

METHOD AND SYSTEM FOR ACTIVATING AN EMERGENCY LOCATOR TRANSMITTER OF AN AIRCRAFT

Technical Field

[0001] The present invention relates generally to an emergency locator transmitter of an aircraft, particularly relates to a method and a system for activating an emergency locator transmitter of an aircraft.

Background

[0002] A distress beacon, also referred to as an emergency locator transmitter (ELT) in aeronautical applications, is an emergency transmitter that, if activated, transmits a distress signal which can be detected by satellites. The distress signal on the frequency of 406 MHz carries data which identifies the aircraft in distress, and can be processed by COSPAS-SARSAT system satellites to aid and coordinate search and rescue (SAR) operations all over the world. The aircraft in distress can thus be located using the Doppler Effect with a precision of approximately 3.7km (i.e., about 2 nautical miles) at any point on the earth. The distress signal can also be transmitted on the international emergency frequencies of 121.5 MHz and 243.0 MHz, which are primarily used for homing during the final stages of the SAR operations.

[0003] Automatic ELT are impact monitors activated by excessive G-force or upon immersion into water. The aircraft is usually equipped with a shock detector, for example, an acceleration sensor, also called a G-switch. In the event of a crash, the G-switch detects significant change of velocity or deceleration of the aircraft, and automatically activates the ELT which will transmit the distress signal upon activation.

[0004] An altitude sensor may be equipped in the aircraft to measure the altitude of the aircraft above the sea level or the ground level. An altitude sensor can come in many forms such as an air data computer that measures the barometric altitude using the pressure difference between aircraft and ground or a radio altimeter that measures the radio altitude based on the reflected pulse off the land/ocean surface. Unlike the barometric altitude, the

radio altimeter signal may require filtering to correctly measure the altitude above ground and eliminate spurious returns.

[0005] US 2015/0134154 proposes an approach to automatically arm a distress beacon when a positional difference between a theoretical position of the aircraft determined from data of the flight plan and a real position of the aircraft determined from the navigation and monitoring equipment exceeds a predetermined value. The system of US 2015/0134154 is also designed to arm the distress beacon when at least one of additional conditions is met including: the real position of the aircraft is distant from the surface of the water/of the land by a distance less than or equal to a predetermined value; the real position of the aircraft is farther than a predetermined distance from an airport zone; etc. After the arming of the distress beacon, the system is designed to deliver an instruction to activate the beacon when the amplitude of a signal delivered by an acceleration sensor exceeds a predetermined threshold. The system of US 2015/0134154 is proposed to improve the reliability of activation of the distress beacon which is susceptible to false alarm, for example, to avoid an automatic triggering of the beacon in the case of a “hard” landing of the aircraft which is not considered as an accident.

[0006] In the existing approaches, there may be a delay in broadcasting of distress signal, since precious time is lost from time of emergency to activation of the ELT. Moreover, the ELT may not be activated effectively in the case of controlled emergency landing, e.g. when there is insufficient g-force, or in the case of a deviation from planned course by a rogue pilot. There is a need to locate an aircraft in distress more effectively and timely.

Summary

[0007] Various embodiments provide a method for activating an emergency locator transmitter of an aircraft. The method may include determining whether a first condition is met by determining whether an altitude of the aircraft is lower than a predetermined altitude and whether a distance between the aircraft and a predetermined airport is greater than a predetermined distance; outputting a first activating instruction to the emergency locator transmitter if the first condition is met; determining whether a second condition is met by determining whether a g-force detected by an acceleration sensor exceeds a predetermined threshold; outputting a second activating instruction to the emergency locator transmitter if

the second condition is met; and activating the emergency locator transmitter upon receiving at least one of the first activating instruction or the second activating instruction at the emergency locator transmitter.

[0008] Various embodiments provide a system for activating an emergency locator transmitter of an aircraft. The system may include a conditional trigger unit configured to determine whether a first condition is met by determining whether an altitude of the aircraft is lower than a predetermined altitude and whether a distance between the aircraft and a predetermined airport is greater than a predetermined distance; and configured to output a first activating instruction to the emergency locator transmitter if the first condition is met. The system may further include an acceleration sensor configured to determine whether a second condition is met by determining whether a g-force detected by the acceleration sensor exceeds a predetermined threshold; and configured to output a second activating instruction to the emergency locator transmitter if the second condition is met. The emergency locator transmitter is activated upon receiving at least one of the first activating instruction or the second activating instruction.

