

VISUAL MODELLING SYSTEM AND METHOD THEREOFField

5 The present invention generally relates to a tourist attraction installation. More in particular, the present invention relates visual modelling apparatuses, methods and systems which may be used to create and generate large-scale visual models on sculptures and other objects.

10 Background

 Major entertainment and tourist attractions from landmark structures to entertainment complexes, such as Disney World, Times Square and Grand Central Station in the U.S. and others throughout the world, receive tens of millions of visitors every year.

15 To keep visitors engaged, there is always a need for new and novel ways to attract visitors' attention and create those awe-inspiring reactions that keep visitors returning and encouraging others to visit. There is a broad range of attractions from those that create thrills, like roller coasters and other amusement park rides that soar ever higher and faster, to those that are visually awe-inspiring like the Eiffel Tower or Mount Rushmore. While the

20 known visually awe-inspiring attractions are undoubtedly impressive, there is a need for more engaging and interactive visual attractions that will keep new generations of visitors captivated.

 An example of a tourist attraction installation is described in US20170004228. The

25 tourist attraction installation described therein, allows visitors to project an image of themselves into a large-scale model visually. However, one of the issues with the described installation is that inaccuracies between the scanned object dataset and the exact position of the lighting elements on the surface of the large-scale model may affect the quality of the image being projected.

30

Summary of the invention

 The present invention aims to provide apparatuses, methods and systems for providing an interactive tourist attraction installation that overcomes the disadvantages of

35 the prior art solutions.

- 2 -

This aim is achieved according to the invention by the visual modelling system
5 showing the technical characteristics of the first claim.

According to an aspect of the present invention, a visual modelling system is provided. The visual system comprises a first scan data set associated with a subject; a structure having a plurality of addressable lighting elements disposed of approximate to the
10 surface of the structure; a second scan data set associated with the location of the addressable lighting elements on the surface of the structure; a processor-based image processing system including a data receiving module to receive the generated first scan data set, and a mapping engine to relate the first scan data set to positionally corresponding lighting elements on the structure as defined by the second dataset; and an electronic
15 lighting control system including a power source and a lighting controller in communication with the plurality of addressable lighting elements, wherein the electronic control system energizes the addressable lighting elements in accordance with the mapping engine's relationship between the first and second scan data sets. According to the present invention, the visual modelling system comprises a structure scanning module operable for
20 generating the second scan data set by building a 3D virtual model of the structure, which 3D virtual model defines the location of the lighting elements and the order the electronic lighting control system addresses them.

It has been found, that by building a 3D virtual model of the structure has the
25 advantage of increasing the accuracy of the image projected onto the structure surface. A 3D virtual model comprises more data points than a traditional 2D scan. As a result, the mapping engine can more accurately map the first scan data set to the second scan data set, thereby creating a more realistic and detailed visual representation of the scanned object on the surface of the structure. The increase in mapping accuracy may significantly
30 increase the number of visitors visiting the tourist attraction installation each year, which may boost the economy of the local community.

According to embodiments of the present invention, the structure scanning module is configured for building the 3D virtual model of the structure by performing the steps of:

- 3 -

- a) operating the electronic lighting control system to cycle through the addressable lighting elements one at a time;
- b) operating scanning equipment configured to scan the structure from different angles, the scanning equipment being configured for detecting the light generated by each energised addressable lighting element;
- c) building a point cloud from the detected light emitted from each addressable lighting element, each point defining the location of the addressable lighting elements on the surface of the structure and the order in which the electronic lighting control system addresses them; and
- d) converting the point cloud into the 3D virtual model of the structure.

It has been found that executing the above steps has the advantage of reducing the processing power and storage required for building the 3D virtual model. The generation of a point cloud made up of a set of points located in a three-dimensional coordinate system, requires significantly less storage and processing power than a comparable 3D model made up of surfaces. The collection of data points can be converted into a polygonal model that may be rendered like a traditional 3D model. The processing of the data obtained by the scanning equipment, and the building of the point cloud, may be performed by a processing unit, which may be part of the processor-based image processing system. Furthermore, the generation of the point cloud may significantly improve the mapping reliability and accuracy, while reducing mapping distortions caused by not being able to map all data points from one set to the other.

According to embodiments of the present invention, steps a) and b) are performed synchronously such that when each addressable lighting element is energised, the scanning equipment is operated at the same time. As a result, a more accurate mapping of the position of the addressable lighting elements may be achieved. According to embodiments of the present invention, the steps a) and d) for generating the 3D model may be performed by means of an executable computer program loaded into a memory of a processor.

