A system is disclosed for identifying, placing and configuring a physical arrangement of a plurality of displays via image analysis of captured digital camera images depicting unique configuration images output to said displays to facilitate uniform operation of said plurality of displays as a single display area for example as a video wall. The system pairs and configures displays depicted in the captured images to individual displays within the physical arrangement through controlling and analyzing of the output of said displays captured in said images. A method and computer readable medium are also disclosed that operate in accordance with the system.
Figure 2

Bezel mis-calculated = images not aligned

Image aligned = bezel corrected
Figure 3
Automated Video-wall Calibration

Output unique image to each screen in the video wall

Prompt user to take phone (initiate photo app and request permission if camera is available to browser client)

Send photo to server for analysis

Analyze image to distinctly identify relative position & orientation of display edges and the exact distance between display edges (bezel size)

Write to video-wall config file

Output test configuration pattern

Output test patterns to displays to confirm display positioning either through additional photo with automated analysis or request user confirmation

Further adjustments (either manually or via automated analysis of test pattern) to fine tune spacing before writing final video-wall configuration file

End Automated Video Wall calibration
Figure 6

1. Begin Image based Display Adjustment Process
2. Output unique identification images or color calibration image(s) to all screens in the array
3. Capture live image of the screens (potentially by displaying instructions to the admin)
4. Transfer and analyze the image
5. Are all settings correct?
   - No: Adjust settings and or relationships between displays in the array based on results of automated image analysis.
   - Yes: End Display Arrangement Process

Flowchart:

- Begin Image based Display Adjustment Process
- Output unique identification images or color calibration image(s) to all screens in the array
- Capture live image of the screens (potentially by displaying instructions to the admin)
- Transfer and analyze the image
- Are all settings correct?
  - No: Adjust settings and or relationships between displays in the array based on results of automated image analysis.
  - Yes: End Display Arrangement Process
**Figure 7**

Server discovers plurality of connected displays

For each connected display assign identifier & collect resolutions & settings

User launches the calibration GUI from a web-browser device with an embedded camera

Output unique calibration image optimized for automated image recognition to each display (e.g., QR codes with corner markers for initial identification image)

Capture image and send to web-server for automated image analysis adjusting identification, positioning, and calibration settings and as required

Calculate canvas size & position of displays within canvas an write all sub-image mapping info to file

While video wall is in-use

Send individual sub-frames to corresponding display adaptors and attached displays for output

End Video Wall
Figure 8

Receive image(s) from camera device and the display information obtained from the displays themselves and mapping data thus far.

Analyze newly received image for recognized markers and match to existing data.

Perform initial checks on image and provide error messages to the user as required.

Build or match to pre-existing geometrical model of the video wall (built by combining the data retrieved from output to the displays with the display positioning and sizing information obtained through image analysis).

Isolated the captured display area of each detected display and analyzes the image data from each display.

Utilizing spatial information from the captured image to automatically determine placement of display.

Compare the captured display area of each of the plurality of displays for perceived differences in the unique configuration images.

Determine adjustment to mapping settings as required for the identity, position, size and output characteristics of the plurality of displays visible within the captured image.

Return adjusted mapping settings for the plurality of displays based on required adjustments determined.

End Image Analysis.
SYSTEM AND METHOD OF VIDEO WALL SETUP AND ADJUSTMENT USING AUTOMATED IMAGE ANALYSIS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority from U.S. Provisional Patent Application No. 61/926,295 filed on Jan. 12, 2014, which is hereby incorporated by reference.

FIELD OF INVENTION

[0002] Large electronic displays, may be formed from an array of monitors referred to as a “video-wall”. For example video-wall might be comprised of a 3 by 3 array of nine monitor, each monitor simultaneously displaying a segment of a single image, thereby creating the appearance of a single large display comprised of rectangular portions.

[0003] The present invention relates generally to improving the setup and operation of large displays and particularly to network addressable video-wall displays.

BACKGROUND OF THE INVENTION

[0004] The present invention relates generally to improving the setup and operation of video-wall displays and particularly to network addressable displays.

[0005] A video-wall display system is a method to overcome the costs of manufacturing and installing very large displays, by assembling a large display using multiple smaller displays arranged and working together. By dividing a single image into several sub-images and displaying the sub-images on an appropriately arranged array of display devices a larger display with higher resolution can be created.

