the lives of the Special Ops troop.

Yet another problem posed is when the target may be moving such as a rapidly moving armoured column which renders the coordinates inaccurate or obsolete by the time the missile is launched and en route to the original target. A number of prior art exists with regard to guiding a missile to hit targets accurately as shown by the following representative prior patents.

U.S. Patent No. 5,855,339 disclosed a method of guiding a missile, particularly the *Tomahawk-STAR (T-STAR)* version of missiles developed specifically against moving armoured columns, to its target. It is more concerned with secure in-flight target updates of data transmission to update the cruising missile towards the moving target.

A remote sensing device in the form of an unmanned aerial vehicle is used to transmit the target's location data to the missile launch site (e.g. a ship deployed with *T-STAR* missiles) where it is processed and encoded before relaying to the missile via a transponder (transceiver and responder) mounted on a satellite. Surprisingly, the encoding uses the mobile telecommunications industry-standard of direct sequence spread spectrum/code division multiple access (CDMA) encoding for transmitting the target updates.

U.S. Patent No. 6,567,044 is another patent that disclosed an arrangement of devices for the purpose of locating or monitoring a target that

has been tagged with a RF transceiver as beacon for at least 3 different apparatuses as scanning platforms which are capable of performing triangulation search operation utilising the global position system (GPS) network of satellites.

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One of the scanning platforms includes employing a miniature unmanned aerial vehicle which, upon eliciting a response from the beacon, transmits data to a command centre for determining the beacon's, i.e. target's position. There appears to be no guidance of a missile homing onto a hostile target which may not be easily tagged with a beacon as in this prior art.

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U.S. Patent No. 6,584,879 is yet another patent that disclosed a missile guidance system which deploys unmanned aerial vehicle to direct the missile to a target. Instead of radio waves, a beam of light is used by the unmanned aircraft to illuminate the target.

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The missile is provided with a sensor which may sense the reflection of light from the target and may hence home in on the target. With the use of a light beam by a hovering aircraft, it would be difficult to keep the target marking operation a covert one and a hostile target is likely to bring down the aircraft.

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Any discussion of documents, devices, acts or knowledge in this specification is included to explain the context of the invention. It should not

be taken as an admission that any of the material forms a part of the prior art base or the common general knowledge in the relevant art in Singapore or elsewhere on or before the priority date of the disclosure and claims herein. All statements as to the date or representation as to the contents of these documents is based on the information available to the applicant and does not constitute any admission as to the correctness of the dates or contents of these documents.

The present invention has as one of its objects to reduce or avoid possible captures of Special Ops by the enemy while conducting the reconnaissance activities deep within enemy territory or behind enemy line and waiting for the strikes on target.

Another object is to provide for a method of guiding a radio frequency guided missile to a target by way of a radio frequency signal from a beacon rather than relying on coordinates or other absolute data such as the triangulation data of the global position system (GPS). Accordingly, the invention does not require satellite-relaying of data or transmission and therefore is not handicapped by the loss of satellite through an enemy's preemptive strike at space. In this invention, the RF transmission of the beacon does not need to relay the target's location data from one device to another device.

With the beacon's signal, the fighter-bomber plane may launch and guide the missile which is thus unaffected by inclement weather, decoys and other forms of distractions from the target's surroundings and is able to home in on the target. Without the need to relay it from one device to another
5 device while the guided missile is *en route* to a moving target, it is therefore less susceptible to electronic jamming or interference.

In terms of human resources, the reconnaissance unit personnel would not be required to make further telecommunications with their base or
10 headquarter other than that is necessary and is able to maintain radio silence for much of their operation, thus reducing the risk of discovery and capture. In fact, it may even be possible to maintain total radio silence if the target-tagging or beacon deployment operation may be estimated with some certainty to be completed within a particular time-frame upon which the
15 missile-carrying fighter-bomber plane would be launched at the end of the time-frame.

Also in terms of human resources, the same reconnaissance unit may be redeployed for another mission since chances of a successful strike is now
20 much higher or make their way back to home territory, without the need to linger around the first mission area any longer which may risk discovery and capture.

SUMMARY OF THE INVENTION

To achieve the aforesaid objects, the present invention thus discloses a method for guiding a self-propelled projectile, including a missile with an explosive payload or warhead, to home onto a target. The method comprises the following steps but not limited to the recited order:

- (a) approaching a target to within a range of travel of a remotely controllable unmanned vehicle comprising
 - at least a radio frequency beacon, and
 - at least a means for delivering said beacon to the target;
- (b) manoeuvring said unmanned vehicle to within range of said beacon delivery means;
- (c) delivering said beacon to be proximate or attached to said target;
- (d) transmit a first radio frequency signal to awaken said beacon;
- (e) upon receiving said first radio frequency signal, self-activating said beacon to transmit a second radio frequency signal;
- (f) remotely detecting second radio frequency signal and compute the coordinates of the beacon's location;
- (g) launching said self-propelled projectile and guiding said projectile to the beacon's location.