According to embodiments of the present invention, the scanning equipment may be in the form of a movable scanner. The scanner being configured for scanning the structure from different angles. The scanner may comprise a LIDAR scanner arranged for identifying the spatial position of the addressable lighting element, and a RASTER scanner

- 4 -

arranged for identifying the addressable lighting element as a bright point. According to embodiments of the present invention, a plurality of scanners may be deployed at a different location around the structure. According to embodiments of the present invention, the scanner may be positioned at ground level. According to embodiments of the present invention, the scanner may be part of an aerial drone device, also referred to as Unmanned Aerial Vehicles, which may be remotely operated by a user.

According to embodiments of the present invention, the electronic lighting control system is configured for comparing the generated 3D virtual model to an expected addressable lighting element map of the structure to identify the presence of faulty addressable lighting elements on the structure surface causing a luminescence uniformity discrepancy. The luminance and/or colour non-uniformity may be caused by a faulty addressable lighting element, e.g. non-operational, brightness colour issues. Furthermore, the luminance and/or colour non-uniformity may be caused by an addressable lighting element being positioned at the wrong location on the structure surface. The position of the addressable lighting elements may be affected by several factors, e.g. weather, misalignment during structure assembly, general wear and tear, and the like. According to embodiments of the present invention, the electronic control system is configured, for generating a list containing the location of the faulty addressable lighting elements detected, which list is communicated via a communication network to a system administrator. In this way, faulty addressable lighting elements can be quickly fixed, thus ensuring that quality of the projected scanned image is not affected. The list generated may further contain other information, such as the potential cause of the fault, e.g. position or operation of the addressable lighting element, and/or the image resolution lost due to the faulty addressable lighting elements detected. In this way, the system administrator can better assess the severity of the luminance and/or colour non-uniformity and accordingly order a corrective action.

According to embodiments of the present invention, the electronic control system is configured, when luminance and/or colour non-uniformity is detected, for adjusting the current supplied to addressable lighting elements. In this way, the colour intensity and/or brightness of the addressable light elements neighbouring the affected structure area can be adjusted to at least partially correct the luminance and/or colour non-uniformity caused by the detected faulty addressable lighting element(s).

35

- 5 -

According to embodiments of the present invention, the electronic control system is configured for adjusting the pulse width supplied to each addressable lighting element. The pulse width is applied to each addressable light element by the electronic lighting controller. Pulse Width Modulation (PWM) is a widely used technique to control the brightness of the addressable lighting elements and can be used to perform uniformity correction. PWM works by operating the addressable lighting elements either full on or full off at a very high rate. The flashes are so fast that the human eye cannot notice them and the duration of the individual flashes (pulse width) determines the perceived brightness.

10 According to embodiments of the present invention, the structure is formed in the approximate shape of the type of subject scanned. For example, the subject scanned may be in the shape of a human figure. The scan data set may be a three-dimensional set of data, and the structure is formed in the approximate three-dimensional shape of the type of subject scanned. A three-dimensional scanner may be used for scanning a subject to be visually modelled. Using a three-dimensional set of data has the advantage of improving the reliability and accuracy of mapping the scanned image to the structure so that an accurate representation of the scanned subjects is achieved.

20 According to embodiments of the present invention, the mapping engine is configured for mapping the 3D point locations defined in the second scan data set to a 2D image points defined in the first data set. In this way, a simple camera may be used instead of a 3D scanner for scanning the subject, thus significantly reducing the cost of the subject scanning equipment. The mapping of the 2D image of the first scan dataset to the 3D virtual model defined in the second scan data set may be performed by means of a UV mapping technique. A UV mapping technique involves the 3D modelling process of projecting a 2D image to a 3D model's surface for texture mapping. The letters "U" and "V" denote the axes of the 2D texture because "X", "Y" and "Z" are already used to denote the axes of the 3D object in model space.

30 According to embodiments of the present invention, the human shaped structure includes at least one of a moveably attached head, neck, arm, torso or leg and a powered actuator for moving at least one of the head, neck, arm, torso or leg. The system may include at least one movement sensor and movement processing engine to translate a subject's movements into movement commands sent to the at least one actuator whereby a user can control the movement of the structure. In this way, the human shaped structure

- 6 -

may imitate basic movements made by the scanned subject e.g. moving head, arms, bending, and the like. According to embodiments of the present invention, the overall shape of the human-shaped structure may change depending on the shape of the scanned subject. For example, portions of the structure may be moved inwards or outwards to
5 increase or decrease the diameter of predetermined sections of the structure e.g. arms, stomach, and the like. In this way, a more realistic representation of the scanned subject may be achieved.

According to embodiments of the present invention, the structure is at least ten times
10 larger than the scanned subject.