[0006] Because the plurality of display devices need to be operated together to display a single image or canvas across a video-wall (rather than a separate independent image for each display), the set-up of the output displays is critical and their fine tuning can be laborious. Informing the server of the initial positioning of each display (so that the image segments are sent to the appropriate displays); the precise cropping of each of the sub-images (to allow the eye to interpret continuity of the total image across the bezels of the displays where no image can appear); and the adjustment of the color of the sub-segments of the image to provide equal luminosity, color and intensity/brightness ranges across the whole array of displays within the video-wall, are all essential to providing the optimal viewing experience. With conventional approaches to video-wall setup these tasks can be laborious. This invention offers methods of automating the setup process to improve the ease and speed of video-wall setup.

DESCRIPTION OF THE INVENTION

[0007] A video wall server splits source-video into sub-images and distributes these sub-images to multiple listening display devices. Built-in algorithms optimize, parse and scale the individual video-wall segments. To accomplish this splitting efficiently it is beneficial to create a configuration file stored in a computer readable medium using information on the position, configuration and settings for each of individual physical display and how they relate to the video-wall canvas. Using such a configuration file allows the video wall server to efficiently create a seamless canvas across the display units. This invention deals with methods of supplying the information for the creation of such files by means of feedback based on test-canvasses and to sequentially changing the configuration file before redeploying a test-canvas to further improve the overall viewer-image.

[0008] Configuration of Displays: This invention provides methods equipping the server with a configuration file containing:

[0009] the overall shape of the video wall;

[0010] the ordering of the sub-images within the video wall;

[0011] any further rotation or displacement of displays required to form the appropriate canvas on the video wall;

[0012] interactively fine-tuning the positioning and bezel width of the displays to achieve perfect alignment across display monitor bezels;

[0013] adjusting the color intensity of displays to achieve a uniform color across the video-wall;

Once this information is established it is stored in the server’s configuration files.

[0014] The methods to achieve the five types of adjustments outlined above by automation presented typically involve a user interacting with the server via a GUI containing instructions and a camera in communication with the server. In a typical usage the user would have a smart-phone, tablet, laptop or similar device, interacting with the server via the web. The user giving permission to the server to use that camera to obtain digital images of the canvas as displayed across the video wall and the server giving instructions to the user about positioning the camera and where required to supply eye-based evaluation concerning the correctness of any changes to the displays made.

[0015] The server knows (via DPMS and EDID) certain details about each display (aspect ratio, number of pixels, etc.). Using these in conjunction with the image captured from the camera gives a unique ability to identify the exact positioning of the display.

[0016] The ordering and overall shape. Once the display units have been mounted to form the wall and connected to the server the server will know the number of display units involved and will analyze for shape. This can be accomplished by sending each display a unique computer-recognizable image. This could for example be a specialized “bar codes” designed for image recognition software (similar to QR codes). The image should have special symbols used to identify the exact spatial location of the corner pixels of each display. Next a message would be sent requesting the user to point the camera at the displays in the wall. Digital analysis of the image in comparison to the information as displayed allows the server to determine which displays are in the wall (some may be playing in a different room), to identify the geometric placement of the displays (rectangular, linear or “artistic” meaning in an informal non-geometric setup) and the position in which each signal sent appears in the display (which Ethernet or other connection leads to each display position). In addition it determines the rotation (do the images need to be rotated through 90 or 180 degrees and what rotations are needed for non-standard setups).

[0017] Once the digital image analysis has been completed the server would re-adjust the canvas presented across the screens and instruct the user to ready the camera for another image. This correction process would continue until the server’s digital analysis was satisfied with the overall alignment, in addition it might ask for by-eye evaluation to confirm the result.
Interactive fine tuning of placement and rotation. Generally the canvas on the video wall will appear to be
interrupted by the bezels making up the edges of each display
monitor. The fine tuning is used to minimize the bezel effect
by appropriately moving each of the displays a few pixel
widths horizontally or vertically. For example this could be
achieved by displaying a test canvas of diagonal lines on the
video wall. The digital analysis being aware of the exact
location of these lines in the canvas sent to the displays can
eaxm the lines to the digital image very precisely for
alignment and by calculation measure the number of pixels
each display must be moved vertically or horizontally to
achieve perfect alignment. Once these corrections have been
made and a new canvas displayed it can be checked digitally
and by eye.