The remotely controllable unmanned vehicle is preferably taken to within range of travel to target by reconnaissance personnel in a covert manner. Preferably, the remotely controllable unmanned vehicle is an all-

terrain vehicle or an aircraft of a suitably small size, including a micro aerial vehicle (MAV) to be inconspicuous so that it may be manoeuvred by at least one of said reconnaissance personnel to within range of its beacon delivery means.

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In a first preferred embodiment of the method, the beacon is provided detachable from the unmanned vehicle and may be delivered to the target by any one or in combination of miniature propulsion means of sufficiently small dimensions to be mounted on the unmanned vehicle; electromagnetic means
10 activated remotely for attaching to a ferrous metal part of the target; vacuum pucks which suction may be activated remotely; adhesive means; hook and like mechanical attachment means.

In a second aspect of the present invention, an apparatus is provided
15 for guiding a self-propelled projectile to home onto a target comprising:

- an unmanned vehicle comprising
 - electro-magnetic components for propulsion means controllable remotely by radio frequency transmission; and
 - power source for operating said electro-magnetic components
20 and radio frequency transmission;
- a beacon mounted on said unmanned vehicle comprising a transponder;
- a radio frequency controller (RC) comprising a transmitter in tele-communicative contact and control of said unmanned vehicle's

propulsion and beacon.

The unmanned vehicle's propulsion includes propelling said vehicle to the target to be attached thereto together with the beacon mounted on said vehicle. Preferably, the unmanned vehicle's propulsion includes means for propelling said vehicle towards the target to be proximate therewith; and means for propelling a detachable beacon to be attached to the target. The beacon's transponder preferably remains passive until receiving a first radio frequency signal which may awaken the transponder to transmit a second radio frequency signal to be picked up by a self-propelled projectile launcher, including an aircraft serving as such a launcher, wherein said launcher computes the location of the beacon based on said second radio frequency signal received, and guide said self-propelled projectile *en route* towards the target.

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In a third aspect of the present invention, a beacon is provided for guiding a self-propelled projectile to home onto a target comprising:

- a receiver for receiving a first radio frequency signal having predetermined frequencies and sequences whereupon
- 20 - a transmitter is activated to transmit a second radio frequency signal receivable by a guidance means for a second radio frequency signal to be used as a signal by a self-propelled projectile launcher to guide said self-propelled projectile *en route* towards the target.

Preferably, the beacon is attached to an unmanned vehicle to be transported to the target and draws power from the same power source for propelling the unmanned vehicle. The beacon may be configured to include a microcontroller which is programmable remotely via radio frequency by a remote radio controller to transmit in a selected frequency to distinguish it from other beacons deployed in the same area.

The aforesaid method, apparatus and beacon may be configured into a system for guiding a self-propelled projectile to home onto a target.

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Other aspects and preferred aspects are disclosed in the specification and / or defined in the appended claims, forming a part of the description of the invention.

Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

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BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be better understood with reference to the accompanying drawings and the detailed description that follows hereinafter
5 wherein specific embodiments are described as non-limiting examples or illustrations of the workings of the invention, in which:

Figure 1 shows an algorithm or logic flow of a general embodiment of a guidance system;
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Figure 2 shows a composite view of the major components of the guidance system;

Figure 3 shows a pictorial view of an enemy position being rigged or
15 tagged with a plurality of beacons in various configurations and positions;

Figure 4 shows a pictorial view of a beacon's principal components;
and

20 Figure 5 shows a pictorial view of the missiles being launched and homing onto the targets based on the beacons' signals.

DETAILED DESCRIPTION OF THE INVENTION

The present invention discloses generally a method that guides a self-propelled projectile, including a missile armed with an explosive payload or warhead, which is guided to its target by radio frequency (RF) signals from a preset beacon placed on or approximate a target. The RF-guided missile that is thus guided is likely to be more accurate since it does not rely on other guiding factors such as heat-seeking or light-seeking sensors in which the enemy may deploy decoys such as flares or flames to confuse or redirect the missile from hitting its original target.