According to embodiments of the present invention, the scan data set may be in the form of a video and wherein the electronic lighting control system energizes the addressable lighting elements to generate a moving image on the structure.
15

According to embodiments of the present invention, the lighting elements are outwardly facing light emitting diodes (LEDs) arranged in a plurality of vertically spaced horizontal rows.

20 According to embodiments of the present invention, the head and front portion of the torso have a higher density of light emitting diodes than the rest of the body. For example, the face portion of the head has a higher density of light emitting diodes than the front portion of the head and torso.

25 According to embodiments of the present invention, the structure comprises a plurality of interconnecting blocks, each block comprising at least one addressable lighting element. As a result, the structure can be easily and quickly assembled and dis-assembled. Each block may comprise at least one socket configured for receiving at least one addressable lighting element. The socket may be an electric socket arranged for providing
30 power signals to the addressable lighting element secured therein. For example, the addressable lighting elements may be positioned on the structure after the structure has been assembled.

- 7 -

According to embodiments of the present invention, the addressable lighting elements may be draped and secured after assembly of the structure. In this way, there may be no need to provide sockets on the structure surface.

5 According to embodiments of the present invention, the blocks forming the structure may be in the form of pixel tiles or pixel blocks. The pixel tiles may be provided with a plurality of addressable lighting elements.

10 According to embodiments of the present invention, each block comprises interconnecting elements configured for releasably connecting each block to each neighbouring block. The interconnecting elements may be configured for carrying power signals between the blocks for controlling the operation of the addressable lighting elements.

15

Brief Description of the drawings

The following drawings are provided as an example to explain further and describe various aspects of the invention.

20

Figures 1 and 2 show and exemplify a tourist attraction installation according to embodiments of the present invention

25 Figure 3 shows an example of a method for visually modelling a scanned image of an object on the structure according to embodiments of the present invention.

Figures 4 shows an exemplified representation of the visual modelling system according to embodiments of the present invention

30 Figure 5 shows an exemplified data flow diagram for obtaining the 3D virtual model of the structure according to embodiments of the present invention

Detailed Description

35

- 8 -

The present invention will be illustrated using the exemplified embodiments shown in the figures 1 to 5, which will be described in more details below. It should be noted that any references made to dimensions are only indicative and do not restrict the invention in any way. While this invention has been shown and described with reference to certain
5 illustrated embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the scope of the invention encompassed by the appended claims. Furthermore, while the invention has been described with references to a particular interactive tourist attraction installation, it should be understood by those skilled in the art that changes in form and details may be made to
10 facilitate other types of tourist attraction installations without departing from the scope of the invention encompassed by the appended claims.

All publications, patents, patent applications and other references mentioned herein are hereby incorporated by reference in their entireties for all purposes as if each individual
15 publication, patent or patent application were specifically and individually indicated to be incorporated by reference and the content thereof recited in full.

The visual modelling system described herein provides a system and method for creating an awe-inspiring amusement and entertainment structure. The vast majority of
20 large-structures today are static and unless having some historic significance are generally of fleeting interest as attractions. The system and method disclosed herein creates a unique and appealing attraction by creating an interactive large-scale structure that can be used to model a smaller figure on a large-scale figure with increased accuracy in comparison to the known methods, such as the one disclosed in US20170004228.

25 In various embodiments, the system can be used to scan and generate a three dimensional ("3D") representational image of a person such as a visitor to the attraction and then the representation can be modelled on the large-scale structure. Various other embodiments may also include movement by means of both streaming video of the visitor
30 and moveable appendages provided on the structure that can be controlled by a visitor to the attraction.

In simple terms, in one preferred embodiment, each person or visitor entering the visitor attraction will enter a 2D or 3D scanner and their image, video and audio will be
35 scanned and digitized using known scanning and recording techniques. The data will then

- 9 -

be processed and transposed to a corresponding matrix map of lighting elements embedded in the structure so that the visitor's likeness may be replicated on the large-scale structure. The audio-video image may also be scanned remotely or acquired from stored data, such as, to replicate celebrities or other famous figures, and be transmitted and or
5 saved to be uploaded at a later time on a large-scale "Giant" structure.

Referring to figure 1, there is shown an illustration of a tourist attraction installation 100 provided with a large-scale structure 109 built in the form of a standing human figure having a head, arms, torso and legs built upon a pedestal 110. While the embodiments
10 depicted herein are a human form, any 3D object could be modelled with the appropriate form, for example, structures might be built to represent or model dinosaurs or other animals. A tower 111 and a platform 112 may be provided to allow the visitors to climb to the top of the structure.

