CLAIMS

1. An apparatus for managing a construction site and/or crane, the apparatus comprising:

a memory storing sensor data received from a plurality of capture devices associated with the construction site and/or crane, wherein the sensor data comprises video received from at least one capture device having a field view including at least part of the construction;

the memory storing one or more rules or thresholds;

a processor configured to:

image process on one or more frames of the video to evaluate at least one of the rules and compute a 3D model of the construction site;

process the sensor data by evaluating at least one of the rules, or by comparing a prediction computed from the sensor data with at least one of the thresholds;

in response to evaluation of a rule, or in response to comparison of a prediction with a threshold, trigger an alert,

wherein the image processing comprises:

detecting a tower crane by inputting the video to a trained object recognition system, and

in response to detecting the tower crane, computing a no-go zone around the tower crane in the 3D model of the construction site.

2. The apparatus of claim 1 wherein the rules are determined or created by a learning algorithm based on historical data and the desired outcomes or decisions, or the associated pattern recognition analysis.

3. The apparatus of claim 2 wherein the sensor data comprises information for the tower crane including the tower crane’s location, contact information, settings for

the tower crane, captured or logged events involving the tower crane, movement direction, height, trolley/luffing, slewing, windspeed and direction, temperature, and reeving, as well as alarm logs, and storm brace mechanism, and the information is delivered in a view mode only.

4. The apparatus of any one of the preceding claims wherein:

the memory stores a schedule of activities forming a critical path of a construction project at the construction site;

the sensor data comprises information about the activities;

the processor is configured to detect differences between the schedule of activities and the information about the activities from the sensor data; and

in response to detecting differences, the processor is configured to mitigate risks by following one or more rules according to the detected differences.

5. The apparatus of claim 4 wherein the processor is configured to send a message comprising the information about the activities and the detected differences to one or more end user devices in real time.

6. The apparatus of any one of the preceding claims wherein the image processing comprises detecting people depicted in the video by inputting the video to a trained object recognition system, and for each detected person, to input a region of the video depicting the person to a trained classifier, which classifies the region as depicting personal protection equipment or not.

7. The apparatus of claim 6 comprising, in response to the classifier classifying a region as not depicting personal protection equipment, triggering the alert by triggering a message to be sent to a specified destination, the message comprising an image of the region input to the trained classifier.

8. The apparatus of any one of the preceding claims wherein the image processing comprises detecting a mobile crane by inputting the video to the trained object

recognition system, and wherein the processor is configured to evaluate a rule by checking if the detected mobile crane is in the no-go zone of the 3D model.

9. The apparatus of claim 1 wherein the sensor data comprises video received from at least one capture device having a field of view including at least part of the construction site and wherein the processor is configured to carry out image processing to detect a building being built at the construction site and to compute a timestamped model of the building; the processor configured to evaluate at least one of the rules by comparing the model with a template having a corresponding timestamp.
10. The apparatus of claim 9 wherein the processor is configured, in response to the comparison identifying a difference between the model and the template, to send a message comprising information about the difference and including one or more frames of the video.
11. The apparatus of claim 10 wherein the processor is configured to access a database of solutions and to select one of the solutions on the basis of the difference, and to send the solution as part of the message.
12. The apparatus of claim 1 wherein the sensor data comprises video received from at least one capture device having a field of view including at least part of the construction site and wherein the processor is configured to carry out image processing to detect a concrete pour by inputting the video to a trained object recognition system.
13. The apparatus of claim 12 wherein the processor is configured to evaluate one of the rules by comparing a time stamp of a frame of the video depicting the concrete pour with a specified time, and in response to the comparison indicating a difference bigger than a threshold amount, sending a message comprising the difference and one or more frames of the video.