Adjusting color intensity across the canvas. In a
typical embodiment the next stage would be to check for
color. The canvas might be such that each display contains
the same pattern of rectangles each of a different color (perhaps
red, blue and green) displayed with a range of intensities.
Now the analysis is of each color intensity across all of the
displays, so that any fine distinction between the treatment of
a particular color/intensity combination can be adjusted for.
Other tests of a similar nature can be used for particular
differences between displays.

In an alternative and potentially complimentary
method of calibration a moving image is output to the video-
wall (for example horizontal and lines moving across the
video-wall canvas) are captured and communicated in real-
time by the camera and image analysis software interprets the
captured frames to determine positioning.

The stage-wise process the methods outlined above are
carried out in stages and at each stage the configuration
file being used by the server is updated based on the new
adjustments calculated, so that the end result is a file that
can be used to promote perfect display of any video file presented
to the server. Color calibration can be achieved in two possi-
bile ways.

In one embodiment of the invention color calibration
is done by controlling monitor settings via the central-
ized server software being in communication with the display
settings (potentially via an RS232 or other interface) and
a uniform image canvas is output to the display. In an alterna-
tive embodiment color adjustments are stored in the server
software and color adjustments are done by the server as it is
output to the display itself. In the first of these cases the
display settings are permanently stored on the server in a
configuration file.

In one realization the same color is output on each of
the displays within the video-wall and after each change in the
display, an image is captured for analysis. This image analysis
detects relative differences between each display and adjust
color output characteristics on individual displays within the
video-wall, successively adjusting hue, intensity and bright-
ness of the individual images so that the same high and low
values for each display are achievable by each of the indi-
vidual displays within the video-wall, making the fine adjust-
ments necessary to the color output characteristics and set-
ing of each individual display.

In one embodiment of the invention the computer-
recognizable images output to each of displays includes a
right-angled line in various corners of the displays compris-
ing the video-walls to aid in detecting the exact placement of
these corners in relation to other display corners within the
video-wall.

In another embodiment of the invention, component
displays within the video-wall provide instructions to the user
on how to connect their camera to the display (for example by
providing a URL, to visit on their network-connected or Inter-
net-connected device).

Visual prompting and status indicators to assist dur-
ing video-wall setup. As displays are linked into a video-wall
it is helpful to the individual setting up the video-wall to receive
visual feedback from the displays themselves as
screens are added to or removed from the video-wall. In one
embodiment of the invention, visual status indicators shows
progress as each display’s position within the video-wall has
been successfully identified and the display is “linked into”
the video-wall. For example, a line, pattern, color change,
picture, or animated effect is used to differentiate monitors
which have been added or positioned within the video-wall
from those that haven’t. A different status indicator such as an
image, icon, or input prompt could be output to those displays
which are being output to by the video-wall server, but are still
awaiting placement/assignment/relative-positioning within
the video-wall. In one embodiment, once an an adjacency
relationship is established between edges of displays within
the video-wall a status indicates that the edges of both dis-
plays have been successfully linked. In one embodiment,
one the full video-wall has been setup, will show a visual
success image indicator spanning the full video-wall.

In one embodiment of the invention, in addition to
the image data, the digital camera device also provides meta-
data about the image. Data such as: camera orientation,
detected ambient light, detected distance from the subject,
focus length, shutter speed, flash settings, camera aperture,
detected camera rotation angle relative to the horizon, GPS
location. This additional data can be used to increase the
accuracy or speed of image analysis or provide additional
details about the video wall.

In one embodiment of the invention, a smart phone
or other mobile device with an embedded camera device is in
communication wirelessly with a video wall control server
(which is in turn in communication with the video wall dis-
plays). The video wall control server outputs one or more
optimized configuration images to the video-wall displays.
An application code executed on the mobile device, either by the
browser or by a native mobile device application) captures
image data from said camera (this could be a still image, a
stream of video data, or a sequence of still images) and
forwards this image data over a wireless connection to the
server.