15 The large-scale structure 109 may be built by any known construction means such as steel or wood frame construction and may be skinned or unskinned. In one embodiment the structure is constructed from a wood frame with horizontal rendering slats or framing defining the form of the object to be modelled. In some embodiments, the front edges of the segments of wood or another material which the structure or Giant is constructed, may be
20 covered with a transparent skin, such as, a diffusion Plexiglass. Addressable lighting elements may be mounted and recessed behind the glass or other see through membrane. In some embodiments the lighting elements are preferably clusters of red, green and blue light emitting diodes, however, any known light emitter may be used.

25 The large-scale structure 109 may be built from interconnecting pixel blocks, each block comprising at least one addressable lighting element, as previously described. Each block may be configured for being connected to a neighbouring block via interconnecting means. For example, each block may be provided on at least one side with an opening, and on another side with a protruding element. In this way, the pixel blocks can be
30 interconnected by pushing the protruding opening provided into the opening of a neighbouring block. The blocks may be provided on at least one side with an opening and a protruding element. The interconnecting means may be arranged to carry electrical signals e.g. power signal, data signal, control signals, etc. Each block may comprise a plurality of pixels comprising at least one addressable lighting element addressed in a

- 10 -

similar way to known LED displays. It should be noted that the blocks may be secured in any way known to the skilled person e.g. bolts, clamps, etc.

5 The lighting elements may be placed at varying depths of recess and the pitch of the pixels may be varied to alter the visual appearance of each pixel. By controlling the pitch and depth of the lighting elements the visual appearance may be configured to create sharp edges or vast pixels that blend into each other.

10 The array or matrix of lighting elements on the structure will preferably cover the entire structure, including the front, back and sides. The pixel resolution or distribution, density or size of lighting elements on the structure may be uniform and consistent, or in some embodiments may be distributed to provide finer resolution in critical areas of the structure. For example, in a human form structure of one embodiment, the majority of the horizontal segments in the structure, which in aggregate create the body of the sculpture,
15 may be mounted with large pixels having a horizontal pitch between 1.0 to 25 cm. For example, the head—excluding the face—and the front torso may be constructed of 4000 medium-pitch pixels with a horizontal pitch of approximately 10 cm. In some embodiments, the vertical pitch is preferably determined by the distance between the individual segments of horizontal structure. For example, the segments creating the face are in aggregate
20 embedded with 3,000 small pixels with approximately 5 cm pixel pitch sufficient for viewing distances of more than 50 m as well as coherent images being visible while standing directly in front of the structure. These exemplary pixel/lighting element distributions in one embodiment may be used on a structure of having a predetermined high e.g. at least 10 larger than the size of the scanned object—it will be understood that higher or lower
25 numbers of lighting elements may be used on proportionally sized structures or as enhanced or decreased resolution is desired.

Referring to figure 2, a block diagram of the visual modelling system 200 is illustrated. The system in one embodiment includes a 2D or 3D scanner 202 that is used to
30 scan visitors to the attraction 100. The system also may include a storage unit 204 and database to buffer or store scanned data. In addition to image data received from the 3D scanner 202, the system and method may receive or use previously scanned or generated data, either stored on storage unit 204 or streamed in real time to be displayed on the large-scale model. While the images in one embodiment preferably relate to the form of the

- 11 -

sculpture, the images may be any photographic imagery or any of a myriad of static or moving visual images—either representational or abstract.

5 The visual modelling system 200 may include one or more servers 206, 208. In other embodiments the entire systems may be self-contained and operate from a single server. The servers 206, 208 may be of any known type of readily available system including a processor, memory and communication ports as such for receiving and transmitting data from and to external devices via any known data receiving and transmitting hardware and
10 software modules.

 The server or servers 206, 208 may be connected to and/or communicate with entities such as, but not limited to: one or more users from user input devices such as keyboard and mice to control the system; peripheral devices such as scanner 202 or other
15 devices such as a positional input device (e.g., to allow a use to control movement of the large scale structure); and output controllers to activate and command control circuitry (e.g., to power and control the lighting element matrix and the motion actuators in the large scale structure).

20 As shown in FIG. 2, the visual modelling system is distributed and includes two or more computers or servers 206, 208 connected by a communications network 200. In such embodiments the scanning and storage system may be adjacent to or remote to the large-scale structure. For example, in this configuration the large-scale structure could be used to permit remote performances, speeches, or presentations wherein a singer, actor, or
25 speaker can make an appearance before a large audience at varied locations in real time by transmitting a live feed to multiple large scale “Giant” structures located around the country or world via the communications network 200.

 The network 200 facilitates the transfer of information from source points to
30 destinations. There are many forms of networks that may be suitable for use, such as, Local Area Networks (LANs), Pico networks, Wide Area Networks (WANs), Wireless Networks (WLANs), etc. For example, the Internet is generally accepted as being an interconnection of a multitude of networks whereby remote clients and servers may access and interoperate with one another and may be used to facilitate such remote video and imagery transmission
35 to the large-scale structure.