Brief Description of the Drawings

[0009] In the drawings, like reference characters generally refer to the same parts throughout the different views. The drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention. In the following description, various embodiments are described with reference to the following drawings, in which:

Fig. 1 shows a flowchart illustrating a method for activating an emergency locator transmitter of an aircraft according to various embodiments.

Fig. 2 shows a schematic diagram illustrating a method for activating an emergency locator transmitter of an aircraft according to various embodiments.

Fig. 3 shows a schematic diagram illustrating a system for activating an emergency locator transmitter of an aircraft according to various embodiments.

Fig. 4 shows a schematic diagram illustrating a system for activating an emergency locator transmitter of an aircraft according to various embodiments.

Description

[0010] Various embodiments provide a method and a system for activating an emergency locator transmitter of an aircraft to ensure that an aircraft in distress or in unusual conditions is located more effectively and timely.

[0011] In this context, the word "exemplary" is used herein to mean "serving as an example, instance, or illustration". Any embodiment or design described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other embodiments or designs.

[0012] Fig. 1 shows a flowchart 100 illustrating a method for activating an emergency locator transmitter (ELT) of an aircraft according to various embodiments.

[0013] At 102, it is determined whether a first condition is met by determining whether an altitude of the aircraft is lower than a predetermined altitude and whether a distance between the aircraft and a predetermined airport is greater than a predetermined distance.

[0014] At 104, a first activating instruction is output to the emergency locator transmitter if the first condition is met.

[0015] At 106, it is determined whether a second condition is met by determining whether a g-force detected by an acceleration sensor exceeds a predetermined threshold.

[0016] At 108, a second activating instruction is output to the emergency locator transmitter if the second condition is met.

[0017] At 110, the emergency locator transmitter is activated upon receiving at least one of the first activating instruction or the second activating instruction at the emergency locator transmitter.

[0018] In other words, various embodiments provide a method to determine a first condition of whether the aircraft is deviated from a flight plan, and determine a second condition of whether an excessive g-force is experienced by the aircraft, such that the ELT can be activated when either one or both of the first condition and the second condition is met.

[0019] According to the method of various embodiments, when the aircraft is deviated from a flight plan, for example, in the scenario of a controlled landing by a rogue pilot at areas not in the vicinity of an airport, the ELT can be directly activated. This also ensures

that the ELT is properly activated, even when the acceleration sensor is malfunctioned. The acceleration sensor is also referred to as the G-switch. The method of various embodiments also ensures that the ELT is activated if the G-switch in normal operation detects an excessive g-force in the event of the crash.

[0020] According to various embodiments, the method may include, after the emergency locator transmitter is armed, determining whether the first condition is met and determining whether the second condition is met. In other words, the ELT is armed or placed in an “Arm” operation mode, prior to the determination of the first condition and the second condition. The “Arm” operation mode is a standby mode, in which activation of the ELT can be enabled by predetermined conditions, e.g., by the first condition and/or by the second condition, or by a Remote Control Panel. When the predetermined condition is met, the ELT is automatically activated and starts to transmit the distress signal.

[0021] It is understood that the steps 102-110 may not be carried out in sequence, and may be carried out in any appropriate order according to various embodiments. In an exemplary embodiment, the determination of the first condition 102 and the determination of the second condition 106 may be carried out simultaneously. The output of the first activating instruction 104 and the output of the second activating instruction 108 are subsequent to the respective determination of the first condition and the second condition, and may be simultaneous or asynchronous depending on the timing of the determination results of the first condition and the second condition. In another exemplary embodiment, the determination of the first condition 102 and the output of the first activating instruction 104 may be carried out before the determination of the second condition 106 and the output of the second activating instruction 108. In a further exemplary embodiment, the determination of the second condition 106 and the output of the second activating instruction 108 may be carried out before the determination of the first condition 102 and the output of the first activating instruction 104.