With collective reference to the accompanying Figures 1 to 5, the method for guiding a self-propelled projectile to home onto a target broadly comprises of the following steps, preferably in but not limited to, the same order as laid out in Figure 1, whereby reconnaissance unit personnel or Special Ops, as shown as step (10) upon finding enemy targets such as bunkers, infantry, artillery and armoured units, encampments, fortifications, etc., [collectively referred to as (30)] may then covertly approach (20) the targets to within a range of travel of a remotely controllable unmanned vehicle (32). For example, if the unmanned vehicle (32) has a maximum range of 600 metres, the reconnaissance unit personnel may covertly approach the target to within 300 metres and then launch the vehicle (32) and manoeuvre it to approach the target.

In the next step (12), the Special Ops would deploy an unmanned vehicle which may be a micro-aerial vehicle (MAV) containing an RF beacon to a designated position on a target or among the cluster of targets. It should be noted that the mode of delivery of RF beacons need not be limited to MAV-mounted means but may include other tactical means such as lobbing, infiltrating to plant it manually, catapulting, etc. The RF beacon would then lie dormant on or nearby the target with standby power in the listening mode so that electronic sweeping conducted by enemy technicians would not discover its presence.

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The next step (14) sees the Special Ops operatives reporting by radio communication devices (17), as illustrated in Figure 2, to their handlers, base or command centre (15) the enemy position having been targeted for air strike. In the subsequent step (16), aircrafts are launched to fly over or approximately over the targeted area at a safe attitude or distance from enemy flak. The aircraft may illuminate the targeted area to wake up the RF beacon by a transmission of unique radio signal. Once awoken the RF beacon proceeds to transmit the target location radio waves to the aircraft.

20 Next, in step (18), the aircraft registers the location of the target and launches an RF-guided missile upon confirming receipt of the RF beacon's transmission. Lastly, in step (20), the in-flight RF-guided missile homes in to the RF beacon's transmission to hit and detonate to destroy the target.

With reference to Figure 2, the unmanned vehicle (32), which may be an all-terrain vehicle (33) or aircraft (34) of a suitably small size so as to be inconspicuous, may comprise of electromagnetic components such as battery-operable motors for propulsion means which manoeuvring is
5 controllable remotely by radio frequency transmission from a radio controller unit (36) operable by a Special Ops personnel within line of sight of the unmanned vehicle. A portable power source such as a battery pack providing a suitable amount of power to operate the propulsion means, as well the radio frequency receiver for receiving signals from the radio controller transmitter to
10 remotely controlling the propulsion by the reconnaissance unit personnel, may be provided with the vehicle.

A beacon (40) mounted on said unmanned vehicle (32) may comprise of a transmitter or a transponder. The propulsion means of the unmanned
15 vehicle (32) may include means for propelling a beacon, which may be detachable from the MAV, to be attached to a target. Thus the unmanned vehicle (32) may be optionally provided with miniature propulsion means of sufficiently small dimensions to enable such means to be mounted on the unmanned vehicle. Such miniature propulsion means may include catapult
20 launcher, air gun means, coiled spring, micro-explosive charges, hook and like mechanical means, vacuum pucks, adhesive means or electromagnetic means to launch the beacon to be securely attached to a target.

It should be noted that the unmanned vehicle (32), which shall be referred to in the following as the micro-aerial vehicle or MAV (34) version, is only a platform for delivering the RF-beacon (40) to a target. If the MAV is small enough, it may itself be attached or lodged with the RF beacon (40) onto the target. Upon lodgement, the main housing of the beacon and/or MAV may be camouflaged in the shape of a nut, bolt or cap rivet cap to be attached to the undercarriage of enemy vehicles or armour vehicles, for example, after MAV's attachments such as the rotor blades, tail section and runner blades are discarded loosely by automatic ejection. These discarded parts may be made of light materials and camouflaged as blades of grass or leaves easily blown away by a little breeze.

Alternatively, the RF-beacons may be camouflaged as natural products such as a plant part in the shape of fruit (42), pine cones, dead branch, stone, etc. commonly found in the area whereby the Special Ops may manually lob, catapult, small charge launcher or bring into enemy encampment using infiltration and other tactical means.

An enemy forces concentrated area such as depicted in Figure 3 may be tagged as multiple targets such as a MAV (34a) with non-detachable RF beacon, an unmanned all-terrain surface vehicle (USV) (33a) with non-detachable RF beacon, or the MAV (34) or USV (33) may be mounted with detachable RF beacons which, once delivered to the targets, the unmanned vehicles are withdrawn from the area to the periphery, leaving the detached

beacons (40, 42) being attached to the targets such as an armoured vehicle or left camouflaged on the open near a target.