- 12 -

The visual modelling system 200 also includes software modules including a communications module, mapping engine, a controller module, a movement processing engine, and a structure scanning module. The communications module is any known
5 interface module using standard communications protocols to communicate over Local Area Networks (LANs), Pico networks, Wide Area Networks (WANs), Wireless Networks (WLANs), and with peripheral devices such as scanner 202, storage unit 204 and an electronic control system for controlling the lighting matrix. The mapping engine and controller module software may be separate modules or be combined into a single module.

10

The function of the mapping engine is to transform the image data to the 3D lighting element matrix on the large scale "Giant" structure. This process is preferably carried out by relational mapping of the scanned or stored image data to the lighting matrix. The process may include the use of known downscaling or downsampling algorithms (e.g.,
15 nearest neighbour, linear, cubic, or bicubic) to reduce the resolution of the original which will typically be higher than the resolution of the light element matrix on the large-scale structure. Where a high pixel density is used on the large-scale structure upscaling or upsampling may be necessary and can be carried by any similar known techniques. In some embodiments, since the pixel resolution or density varies across the large-scale structure selective upscaling or downscaling may be used on portions of the image to map the image
20 to the lighting matrix of the large-scale Giant structure. For example, in a human form embodiment, where the face has a high pixel density in certain embodiments upscaling may be necessary, whereas, the legs and arms of the large-scale structure may have low pixel density and may need to be downscaled to map to the lighting element matrix.

25

The controller module interfaces with a lighting control system that addressable energises the lighting elements. The lighting elements may be addressed by any known method used in conjunction with traditional LED displays, such as, arranging the light elements in a passive matrix and using multiplexing techniques to reduce the number of
30 physical connections. Alternatively, the lighting element matrix may be configured using active matrix techniques to provide faster response times in video and multimedia version of the system and method.

The lighting control system circuitry may also include power source and/or lighting
35 control for the lighting element matrix and may be wired in a combination of series and

- 13 -

parallel configurations using an AC mains voltage supply transformed to a lower voltage and rectified to a stabilized DC output. Pulse width modulation may be used for dimming the lighting elements. Data communications may use a TCP/IP based protocol, such as Artnet or sACN, or other protocols described above for fast display of lighting changes.

5

The control module provides the software communications interface with the lighting control system, and in some embodiments provides the commands to drive the lighting sequence of the lighting element matrix. In alternative embodiments the control module functions and lighting control system may be combined in a single unit for example in server 10 208 in base 110.

The movement processing engine provides software for receiving movement data and relating the movements into commands to control actuators on the Giant. Movement data may be received from movement sensors attached to a user, scans of the user's 15 movements, or from a movement file stored in memory. The movement processing engine is connected directly or wirelessly the via servers or controllers to actuators controlling the Giant's appendages and sends movement commands to the actuators to create movement.

Referring to figure 3, a flow diagram of one embodiment is illustrated. The exemplary 20 flow diagram illustrates how the system may function as a tourist attraction. The process starts at 300 with a visitor or user entering the attraction. At start-up, the system would load a lighting matrix map containing a map of the addressable lighting element layout for the large-scale Giant structure in Step 302. Next, the system will load or scan data associated with the visitor (e.g. first scan data set) in Step 304. In one embodiment, the visitor 25 preferably steps into a 3D scanner upon entry to the attraction. The 3D scanner, in turn, scans the visitor and generates visualisation and/or position data for the visitor. The visualization data is essentially a scan of both the visitor's 3D form and image data. The position data may optionally be used to pose the large-scale structure's appendages to match those of the visitor, or with a real-time scanner to read the visitors movement and 30 move the structure in sync with the visitor's movements.

In Step, 306 the mapping engine transforms and maps the visualisation data such as the visitor's image data onto the matrix map for the lighting elements using upscaling, downscaling and/or relational mapping as discussed above. In step 308, the lighting control

- 14 -

system and module, energize the lighting elements in accordance with the transformed visualization data.

In embodiments having movable appendages, in Step 310 the appendages are
5 positioned using the control module and system to move actuators in the arms, legs, neck
and torso to pose the structure in accordance with the visitor's movements. In systems
configured for interactive or real-time video or movement, in Step 312, the system will look
for updated frame or movement data. Information on movement may be read from a 3D
10 scanner, other sensors or actuators attached to or controlled by the visitor or from a pre-
recorded movement file stored in memory. Similarly, image or video data may be retrieved
from real-time scans or pre-recorded video in the storage system. If there are additional
movements or video for the next frame of movement and display, the data is retrieved in
Step 314. Thereafter the process repeats, displaying and positioning the figure according
15 to the next frame in Steps 308 through 310. This process may repeat until the entire video
is played or some allotted period for the visitor expires and the process ends at Step 316.