[0022] In various embodiments, the activation of the ELT 110 may be carried out once the ELT receives either one of the first activating instruction and the second activating instruction, which means that the activation of the ELT 110 may be carried out anytime an activating instruction is received and is not necessarily after both the first condition and the second condition are determined. In various embodiments, the activation of the ELT 110 may also be carried out when the ELT receives both the first activating instruction and the

second activating instruction, which is after the determination of both the first condition and the second condition.

[0023] In various embodiments, when the ELT 110 is activated, the ELT 110 transmits a distress signal, for example, one or more of a 406MHz radio signal, a 121.5 MHz radio signal and a 243.0 MHz radio signal, which can be detected by geostationary satellites.

[0024] According to various embodiments, the method may include receiving the altitude of the aircraft from an altitude sensor. The altitude sensor measures the current altitude of the aircraft, and provides the altitude of the aircraft for comparison with the predetermined altitude. The measured altitude represents the height of the aircraft above sea level, or the height of the aircraft above ground level (i.e. surface of the earth). In an exemplary embodiment, the predetermined altitude may be about 762 meters (i.e. about 2500 feet). The predetermined altitude may be other suitable values in other embodiments.

[0025] In various embodiments, the altitude sensor may include an air data computer which measures the barometric altitude using the pressure difference between aircraft and ground, or may include a radio altimeter which measures the radio altitude based on the reflected pulse off the ground/sea surface, or may include a combination of the air data computer and the radio altimeter. Unlike the barometric altitude, the radio altimeter signal may require filtering to correctly measure the altitude above ground and eliminate spurious returns. In other embodiments, the altitude sensor may include any other suitable types of sensor which can measure the altitude of the aircraft.

[0026] In various embodiments, the method may include determining the distance between the aircraft and the predetermined airport by comparing a current position of the aircraft with a position of the predetermined airport, wherein each of the positions is represented by a latitude and a longitude. The latitude and the longitude representing the current position of the aircraft may be received from a global positioning system (GPS). The latitude and the longitude representing the position of the predetermined airport may be retrieved from an airfield database.

[0027] In various embodiments, the predetermined airport may be a nearest airport from the aircraft determined from an airfield database based on the latitude and the longitude representing the current position of the aircraft. For example, the airfield database may include position information of a plurality of airports. Based on the current position of the

aircraft, it is searched from the airfield database to determine one airport as the predetermined airport which is positioned nearest to the current position of the aircraft.

[0028] In an exemplary embodiment, the predetermined distance may be about 27780 meters (i.e. about 15 nautical miles). The predetermined distance may be other suitable values in other embodiments. If the distance between the aircraft and the predetermined airport is greater than the predetermined distance, the aircraft can be determined to be not in the vicinity of the predetermined airport.

[0029] In an exemplary embodiment, it is determined that the first condition is met, if the altitude of the aircraft is lower than about 762 meters and if the distance between the aircraft and the predetermined airport is greater than about 27780 meters.

[0030] According to various embodiments above, the first condition is determined using the real altitude and the real position of the aircraft. In other words, whether the aircraft is deviated from course is determined using the real altitude and the real position of the aircraft only, without the need to compare with the theoretical position of the aircraft provided by a flight management system. This ensures that the first condition is determined accurately and correctly, since the flight management system may be controlled by the pilot and may not provide correct information.

[0031] According to various embodiments, the method for activating the ELT is further illustrated in the schematic diagram 200 of Fig. 2. Various embodiments of the method described with reference to Fig. 1 above are analogously valid for the method described in Fig. 2, and vice versa.

[0032] Block 202 determines whether the first condition is met, by determining whether the aircraft is not in the vicinity of the predetermined airport and whether the aircraft is below a threshold altitude. The determination may be carried out by comparing the distance between the aircraft and the predetermined airport with the predetermined distance (e.g., representing a radius of the airport zone), and comparing the altitude of the aircraft with the predetermined altitude. The block 202 outputs the first activating instruction if it is determined that the aircraft is not in the vicinity of the predetermined airport and is below the threshold altitude.

[0033] Block 204 determines whether the second condition is met by determining whether the g-force detected by the acceleration sensor exceeds the predetermined

threshold. The block 204 outputs the second activating instruction if it is determined that the detected g-forces exceeds the predetermined threshold.