As shown in Figure 3, a plurality of such beacons placed around an
5 enemy concentration may be mapped as a perimeter defining a targeted area of multiple missile strikes while leaving civilian areas unharmed, thus reducing collateral damage.

When used as a singular target tag, the RF beacon (40) may still be
10 deployed in the manner above-described to a single vehicle or building to guide a single missile strike against a particular person such as in a coordinate decapitation attack against the enemy's military and political leadership, or in extra-judicial termination of a master terrorist or mastermind.

15 The beacon's transponder will remain passive or silent upon attachment until it receives a first wake-up signal from a friendly bomber aircraft (44) sweeping the area with a unique radio frequency signal. The unique signal may be predetermined as having dual signal multiple frequency signals (similar to the principle in keyphone's DTMF tone dialing) in a specific
20 sequence or train of pulses. As shown in Figure 4, the RF beacon (40) may have a transceiver (50) or a transponder in communicative contact with a microcontroller (52) as its main components which may be both powered by a common power source such as a battery pack (54).

The awakened RF beacon (40) may then transmit a second radio frequency signal which is picked up by the receiver of the aircraft (44) to be computed to determine the beacon location. The location data may then be incorporated into a broadcast signal to guide said self-propelled missile (46)
5 *en route* to strike the target (30) as shown in Figure 5.

It would be important to have multiple beacons to guide multiple missiles in flight, perhaps each with a predetermined unique radio frequency signal by the individual microcontroller (52) to be broadcast by the transceiver
10 (50) and received by an aircraft's transceiver to guide the respective missile's flight guidance system. In this manner, the successful strike of the first missile on the target will likely to destroy or damage the first beacon while leaving the other beacons to continue to broadcast unique signals to the rest of the incoming missiles. It will also avoid having the missiles slamming onto
15 the same beacon while leaving other beacons unscathed for the enemy to collect and reverse-engineer.

With the unique frequency signals from a corresponding RF beacon and having the missile flight guidance system's receiver of the aircraft tuned
20 to receive only such encoded signal, there is even less likelihood of electronic jamming or interference to the missile's ultimate fateful destiny, not to mention the futility of conventional decoys of flares, smoke screens, etc.

Another advantage of having a micro-controller (52) onboard the RF

beacon (40) is to enable programmability by remote means, such as via radio frequency by a remote radio controller (36) operated by the Special Ops personnel or by the aircraft crew to detect the unique signal for each beacon, in addition to computing the coordinates of the target.

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In the case of a transponder employed onboard a beacon, it is possible to use one that may include as its receiving means, a receiver for receiving RF signals from the aircraft performing the scanning or sweeping to awaken the beacon.

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It will be appreciated that a number of the above-described features may be adopted modularly, modified, reconfigured, or alternatively adapted according to target to be tagged with the beacon, using different electromagnetic wavelengths in addition to radio frequency wavelengths, as well as the configurations of the unmanned vehicles depending on the range of deployment required, all of which may be based on the same general concept, features and working principles of the present invention.

These variations and alternative embodiments may be used in substitution of the aforesaid parts, components, materials, steps or processes as alternative configurations or embodiments not specifically described herein but which may still be used to effectively work the concept and working principles of this invention. Accordingly, they are not to be considered as departures from the present invention but shall be considered as falling within

the letter and scope of the following claims.

While this invention has been described in connection with specific embodiments thereof, it will be understood that it is capable of further
5 modification(s). This application is intended to cover any variations uses or adaptations of the invention following in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice within the art to which the invention pertains and as may be applied to the essential features hereinbefore set forth.

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As the present invention may be embodied in several forms without departing from the spirit of the essential characteristics of the invention, it should be understood that the above described embodiments are not to limit the present invention unless otherwise specified, but rather should be
15 construed broadly within the spirit and scope of the invention as defined in the appended claims. Various modifications and equivalent arrangements are intended to be included within the spirit and scope of the invention and appended claims. Therefore, the specific embodiments are to be understood to be illustrative of the many ways in which the principles of the present
20 invention may be practiced. In the following claims, means-plus-function clauses are intended to cover structures as performing the defined function and not only structural equivalents, but also equivalent structures. For example, although a nail and a screw may not be structural equivalents in that a nail employs a cylindrical surface to secure wooden parts together, whereas

a screw employs a helical surface to secure wooden parts together, in the environment of fastening wooden parts, a nail and a screw are equivalent structures.

- 5 “Comprises/comprising” when used in this specification is taken to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.”