The steps 310-316, may also be accompanied by audio or sound in sync with the
image display and movement of the Giant. In some embodiments, the audio is from the user
or visitor engaged with the Giant. In other embodiments, the audio may be part of a recorded
20 video segment such as from a speech.

Figure 4, shows an exemplified embodiment of a structure scanning module 400 for
generating the lighting matrix map of the structure according to embodiments of the present
invention. The structure scanning module 400 may be operable for generating a 3D virtual
25 model of the structure 109 by mapping the position of the LEDs 410 positioned on the
structure surface and the order each lighting element is addressed by the electronic lighting
control system 420. The structure scanning module 400 may be configured for generating
the 3D virtual model of the structure by performing a series of steps, which may include:

- a) operating the electronic lighting control system 420 to cycle through the
30 LEDs 410 one at a time;
- b) operating scanning equipment 430 configured to scan the structure 109 from
different angles, the scanning equipment being configured for detecting the light emitted by
each energised LED 410;

- 15 -

- c) building a point cloud from the detected light emitted from each LED 410, each point defining the location of the LEDs 410 on the surface of the structure 109 and the order they are addressed by the electronic lighting control system 420; and
- d) converting the point cloud into a 3D virtual model of the structure 109.

5

The structure scanning module 400 may comprise a triggering software module 450 configured for synchronously triggering the operation of the electronic lighting control system 420 and the scanning equipment 430.

10 The scanning equipment used for scanning the structure may comprise known scanning equipment 430 such as LIDAR and RASTER scan systems, which may be operated via a wireless or wired communication data network 440. For example, the LIDAR scanner may be arranged for capturing the spatial position of the LED 410 while the RASTER scanner may be arranged for identifying the LED 410 as a bright point. It should be noted that any other known scanning equipment may be used for generating point cloud
15 representing the position of the addressable lighting elements on the structure.

The content for the lighting element matrix, movement and audio may be generated in a real-time or nearly real-time interactive program that uses video streams from cameras and face-detection algorithms to capture images and videos, movements and sounds such
20 as of human figures or faces. These images are then processed to derive abstract images or motion pictures that are mapped onto the lighting element matrix. The mapping may be implemented using known coding environments and techniques, including, visual live programming environments such as the freely available MaxMSP/Max 7.1 (<https://cycling74.com/products/max/>) or vvvv (<https://vvvv.org>). Similarly, as discussed
25 above, the scanned or computer-generated images, video and/or audio may be loaded onto a flash memory data storage card which is inserted into a media player to be mapped to the lighting element matrix.

Referring to figure 5, an exemplified data flow for building the 3D virtual data model is
30 presented. The structure scanning module 400 operates the electronic lighting control system 420 to energise one of the LEDs 410 on the structure surface. The electronic lighting control system 420 energises an LED 410 according to an addressable LED map, which may be stored in the lighting control system 420, and confirms to the structure scanning module 400 that the LED is on. Once the confirmation is received from the electronic lighting
35 control system 420, the structure scanning module 400 triggers the scanning equipment

- 16 -

430 to perform a LIDAR and RASTER scan. The scanning equipment 430 once receiving the triggering command execute a LIDAR and RASTER scan, store the raster and 3D point models obtained, and transmit the stored models to the structure scanning module 400. Once the models are received at the structure scanning module 400, the transmitted
5 scanned data is processed to identify the LED position on the structure 109 and a signal is transmitted to the electronic lighting control system 420 to turn-off the energised LED 410. Once confirmation has been received from the electronic lighting control system 420 that the LED 410 has been turned-off, the structure scanning module 400 adds the detected LED position to a 3D model and mapping model of the structure. The process is repeated
10 until all LEDs 410 on the structure, or at least a desirable amount of LEDs 410, have been energised by the electronic lighting control system 420 .

The method for building the 3D virtual data model may be executed at regular intervals, e.g. one a day or more often if necessary. In this way, faulty addressable light
15 elements can be quickly identified and fixed.

In general, the routines executed to implement the embodiments of the invention, whether implemented as part of an operating system or a specific application, component, program, object, module or sequence of instructions, or even a subset thereof, may be
20 referred to herein as "computer program code," or simply "program code." Program code typically comprises computer readable instructions that are resident at various times in various memory and storage devices in a computer and that, when read and executed by one or more processors in a computer, cause that computer to perform the operations necessary to execute operations and/or elements embodying the various aspects of the
25 embodiments of the invention. The computer readable program instructions for carrying out operations of the embodiments of the invention may be, for example, assembly language or either source code or object code is written in any combination of one or more programming languages.