An an image analysis module (could be either
executed on the server or on the mobile device, or parts of
the analysis could be performed by each) processes the captured
image data
determining the display identity and placing each
within the captured image then subsequently assessing dif-
fences in display placement, rotation, color, brightness,
contrast, and other attributes of the various displays present
within the capture image data. Via these comparisons the
automated image analysis module is able to determine any
adjustments required for mappings of various ones of the
displays captured in the image and subsequently translate
these adjustments into changes to the video wall configura-
tion mapping file(s) or data stores. The updated mapping
would then be communicated by the control module, in response to these changes to the server, server updates test images or sequences to the next test image, repeating any failed steps as necessary and moving to subsequent configuration tests as successful calibration of each unique configuration image is achieved.

[0031] In one embodiment the user is visiting a web-page with their mobile device (equipped with a camera), and the server is a web-server. That web-server also being in communication (able to send controlling signals) to the displays comprising the video wall. The displays being controlled by the web-server to output the configuration images.

[0032] With the above embodiments in mind, it should be understood that the embodiments might employ various computer-implemented operations involving data stored in computer systems. These operations are those requiring physical manipulation of physical quantities. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared, and otherwise manipulated. Further, the manipulations performed are often referred to in terms, such as producing, identifying, determining, or comparing. Any of the operations described herein that form part of the embodiments are useful machine operations. The embodiments also relate to a device or an apparatus for performing these operations. The apparatus can be specially constructed for the required purpose, or the apparatus can be a general-purpose computer selectively activated or configured by a computer program stored in the computer. In particular, various general-purpose machines can be used with computer programs written in accordance with the teachings herein, or it may be more convenient to construct a more specialized apparatus to perform the required operations.

[0033] The embodiments can also be embodied as computer readable code on a computer readable medium. The computer readable medium is any data storage device that can store data, which can be thereafter read by a computer system. Examples of the computer readable medium include hard drives, solid state drives (SSD), network attached storage (NAS), read-only memory, random-access memory, Optical discs (CD/DVD/Blu-ray/HDDVD), magnetic tapes, and other optical and non-optical data storage devices. The computer readable medium can also be distributed over a network coupled computer system so that the computer readable code is stored and executed in a distributed fashion. Embodiments described herein may be practiced with various computer system configurations including hand-held devices, tablets, microprocessor systems, microprocessor-based or programmable consumer electronics, minicomputers, mainframe computers and the like. The embodiments can also be practiced in distributed computing environments where tasks are performed by remote processing devices that are linked through a wire-based or wireless network.

[0034] Although the method operations were described in a specific order, it should be understood that other operations may be performed in between described operations, described operations may be adjusted so that they occur at slightly different times or the described operations may be distributed in a system which allows the occurrence of the processing operations at various intervals associated with the processing.

[0035] While the system and method has been described in conjunction with several specific embodiments, it is evident to those skilled in the art that many further alternatives, modifications and variations will be apparent in light of the foregoing description. Thus, the embodiments described herein are intended to embrace all such alternatives, modifications, applications and variations as may fall within the spirit and scope of the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036] Embodiments will now be described more fully with reference to the accompanying drawings in which:

[0037] FIG. 1 illustrates the basic problem to be solved.

[0038] FIG. 2 illustrates the need for precise mapping, placement and bezel correction of displays when creating a video wall

[0039] FIG. 3 shows a schematic diagram depicting a 2×2 video wall

[0040] FIG. 4 illustrates in detail camera use in combination with uniquely identifying output images.

[0041] FIG. 5 shows a process flow-chart of automated video-wall calibration.

[0042] FIG. 6 illustrates the display adjustment process.

[0043] FIG. 7 illustrates a specific embodiment of the whole process

[0044] FIG. 8 is the flow diagram for an image analysis and detection module.

DETAILED DESCRIPTION OF THE DRAWINGS

[0045] FIG. 1 illustrates the basic problem. It shows a complex video wall layout (multiple displays arranged artistically at multiple angles). It also shows how the image output to each of these displays has been correctly aligned and correctly color calibrated so that the image displays correctly and evenly across on all screens regardless of their placement, rotation, spacing, bezel, etc. The 9 displays comprising the video wall are showing a test pattern illustrating the precise placement of the artistic display orientations within a video-wall. Once the physical video-wall displays have been installed, the mapping and placement of these individual displays within video wall canvas are accomplished by multiple means, however disclosed herein is an automated method for accomplishing this process adaptable even to complex non-standard video wall layouts such as this.