[0034] If block 206 detects either one or both of the first activating instruction and the second activating instruction, block 208 triggers an activation of the ELT.

[0035] Fig. 3 shows a schematic diagram illustrating a system 300 for activating an emergency locator transmitter 302 of an aircraft according to various embodiments. The system 300 may be configured to carry out the method of various embodiments as described above, and various embodiments of the method described above are analogously valid for the system, and vice versa.

[0036] The system 300 may include a conditional trigger unit 304 configured to determine whether a first condition is met by determining whether an altitude of the aircraft is lower than a predetermined altitude and whether a distance between the aircraft and a predetermined airport is greater than a predetermined distance. The conditional trigger unit 304 is configured to output a first activating instruction to the emergency locator transmitter 302 if the first condition is met.

[0037] In various embodiments, the conditional trigger unit 304 may be configured to receive the altitude of the aircraft from an altitude sensor, such as a radio altimeter or an air data computer or a combination of both. The altitude sensor may be provided on board the aircraft for measuring the current altitude of the aircraft.

[0038] In various embodiments, the conditional trigger unit 304 may be configured to determine the distance between the aircraft and the predetermined airport by comparing a current position of the aircraft with a position of the predetermined airport. The current position of the aircraft and the position of the predetermined airport may each be represented by a latitude and a longitude. The latitude and the longitude representing the current position of the aircraft may be measured by a global positioning system (GPS) provided on board the aircraft, and may be retrieved from the GPS by the conditional trigger unit 304. The conditional trigger unit 304 may be loaded with an airfield database or may have access to the airfield database, and the latitude and the longitude representing the position of the predetermined airport may be obtained from the airfield database.

[0039] In various embodiments, the conditional trigger unit 304 may be configured to determine the predetermined airport as a nearest airport from the aircraft. The nearest

airport is determined from the airfield database based on the latitude and the longitude representing the current position of the aircraft.

[0040] The system 300 may further include an acceleration sensor 306, also referred to as a G-switch, configured to determine whether a second condition is met by determining whether a g-force detected by the acceleration sensor exceeds a predetermined threshold. The acceleration sensor 306 is configured to output a second activating instruction to the emergency locator transmitter 302 if the second condition is met.

[0041] The emergency locator transmitter 302 is activated upon receiving at least one of the first activating instruction or the second activating instruction. In other words, if either one or both of the first activating instruction and the second activating instruction is received by the ELT 302, the ELT 302 is automatically activated to transmit a distress signal.

[0042] It is understood that either one or both of the conditional trigger unit 304 and the acceleration sensor 306 may be separated from the ELT 302, or may be integrated within the ELT 302.

[0043] According to various embodiments, after the emergency locator transmitter is armed, the conditional trigger unit 304 is configured to determine whether the first condition is met and the acceleration sensor 306 is configured to determine whether the second condition is met. In other words, the ELT is armed or placed in an “Arm” operation mode, prior to the operations of the conditional trigger unit 304 and the acceleration sensor 306. After the ELT is armed, it can be subsequently activated by predetermined conditions, e.g., by the first condition and/or by the second condition, or by a Remote Control Panel.

[0044] Fig. 4 shows a schematic diagram illustrating a system 400 for activating an emergency locator transmitter 402 of an aircraft according to various embodiments. Various embodiments of the method and the system described above are analogously valid for the system of Fig. 4, and vice versa.

[0045] The ELT 402 may include an antenna 404 which is used to radiate a radio signal, i.e. the distress signal, when the ELT 402 is activated.

[0046] The ELT 404 may have a plurality of operation modes, including but not limited to “OFF”, “Arm” and “ON” operation modes. The ELT is in the “OFF” operation mode usually only when the ELT is removed from the aircraft or when the aircraft is parked for a

long period or for maintenance. In the “OFF” operation mode, the ELT is off and no part of the ELT is energized, which means that the ELT cannot be activated.

[0047] The “Arm” operation mode is a standby mode, in which activation of the ELT can be enabled by predetermined conditions, e.g., by the G-Switch or by the conditional trigger unit, or by a Remote Control Panel. When the predetermined condition is met, the ELT is automatically switched to the “ON” operation mode. In other words, the ELT is activated and starts to transmit the distress signal. The ELT can also be switched to the “ON” operation mode by the Remote Control Panel.