30 The program code embodied in any of the applications/modules described herein is capable of being individually or collectively distributed as a program product in a variety of different forms. In particular, the program code may be distributed using a computer readable storage medium having computer readable program instructions thereon for causing a processor to carry out aspects of the embodiments of the invention.

35

- 17 -

Computer readable storage media, which is inherently non-transitory, may include volatile and non-volatile, and removable and non-removable tangible media implemented in any method or technology for storage of information, such as computer-readable instructions, data structures, program modules, or other data. Computer readable storage
5 media may further include RAM, ROM, erasable programmable read-only memory (EPROM), electrically erasable programmable read-only memory (EEPROM), flash memory or other solid state memory technology, portable compact disc read-only memory (CD-ROM), or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to store
10 the desired information and which can be read by a computer. A computer readable storage medium should not be construed as transitory signals per se (e.g., radio waves or other propagating electromagnetic waves, electromagnetic waves propagating through a transmission media such as a waveguide, or electrical signals transmitted through a wire). Computer readable program instructions may be downloaded to a computer, another type
15 of programmable data processing apparatus, or another device from a computer readable storage medium or to an external computer or external storage device via a network.

Computer readable program instructions stored in a computer readable medium may be used to direct a computer, other types of programmable data processing apparatus,
20 or other devices to function in a particular manner, such that the instructions stored in the computer readable medium produce an article of manufacture including instructions that implement the functions/acts specified in the flowcharts, sequence diagrams, and/or block diagrams. The computer program instructions may be provided to one or more processors of a general-purpose computer, special purpose computer, or other programmable data
25 processing apparatus to produce a machine, such that the instructions, which execute via the one or more processors, cause a series of computations to be performed to implement the functions and/or acts specified in the flowcharts, sequence diagrams, and/or block diagrams.

30 In certain alternative embodiments, the functions and/or acts specified in the flowcharts, sequence diagrams, and/or block diagrams may be re-ordered, processed serially, and/or processed concurrently without departing from the scope of the invention. Moreover, any of the flowcharts, sequence diagrams, and/or block diagrams may include more or fewer blocks than those illustrated consistent with embodiments of the invention.

35

- 18 -

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the embodiments of the invention. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms

5 “comprises” and/or “comprising,” when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. Furthermore, to the extent that the terms

10 “includes”, “having”, “has”, “with”, “comprised of”, or variants thereof are used in either the detailed description or the claims, such terms are intended to be inclusive in a manner similar to the term “comprising”.

While all of the inventions has been illustrated by a description of various embodiments and while these embodiments have been described in considerable detail, it

15 is not the intention of the Applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. The invention in its broader aspects is therefore not limited to the specific details, representative apparatus and method, and illustrative examples shown and described. Accordingly, departures may be made from such details without departing from

20 the spirit or scope of the Applicant's general inventive concept.

CLAIMS

1. A visual modelling system, comprising:
- 5 a first scan data set associated with a subject;
a structure (109) having a plurality of addressable lighting elements (410);
a second scan data set associated with the location of the addressable lighting elements (410) on the surface of the structure (109);
a processor-based image processing system (206) including a data receiving
10 module to receive the generated first scan data set, and a mapping engine to relate the first scan data set to positionally corresponding lighting elements (410) on the structure (109) as defined by the second dataset; and
an electronic lighting control system (420) including a power source and a lighting controller in communication with the plurality of addressable lighting elements (410),
15 wherein the electronic lighting control system (420) energizes the addressable lighting elements (410) in accordance with the mapping engine relation between the first and second scan data sets;
wherein the visual modelling system comprises a structure scanning module (400) operable for generating the second scan data set by building a 3D virtual model of the
20 structure (109) defining the location of the lighting elements and the order they are addressed by the electronic lighting control system.
2. The system of claim 1, wherein the structure scanning module (400) is configured for building the 3D virtual model of the structure by performing the steps of:
- a) operating the electronic lighting control system (420) to cycle through the
25 addressable lighting elements (410) one at a time;
b) operating scanning equipment (430) configured to scan the structure (109) from different angles, the scanning equipment (430) being configured for detecting the light emitted by each energised addressable lighting element (410);
c) building a point cloud from the detected light emitted from each addressable lighting
30 element (410), each point defining the location of the addressable lighting elements (410) on the surface of the structure (109) and the order they are addressed by the electronic lighting control system (420); and
d) converting the point cloud into a 3D virtual model of the structure (109).

- 20 -

3. The system of claim 2, wherein steps a) and b) are performed synchronously such that when each addressable lighting element (410) is energised, the scanning equipment (430) is operated at the same time.

4. The system of claim 3, wherein the steps a) and d) are performed by means of an
5 executable computer program loaded into a memory of the processor.