[0046] FIG. 2 illustrates the need for precise mapping, placement and bezel correction of displays when creating a video wall. The figure again shows a 9-screen video wall this time arranged in a 3×3 grid configuration video-wall presenting. The output image shown on the two video walls depicted is again an image of diagonal straight lines which have been drawn to span the whole video-wall canvas. In both versions the pattern is interrupted by the bezel edges of the nine displays which form pairs of horizontal and vertical interruption bands. However in the upper illustration of FIG. 2 (where the display placement within the video wall canvas has not been corrected/adjusted to account for bezel interruptions) you can see that the lines on the video-wall canvas do not align correctly hence to not appearing as portions of a single straight line. This is emphasized by the overlayed dotted straight diagonal lines (21) and (22). Notice that the lines on the non-aligned (non-bezel corrected) canvases do not exactly follow these ruled lines. The bottom half of the figure illustrates the view after effective bezel adjustments have been performed: the diagonals on the canvas line up accurately and the fine lines added at (23) and (24) confirm this. In practice such
lines cannot be generated by the video wall server, and evaluation of alignment must be observed by a viewer either by eye or by automated image capture (method for which is disclosed herein).

[0047] FIG. 3 shows a schematic diagram depicting a 2x2 video wall comprising four independent displays working together to output a video wall that has been configured to correctly compensate for the display bezel. Also shown is a tablet computing device with a built in camera (31) which is being operated by a user (32) to capture an image of all four of the displays comprising the video wall (along with their output).

[0048] FIG. 4 illustrates in more detail the method of using a camera in combination with uniquely identifying output images along with automated image analysis to inform the server both of the identity of the individual displays in the video wall as well as the precise relative position and size of the displays in the video-wall. In this example, the video-wall server has output a different QR code to each of the nine displays comprising the video wall as seen in the top half of the FIG. (41), and it also shows a blown up enlarged view of one single display with the QR code (45) with corner markers (46) which would be a potential cue used as part of the system to help spatially locate edges and corners correctly through the image capture and analysis process. Also depicted is a schematic that a smartphone or tablet equipped with a built-in camera (42) being used to capture and relay images of the real-world video-wall output and relay it back to the video-wall server, allowing the video-wall server, through automated image recognition and analysis of the captured rendition of the output images, to correctly align and place the individual sub-image segments (and displays) within the video-wall canvas to create a mapping for use when outputting to the video wall. In one embodiment different images are output at different stages in the automated calibration process. For example at the next stage the server might output a line pattern for precise calibration and use the image capture of a line pattern across the displays to automatically make the fine adjustments needed to allow for bezel corrections. Finally a color adjustment image (e.g., uniform colors across all displays) might be output across the video-wall using feedback from image analysis of the camera captured image to access differences in color output across various displays comprising the video wall. A second video wall is depicted in the lower half of FIG. 4 showing a non-rectangular video-wall (43) this time with a different type of identification and calibration image differentiating individual displays. Again the image of the video-wall is captured by a camera, in this case depicted as a mobile phone or tablet (44).

[0049] FIG. 5 shows a process flow-chart of automated video-wall calibration (50). Here (in step 51) video-wall is configured to output unique images to each of the unassigned displays within the system (some of which may be arranged into a video-wall). The user is then prompted (either on the displays or from within an administrative GUI potentially accessed from a mobile device such as a tablet, smart-phone, or laptop) to take a photo of the video-wall (step 52). In the case that the user is using a mobile device, the administrative web-application may request permission to directly access the mobile device's camera. The user then takes a photo of the video-wall and transfers this to the server for automated analysis (step 53). The server then (using automated image analysis of the specially output images) determines which display is arranged where within the video-wall and also determines the exact spacing, rotation, and placement of the displays by recognizing the distinctive identifying images in the photo and also by calculating the distances between each adjacent display edge within the photo (step 54). This information is then used to create a video-wall configuration file which is stored in a computer readable medium (step 55). A test pattern is then output to each of the displays comprising the video-wall (the displays that were contained within the photo taken by the administrator in step 52 (56), and it is checked for the accuracy of the completed step and reported either by an automated process or by a human observer (57). Subsequently further adjustments to this pattern are made if it is not satisfactory and a sequence of new test patterns analyzed (58) continuing until the total result is optimal and the process ends (59).