CLAIMS

1. A method for guiding a self-propelled projectile to home onto a target comprising the steps of:
 - 5 (a) approaching a target to within a range of travel of a remotely controllable unmanned vehicle comprising
 - at least a radio frequency beacon, and
 - at least a means for delivering said beacon to the target;
 - (b) manoeuvring said unmanned vehicle to within range of said beacon

10 delivery means;
 - (c) delivering said beacon to be proximate or attached to said target;
 - (d) transmitting a first radio frequency signal to awaken said beacon;
 - (e) upon receiving said first radio frequency signal, self-activating said beacon to transmit a second radio frequency signal;
 - 15 (f) remotely detecting second radio frequency signal and compute the coordinates of the beacon's location;
 - (g) launching said self-propelled projectile and guiding said projectile to the beacon's location.

- 20 2. A method according to Claim 1 wherein the remotely controllable unmanned vehicle is taken to within range of travel to target by reconnaissance personnel in a covert manner.

3. A method according to Claim 1 wherein the remotely controllable unmanned vehicle is an all-terrain vehicle of a suitably small size to be inconspicuous.
- 5 4. A method according to Claim 1 wherein the remotely controllable unmanned vehicle is an aircraft of suitably small size to be inconspicuous.
5. A method according to Claim 1 wherein the steps are in the order listed.
- 10 6. A method according to Claim 2 wherein the remotely controllable unmanned vehicle is manoeuvred by at least one of said reconnaissance personnel to within range of its beacon delivery means.
- 15 7. A method according to Claim 6 wherein the beacon is detachable from the unmanned vehicle.
8. A method according to Claim 6 wherein the beacon is delivered to the target by any one or in combination of
- 20 - miniature propulsion means of sufficiently small dimensions to be mounted on the unmanned vehicle;
- electromagnetic means activated remotely for attaching to a ferrous metal part of the target;
- vacuum pucks which suction may be activated remotely;

- adhesive means;
- hook and like mechanical attachment means.

9. An apparatus for guiding a self-propelled projectile to home onto a
5 target comprising:

- an unmanned vehicle comprising
 - electro-magnetic components for propulsion means controllable remotely by radio frequency transmission; and
 - power source for operating said electro-magnetic components
10 and radio frequency transmission;
- a beacon mounted on said unmanned vehicle comprising a transponder;
- a radio frequency controller (RC) comprising a transmitter in tele-communicative contact and control of said unmanned vehicle's
15 propulsion and beacon.

10. An apparatus according to Claim 9 wherein the unmanned vehicle's propulsion includes propelling said vehicle to the target to be attached thereto together with the beacon mounted on said vehicle.

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11. An apparatus according to Claim 9 wherein the unmanned vehicle's propulsion includes
- means for propelling said vehicle towards the target to be proximate therewith; and

- means for propelling a detachable beacon to be attached to the target.

12. An apparatus according to Claim 9 wherein the beacon's transponder remains passive until receiving a first radio frequency signal.

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13. An apparatus according to Claim 12 wherein the first radio frequency signal awakens said transponder to transmit a second radio frequency signal to be picked up by a self-propelled projectile launcher, including an aircraft serving as such a launcher, wherein said launcher computes the location of
10 the beacon based on said second radio frequency signal received, and guide said self-propelled projectile *en route* towards the target.

14. An apparatus according to Claim 9 wherein the remotely controllable unmanned vehicle is an unmanned all-terrain surface vehicle of a suitably
15 small size to be inconspicuous.

15. An apparatus according to Claim 9 wherein the remotely controllable unmanned vehicle is an aircraft of suitably small size to be inconspicuous.

20 16. An apparatus according to Claim 15 wherein the aircraft is a micro-aerial vehicle (MAV).

17. A beacon for guiding a self-propelled projectile to home onto a target comprising:

- a receiver for receiving a first radio frequency signal having predetermined frequencies and sequences whereupon
- a transmitter is activated to transmit a second radio frequency signal receivable by a guidance means for a second radio frequency signal to be used as a signal by a self-propelled projectile launcher to guide said self-propelled projectile *en route* towards the target.

18. A beacon according to Claim 17 which is attached to an unmanned vehicle to be transported to the target.

19. A beacon according to Claim 18 which draws power from the same power source for propelling the unmanned vehicle.

20. A beacon according to Claim 17 including a microcontroller which is programmable remotely via radio frequency by a remote radio controller to transmit in a selected frequency to distinguish it from other beacons deployed in the same area.

21. A system for guiding a self-propelled projectile to home onto a target comprising at least

- an apparatus according to any one of Claims 9 - 16;
- a beacon according to any one of Claims 17 - 20; and
- a method according to any one of Claims 1 - 8.