SUMMARY

An embodiment of the subject disclosure provides a method for controlling an aircraft. A target state for the aircraft is identified. A current mission state is determined for the aircraft. The current mission state of the aircraft includes a set of state variables for the aircraft. A sequence of actions is selected from a pool of potential actions to reach the target state from the current mission state for the aircraft. The sequence of actions is selected based on the current mission state. Actions in the sequence of actions for which preconditions for the actions that have been met are performed. The actions are performed in an order defined by the sequence of actions. Each of the actions in the sequence of actions includes a set of effects. The set of effects is one or more changes that occur to the state variables when each of the actions is performed. An effect that changes one of the state variables is a change in a value for the state variable in response to a performance of each of the actions. The performance of each of the actions changes the current state resulting in a new mission state becoming the current mission state. The sequence of actions is reselected from the pool of potential actions to reach the target state, in response to an event. The event is a current mission state change. The reselected sequence of actions includes one of: (i) the same actions as the sequence of actions in a same order; (ii) the same action as the sequence of actions in a different order; or (iii) different actions to the sequence of actions

Another embodiment of the subject disclosure provides an aircraft control system comprising a computer system and an action manager in the computer system. The action manager is configured to identify a target state for the aircraft and determine a current mission state for the aircraft from state variables received from aircraft systems in the aircraft. The

action manager is configured to select a sequence of actions from a pool of potential actions to reach the target state from the current mission state for the aircraft using a set of path planning algorithms in which the sequence of actions is selected based on the current mission state. The action manager is configured to perform actions in the sequence of actions for which preconditions for the actions that have been met. The actions are performed in an order defined by the sequence of actions.

Still another embodiment of the subject disclosure provides an aircraft control system comprising a computer system. The computer system is configured to perform the method as described.

The features and functions can be achieved independently in various embodiments of the subject disclosure or may be combined in yet other embodiments in which further details can be seen with reference to the following description and drawings.

CLAIMS:

1. A method comprising:

identifying, by a computer system, a target state for an aircraft;

determining, by the computer system, a current mission state for the aircraft, wherein the current mission state of the aircraft comprises a set of state variables for the aircraft;

selecting, by the computer system, a sequence of actions from a pool of potential actions to reach the target state from the current mission state for the aircraft in which the sequence of actions is selected based on the current mission state;

performing, by the computer system, actions in the sequence of actions for which preconditions for the actions that have been met, in which the actions are performed in an order defined by the sequence of actions, wherein each of the actions in the sequence of actions comprises a set of effects, wherein the set of effects is one or more changes that occur to the state variables when each of the actions is performed, wherein an effect that changes one of the state variables is a change in a value for the state variable in response to a performance of each of the actions, and wherein the performance of each of the actions changes the current state resulting in a new mission state becoming the current mission state; and

reselecting, by the computer system, the sequence of actions from the pool of potential actions to reach the target state, in response to an event, wherein the event is a current mission state change, wherein the reselected sequence of actions comprises one of: (i) the same actions as the sequence of actions in a same order; (ii) the same action as the sequence of actions in a different order; or (iii) different actions to the sequence of actions.

2. The method of claim 1, wherein the actions and the sequence of actions are selected based on a cost of performing the actions.

3. The method of claim 1 or 2, wherein the actions and the sequence of actions is selected from the pool of potential actions by an artificial intelligence system.

4. The method of any one of claims 1-3, wherein determining, by the computer system, the current mission state for the aircraft comprises:

receiving the state variables from aircraft systems in the aircraft; and

determining the current mission state using the state variables for the current mission state.

5. The method of any one of claims 1-4, wherein selecting, by the computer system, the sequence of actions comprises:

identifying nodes in a path from the current mission state to the target state based on the nodes having a lowest cost; and

selecting the sequence of actions from the pool of potential actions based on the nodes identified in the path, and

optionally wherein a cost used to determine the lowest cost comprises a set of factors selected from at least one of a number of effects of an action, a monetary cost, an amount of time, a maintenance cost to be incurred, an amount of fuel to be consumed, a personnel cost connected to time, or passenger comfort.

6. The method of any one of claims 1-5, wherein selecting the sequence of actions, by the computer system, from the pool of potential actions to reach the target state to reach the current mission state for the aircraft comprises:

selecting the sequence of actions, by the computer system, from the pool of potential actions to reach the target state based on the current mission state for the aircraft using a set of path planning algorithms, and

optionally wherein the set of path planning algorithms is selected from at least one an A* search algorithm, a Dijkstra's algorithm, a D*, an incremental search algorithm, a Backtracking algorithm, a Fringe search, an Any-angle path planning algorithm, an iterative deepening A* search algorithm, a Bellman–Ford search algorithm, a Floyd–Warshall algorithm, a Hill climbing algorithm, a Bidirectional search algorithm, or a Johnson’s algorithm.

7. The method of any one of claims 1-6, wherein the preconditions comprise at least one of a current location of the aircraft, a performance of a selected action, a configuration of the aircraft, a position of a control surface, a weather condition, or an instruction from an air traffic controller.

8. The method of any one of claims 1-7, wherein the target state is one of an operational target state and a spatial target state.

9. The method of any one of claims 1-8, wherein the target state comprises a set of state variables with a set of values for the target state.

10. The method of any one of claims 1-9, further comprising:

defining the target state for the aircraft based on user input received from a human machine interface system, wherein the human machine interface system is at least one of located in the aircraft, a remote location in communication with the aircraft, an air traffic control system, or an airline system.

11. An aircraft control system comprising:

a computer system configured to perform the method of any one of claims 1 to 10.

12. The aircraft control system of claim 10, wherein the actions and the sequence of actions are selected based on a cost of performing the actions.

13. The aircraft control system of claim 11 or 12, wherein the actions and the sequence of actions are selected from the pool of potential actions by an artificial intelligence system.

14. The aircraft control system of any one of claims 11 to 13, wherein in determining, by the computer system, the current mission state for the aircraft, the computer system is configured to receive state variables from aircraft systems in the aircraft and determine the current mission state using the state variables for the current mission state, and optionally wherein the aircraft systems are selected from at least of a flight management system, a flight navigation system, an environmental control system, an engine, a flight control surface system, an auto pilot, a communications system, a satellite communications system, a very high frequency communication system, microwave-band communication system, a radar system, an autopilot, a fuel system, a weather radar, an electronic centralized aircraft monitoring system, a quick access data recorder, an onboard network server, an electronic flight instrument system.

15. The aircraft control system of any one of claims 11 to 14, wherein in selecting the sequence of actions from the pool of potential actions to reach the target state from the current mission state for the aircraft in which the sequence of actions

is selected based on the current mission state, the computer system is configured to identify nodes in a path from the current mission state to the target state based the nodes having a lowest cost using an artificial intelligence system and select the sequence of actions from the pool of potential actions based on the nodes identified in the path.

16. The aircraft control system of any one of claims 11 to 15, wherein a cost used to determine a lowest cost comprises a set of factors selected from at least one of a number of effects of an action, a monetary cost, an amount of time, a maintenance cost incurred, an amount of fuel to be consumed, a personnel cost connected to time, or passenger comfort.

17. The aircraft control system of any one of claims 11 to 16, wherein the computer system includes at least one of a flight management system, a line replaceable unit, a tablet computer, or an electronic flight bag.