[0050] FIG. 6 illustrates the display adjustment process (60). The server outputs the appropriate (as needed at this stage in the process) unique identification images or color calibration image(s) to all the screens in the array (61). The user captures a live image of the screens (as requested by the server) (62). These are transferred to the server and analyzed (63). If both the user and server regard the results as satisfactory this step in the adjustment process ends (66), otherwise, the server adjusts the settings and or relationships between displays in the array based on results of automated image analysis (65) and outputs appropriate images at (61) once more.

[0051] FIG. 7 is an illustration of one specific embodiment of the whole video-wall system process of set-up and use with a networked video wall using zero clients. The user using a browser device with a camera authenticates as a user and authorizes the web calibration process (70). The server first discovers and connects to the zero-client devices over the network and builds a list of displays and assigns a unique identity to each display (71). Next it collects the available display resolutions and other available settings from all the connected displays (72). Then the automated setup process is launched beginning with a browser accessible GUI containing instructions for the user being launched on the user's web-browser device with an embedded camera (73). Initially the web-server requests permission to access to a camera (if permission in not granted the system will fall back to manual calibration methods). Once permission has been granted the user will be provided with instructions and real time feedback as needed throughout the whole process to assist them to accurately capture an image of the video wall (e.g., it may provide screen recognition features to ensure all screens have been captured from a usable angle). The process outputs unique calibration image optimized for automated image recognition to each display (e.g., QR codes with corner markers for initial identification image) (74). Capture image(s) and send to web-server for automated image analysis adjusting identification, positioning, and calibration settings and as required (75). The camera is controlled (either by the user or the web-server) to capture one or more images of the video wall of sufficient resolution to perform the required analysis (e.g., via html media capture or similar method). The images are transmitted to the web-server (wirelessly) for analysis by image analysis module (see flow-chart in FIG. 8). Further image data from the camera may also sent (such as orientation, ambient light, GPS, etc.). Update the settings file representing the positions and order of the display units as communicated in automated analysis. As needed throughout the whole calibration process update this file and update both the
user instructions and individual displays as changes occur to this file. Check the results of the calibration (710) and evaluate if the current step is satisfactory in all respects (and if not continue calibration at (74)). If it is satisfactory, proceed to the next set of calibration images, for example line calibration images to line-tune display placement or color calibration once no further calibration steps remain execute canvas size and position of displays within canvas and write all sub-image mapping info to the settings file.  

[0052] The preliminary steps in the setup of the video wall system are now complete and the system is ready to process and deliver content to the video wall displays. It can now receive content for display via the primary GPU processing application output frame by frame to the frame buffer (78), and process (e.g., crop/split/rotate/resize/color-convert) based on stored identity, placement, and calibration settings individual sub-image portions (79) to be encoded and sent to the appropriate devices for output to the appropriate secondary display adapters which in turn outputs the transformed image data to the corresponding displays (710), together creating displaying the video wall image across all displays. This decoding and displaying process is continued while the video-wall is in use (711), and ends when terminated (712).  

[0053] FIG. 8 is the flow diagram for an image analysis and detection module. The process begins at (80) and starts by receiving image(s) from camera device and the display information appropriate to the displays that formed the canvas for the camera (81). It analyzes the newly received image for recognized markers and match to existing data (82). It performs initial checks on the image and provides error messages to the user as required (e.g., does the number of displays in the captured image match the number of detected displays in communication with the web-server? Is the angle, clarity, and resolution of the image sufficient for automated detection routines?) (83). Next it matches the geometrical model of the video wall (either pre-existing model built at an earlier stage in the automated setup process or built by combining the data retrieved from output to the displays with the display positioning and sizing information obtained through image analysis (84). Next the process isolates the captured display area of each detected display and analyzes the image data from each display (85); and utilizing the spatial information from the captured image automatically determines the placement of this display (86). By comparing the captured display area of each of the plurality of displays for perceived differences in the unique configuration images (87), it determines the adjustments to the mapping settings as required for the identity, position, size and output characteristics of the plurality of displays visible within the captured image (88). It returns the adjusted mapping settings for the plurality of displays based on required adjustments determined in the previous step (89). This ends the current step in image analysis (810) and allows a new new and better canvas to be displayed using the modifications to the updated configuration file.  