[0048] The system 400 may include a conditional trigger unit 406 configured to determine whether a first condition is met by determining whether an altitude of the aircraft is lower than a predetermined altitude and whether a distance between the aircraft and a predetermined airport is greater than a predetermined distance, and configured to output a first activating instruction to the ELT 402 if the first condition is met.

[0049] In various embodiments, the system 400 may further include an altitude sensor 408, which may include at least one of a radio altimeter or an air data computer, for measuring the altitude of the aircraft. The altitude of the aircraft represents the height of the aircraft above the sea level or ground level. The conditional trigger unit 406 may receive the current altitude information of the aircraft from the altitude sensor 408, and compares the current altitude of the aircraft with the predetermined altitude to determine whether the aircraft is flying too low. In an exemplary embodiment, the predetermined altitude is about 762 meters (i.e. about 2500 feet).

[0050] In various embodiments, the system 400 may further include a GPS 410, which provides the conditional trigger unit 406 with the current position of the aircraft, for example, in the form of latitude and longitude information.

[0051] The conditional trigger unit 406 may be loaded with an airfield database or may have access to the airfield database, which includes position information (e.g. latitude and longitude) of a plurality of airports. Based on the current position of the aircraft, the conditional trigger unit 406 may be configured to determine a nearest airport from the airfield database as the predetermined airport. In other embodiments, the predetermined airport may be a preset airport, the position information of which is provided to the conditional trigger unit 406.

[0052] The conditional trigger unit 406 may be configured to determine the distance between the aircraft and the predetermined airport by comparing the current position of the aircraft with the position of the predetermined airport, and determine whether such a distance is greater than the predetermined distance so as to determine whether the aircraft is not within the airport zone. In an exemplary embodiment, the predetermined distance is about 27780 meters (i.e. about 15 nautical miles).

[0053] The system 400 may further include an acceleration sensor 412 configured to determine whether a second condition is met by determining whether a g-force detected by the acceleration sensor 412 exceeds a predetermined threshold. The acceleration sensor 412 is configured to output a second activating instruction to the ELT 402 if the second condition is met.

[0054] When receiving either one or both of the first activating instruction and the second activating instruction, the ELT 402 is activated to transmit the distress signal via the antenna 404.

[0055] According to various embodiments, the emergency locator transmitter is armed or placed in the "Arm" operation mode, before the conditional trigger unit 406 determines whether the first condition is met and before the acceleration sensor 412 determines whether the second condition is met.

[0056] In various embodiments, the conditional trigger unit 406 may be integrated with the ELT 402 to form an enhanced ELT 414 as illustrated in Fig. 4. In other embodiments, either one or both of the conditional trigger unit 406 and the acceleration sensor 412 may be integrated with the ELT 402 to form the enhanced ELT 414.

[0057] The conditional trigger unit 304, 406 provides an alternative means of activating the ELT, and maybe implemented by one or more circuits, for example. A "circuit" may be understood as any kind of a logic implementing entity, which may be special purpose circuitry or a processor executing software stored in a memory, firmware, or any combination thereof. Thus, in an embodiment, a "circuit" may be a hard-wired logic circuit or a programmable logic circuit such as a programmable processor, e.g. a microprocessor (e.g. a Complex Instruction Set Computer (CISC) processor or a Reduced Instruction Set Computer (RISC) processor). A "circuit" may also be a processor executing software, e.g. any kind of computer program, e.g. a computer program using a virtual machine code such

as e.g. Java. . Any other kind of implementation of the respective functions which will be described in more detail below may also be understood as a "circuit".

[0058] Various embodiments above provide a more pro-active triggering technique which can be implemented based on the altitude of the aircraft and the proximity from airport. The ELT will be activated when the aircraft experiences a deviation from normal operation governed by setting a minimum aircraft operating condition, i.e. the first condition described above. Deviation from this condition will activate the ELT, which improves the effectiveness of SAR.