5. The system of any one of claims 2 to 4, wherein the scanning equipment (430) comprises at least one rotatable scanner.

6. The system of any one of the preceding claims, wherein the scanning equipment (430) comprise at least one LIDAR scanner arranged for identifying the spatial position of
10 the addressable lighting element (410), and at least one RASTER scanner arranged for identifying the addressable lighting element (410) as a bright point.

7. The system of claim 6, wherein the electronic lighting control system (420) is configured for comparing the generated 3D virtual model to an expected addressable lighting element map of the structure to identify the presence of faulty addressable lighting
15 elements (410) on the structure surface causing a luminescence uniformity discrepancy.

8. The system of claim 7, wherein the electronic control system (420) is configured, for generating a list containing the location of the faulty addressable lighting elements detected, which list is communicated via a communication network to a system administrator.

9. The system of claim 7 or 8, wherein the electronic control system (420) is configured,
20 when a luminance and/or colour non-uniformity is detected, for adjusting the operation of addressable lighting elements neighbouring the affected structure area.

10. The system of claim 9, wherein the electronic control system (420) is configured for adjusting the current supplied to each addressable lighting element.

11. The system of claim 9, wherein the electronic control system (420) is configured for
25 adjusting the pulse width supplied to each addressable lighting element.

12. The system any one of the preceding claims, wherein the structure (109) is formed in the approximate shape of the type of the subject scanned.

13. The system of any one of the preceding claims, wherein the scan data set is a three-dimensional set of data, and the structure (109) is formed in the approximate three-
30 dimensional shape of the type of the subject scanned.

14. The system of any one of claim 1 to 12, wherein the mapping engine is configured for mapping the 3D point locations defined in the second scan data set to a 2D image points defined in the first data set.

15. The system of claim 14, wherein the mapping is performed by means of a UV
35 mapping technique.

- 21 -

16. The system of any one of the preceding claims, further comprising a three-dimensional scanner (202) for scanning a subject to be visually modelled.

17. The system of claim 16, wherein the subject is a human and the structure (109) is formed in the shape of a human figure.

5 18. The system of claim 17, wherein the human-shaped structure includes at least one of a moveably attached head, neck, arm, torso or leg and a powered actuator for moving the at least one of the head, neck, arm, torso or leg.

19. The system of claim 18, wherein the system includes at least one movement sensor and movement processing engine to translate a subject's movements into movement
10 commands sent to the at least one actuator whereby a user can control the movement of the structure (109).

20. The system of any one of the preceding claims, wherein the structure (109) is at least ten times larger than the scanned subject.

21. The system of any one of the preceding claims, wherein the scan data set is video
15 and wherein the electronic lighting control system energizes the addressable lighting elements to generate a moving image on the structure (109).

22. The system of any one of the preceding claims, wherein the lighting elements are outwardly facing light emitting diodes arranged in a plurality of vertically spaced horizontal rows.

20 23. The system of claim 22, wherein the head and front portion of the torso have a higher density of light emitting diodes than the rest of the body.

24. The system of claim 23, wherein a face portion of the head has a higher density of light emitting diodes (410) than the front portion of the head and torso.

25. The system of any one of the preceding claims, wherein the structure (109)
25 comprises a plurality of interconnecting block, each block comprising at least one addressable lighting element (410).

26. The system of claim 25, wherein the blocks are in the form of pixel tiles.

27. The system of claims 25 or 26, wherein each block comprises interconnecting elements configured for releasably connecting each block to each neighbouring block.

30 28. A method for building a 3D virtual data model of a structure, the method comprising the steps of:

35 a) operating using a structure scanning module (400) the electronic lighting control system to energise one of the plurality of addressable lighting elements (410) on the structure surface according to an addressable lighting elements map, which map is stored in a memory of the lighting control system (420), wherein the lighting

- 22 -

- control system (420) confirms to the structure scanning module (400) that the addressable lighting element (410) is switched-on;
- b) once confirmation is received at the structure scanning module (400), operating at least one scanning equipment (430) to generate a 3D point model of the structure,
- 5 c) processing by the structure scanning module (400) the 3D point structure model to identify the position of the energised addressable lighting element (410) on the structure surface;
- d) transmitting a signal to the lighting control system (420) to turn-off the energised addressable lighting element (410);
- 10 e) once confirmation has been received from the electronic lighting control system (420) that the addressable lighting element (410) is turned-off, adding by means of the structure scanning module (400) the detected addressable lighting element position to a 3D model and mapping model of the structure; and
- f) repeating steps a) to e) for the remain addressable lighting elements (410)
- 15 wherein step b) comprises the steps of:
- b1) storing the scanning model; and
- b2) transmitting the stored models to the structure scanning module for further processing.