14. The apparatus of claim 1 wherein the sensor data comprises video received from at least one capture device having a field of view including at least part of the construction site and wherein the processor is configured to carry out image processing to detect cease of building work at the construction site and in response, to request information from a human.
15. The apparatus of claim 14 wherein the sensor data comprises information about weather at the site and information about road traffic around the site; and wherein the processor selects a solution from a database of solutions according to the sensor data and information received from a human operator.
16. The apparatus of claim 9 wherein the processor is configured, in response to the comparison identifying a difference between the model and the template, to compute an update to a schedule and send the updated schedule to members of a labor force.
17. The apparatus of any one of the preceding claims wherein the image processing comprises detecting one or more of: fuel spillage, tree damage, waste disposal, by inputting the video to a trained object recognition system.
18. The apparatus of any of the preceding claims wherein at least one of the capture devices is a satellite and wherein the processor is configured to evaluate one of the rules by comparing a design plan with one of more images from the satellite depicting the construction site.
19. The apparatus of any of the preceding claims wherein at least one of the capture devices is either:

    a stress sensor within a building being constructed at the construction site and wherein the processor is configured to evaluate one of the rules by comparing data from the stress sensor with a threshold; or

a sensor measuring reduced level, which is a vertical distance between a survey point and an adopted datum plane, and wherein the processor is configured to evaluate one of the rules by comparing data from the sensor measuring reduced level with a target value from a stamped design of a building being constructed at the construction site.

20. The apparatus of any of the preceding claims wherein at least one of the capture devices is a load-moment indicator or strain-gauge of a crane at the construction site and wherein the processor is configured to:

    detect reinforcing metal carried on a hook of the crane by inputting the video to an object recognition system;

    synchronize sensor data from the load-moment indicator or strain gauge with the video; and

    compare data from the load-moment indicator or strain gauge at the time the reinforcing metal is detected, with data from the load-moment indicator when the reinforcing metal is absent from the crane hook.

21. The apparatus of any of the preceding claims wherein the prediction is a prediction that an occupational health and safely accident is likely to occur at the construction site and where the prediction is computed from the sensor data by inputting the sensor data to a trained machine learning model together with information about one or more site incidents which have occurred at the construction site, the machine learning model having been trained using historical sensor data and historical site incident data from other construction sites.

22. The apparatus of any of the preceding claims, wherein:

    the construction site comprises a crane system; and

    the one or more rules or thresholds relate to at least one operation of the crane system.

23. The apparatus of claim 22, wherein:

    the memory further stores a schedule of operations of the crane system;

    the sensor data comprises information about the operations of the crane system;

    the processor is further configured to detect differences between the schedule of operations of the crane system and the information about the operations of the crane system from the sensor data; and

    in response to detecting differences, the processor is configured to follow one or more actions according to the detected differences.

24. The apparatus of claim 23 wherein the processor is further configured to send a notification comprising the detected differences to a user device in real time.

25. The apparatus of claim 22 wherein the sensor data further comprises video data from at least one capture device, the video data depicting at least part of the crane system or at least part of an environment in the vicinity of the crane system and wherein the processor is configured to perform image processing on one or more frames of the video in order to evaluate at least one of the rules or thresholds.

26. The apparatus of claim 22 wherein the sensor data comprises motion data from at least one capture device providing information about the movement of the crane system and wherein the processor is configured to process the motion data in order to evaluate at least one of the rules or thresholds.

27. The apparatus of claim 26 wherein the motion data is time-stamped and includes an amount of load carried, radius, and environmental conditions.

28. The apparatus of any of the preceding claims wherein the sensor data comprises image depicting a termination rope of a tower crane and wherein the rules or thresholds relate to correct termination of the termination rope or to presence of abnormality in the termination rope.

29. The apparatus of claim 28 configured to perform start-up check and if the capture devices monitoring the termination rope is not functioning correctly, the processor is configured to disallow the tower crane to being operations and commence shut down procedures of any components already in operation.
30. The apparatus of claim 22 wherein the sensor data comprises data relating to aviation lights of a crane and wherein the rules or thresholds relate to correct operation of the aviation lights.
31. The apparatus of claim 22 configured to automatically generate a crane monitoring diagram providing an overview of the sensor data and a crane.
32. The apparatus of claim 24 wherein the rules or thresholds relate to a misalignment in a hoist termination pin of a crane, and wherein the apparatus is configured, in response to the rules or thresholds being triggered, to send instructions to have the crane shut down using an emergency shut down procedure and to send an alert to specified addresses.