[0059] The method and system for activating the ELT according to various embodiments above ensure that the aircraft in distress can be located as soon as possible in various scenarios which may not be able to activate the ELT in the existing approaches. In an exemplary scenario of controlled landing at areas not in the vicinity of an airport, e.g. intentionally by a rogue pilot, the method and system of the various embodiments are able to timely and effectively activate the ELT. In another exemplary scenario when the G-switch is malfunctioned, the method and system of the various embodiments can also activate the ELT when it determines the first condition as described above.

[0060] While the invention has been particularly shown and described with reference to specific embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined by the appended claims. The scope of the invention is thus indicated by the appended claims and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced.

Claims

What is claimed is:

1. A method for activating an emergency locator transmitter of an aircraft, the method comprising:

determining whether a first condition is met by determining whether an altitude of the aircraft is lower than a predetermined altitude and whether a distance between the aircraft and a predetermined airport is greater than a predetermined distance;

outputting a first activating instruction to the emergency locator transmitter if the first condition is met;

determining whether a second condition is met by determining whether a g-force detected by an acceleration sensor exceeds a predetermined threshold;

outputting a second activating instruction to the emergency locator transmitter if the second condition is met; and

activating the emergency locator transmitter upon receiving at least one of the first activating instruction or the second activating instruction at the emergency locator transmitter.

2. The method according to claim 1, further comprising:

after the emergency locator transmitter is armed, determining whether the first condition is met and determining whether the second condition is met.

3. The method according to claim 1 or 2, further comprising:

receiving the altitude of the aircraft from an altitude sensor.

4. The method according to claim 3, wherein the altitude sensor comprises at least one of a radio altimeter or an air data computer.

5. The method according to any one of claims 1 to 4, further comprising:

determining the distance between the aircraft and the predetermined airport by comparing a current position of the aircraft with a position of the predetermined airport, wherein each of the positions is represented by a latitude and a longitude.

6. The method according to claim 5, further comprising:

receiving the latitude and the longitude representing the current position of the aircraft from a global positioning system.

7. The method according to claim 5 or 6, wherein the predetermined airport is a nearest airport from the aircraft determined from an airfield database based on the latitude and the longitude representing the current position of the aircraft.

8. The method according to any one of claims 1 to 7, further comprising:

determining the first condition is met if the altitude of the aircraft is lower than about 762 meters and if the distance between the aircraft and the predetermined airport is greater than about 27780 meters.

9. A system for activating an emergency locator transmitter of an aircraft, the system comprising:

a conditional trigger unit configured to determine whether a first condition is met by determining whether an altitude of the aircraft is lower than a predetermined altitude and whether a distance between the aircraft and a predetermined airport is greater than a predetermined distance; and configured to output a first activating instruction to the emergency locator transmitter if the first condition is met; and

an acceleration sensor configured to determine whether a second condition is met by determining whether a g-force detected by the acceleration sensor exceeds a predetermined

threshold; and configured to output a second activating instruction to the emergency locator transmitter if the second condition is met;

wherein the emergency locator transmitter is activated upon receiving at least one of the first activating instruction or the second activating instruction.

10. The system according to claim 9, wherein

after the emergency locator transmitter is armed, the conditional trigger unit is configured to determine whether the first condition is met and the acceleration sensor is configured to determine whether the second condition is met.

11. The system according to claim 9 or 10, further comprising an altitude sensor configured to provide the altitude of the aircraft to the conditional trigger unit.

12. The system according to claim 11, wherein the altitude sensor comprises at least one of a radio altimeter or an air data computer.

13. The system according to any one of claims 9 to 12, wherein the conditional trigger unit is configured to determine the distance between the aircraft and the predetermined airport by comparing a current position of the aircraft with a position of the predetermined airport, wherein each of the positions is represented by a latitude and a longitude.

14. The system according to claim 13, further comprising a global positioning system configured to provide the latitude and the longitude representing the current position of the aircraft to the conditional trigger unit.

15. The system according to claim 13 or 14, wherein the predetermined airport is a nearest airport from the aircraft determined from an airfield database based on the latitude and the longitude representing the current position of the aircraft.

16. The system according to any one of claims 9 to 15, wherein the conditional trigger unit is configured to determine the first condition is met if the altitude of the aircraft is lower than about 762 meters and if the distance between the aircraft and the predetermined airport is greater than about 27780 meters.