What is claimed is:  

1. A control module in communication with each of said plurality of displays, configured to receive display information from, and provide output commands to, individual ones of the plurality of displays;  
   - unique configuration images, designed to be interpretable via computerized image analysis of their captured output, to provide information on ones of identity, edges, corners, color characteristics, settings, size and placement of individual displays. Said unique configuration images being output to individual ones of the plurality of displays, in response to commands from the control module;  
   - a digital camera device in communication with the control module, being configured to capture and send for analysis digital camera images depicting ones of the plurality of displays including the unique configuration images output thereupon at the time of capture;  
   - an automated image analysis module, in communication with the control module, for receiving and analyzing said digital camera images, said analyzing comprising:  
     - isolating image data from the unique configuration images output thereupon;  
     - pairing ones of the depicted displays in digital camera images to corresponding ones of the plurality of displays;  
     - deriving individual display mapping data relative to ones of identity, position, placement, rotation, settings and color for ones of the displays within the video wall;  
   - said mapping being stored in computer readable memory and applied to facilitate uniformity of output of said plurality of displays.  

2. The system of claim 1, further comprising a Graphical User Interface (GUI) module consisting of a user interacting with a web-page being rendered by a web-browser running on a web-browsing device comprising a digital camera, the web-browser in communication with the control module, being configured to request the user to grant camera access and capture digital images of the plurality of displays.  

3. The system of claim 2, further comprising the automated method being used in conjunction with a GUI controlled by a user certain ones of the setup and configuration information required being provided by the user other being performed via the automated image analysis module.  

4. The system of claim 3, further comprising the GUI being configured to display a graphical representation of the mapping comprising a plurality of blocks, each block a representing, and corresponding to, one of devices comprising the video wall, the user being able to manipulate elements of the display to further adjust the mapping data.  

5. The system of claim 2, wherein the digital camera device embedded within a smart-phone device and the GUI is provided by a native smart-phone application in communication with the control module over wireless network connection.  

6. The system of claim 2, wherein the user is interacting with the GUI via ones of:  
   - a web browser;  
   - a laptop;  
   - a smartphone;  
   - a tablet;  
   - a personal computer;  
   - a mobile device;  
   - a touch-screen;  
   - a mouse;  
   - a keyboard;  
   - an input device;  
   - voice commands;  
   - gesture input;  
   - touch input.  

7. The system of claim 1, wherein the control module further comprises a web-server running an embedded PC housed within at least one of the plurality of displays.
8. The system of claim 1, further comprising the plurality of displays being updated to output, using the mapping data, at least one image spanning the plurality of displays.

9. The system of claim 1, being further configured to perform the outputting (of the unique configuration images), capturing (via a digital camera device), and analyzing (to derive mapping data) multiple times in sequence, each time utilizing the updated mapping data and each time further facilitating uniformity of output to the plurality of displays, the output of subsequent unique configuration images being controlled by the system.

10. The system of claim 1 wherein, the updating of the mapping data based on digital image analysis performed by the automated image analysis module includes one of: adjusting the aspect ratio or size of the video-wall canvas to match one or more of the bounding edges of the total display canvas captured by the camera;
    spatially positioning (shifting and rotating) of ones of the displays based on detected markers;
    adjusting the relative size of each display based on detected locations of display corner markers;
    modifying the positioning and scaling of the images in response to detected physical display sizes;
    increasing or decreasing the relative brightness settings for image data sent to individual ones of the displays;
    increasing or decreasing various color settings for image data sent to individual ones of the displays;
    increasing or decreasing various color settings in communication with the display itself via a communications protocol;
    detecting the size of the bezel for ones of the displays.

11. The system of claim 1 wherein, the sending for analysis of the captured images comprises wireless transmission of image data from the digital camera device over a wireless communication network.

12. The system of claim 1, further comprising the digital camera device supplying additional meta-data about the captured image comprising ones of: camera orientation, detected ambient light, detected distance from the subject, focal length, shutter speed, flash settings, camera aperture, detected camera rotation angle relative to the horizon, GPS location these additional data being used to increase the accuracy or speed of image analysis or provide additional details about the video wall.

13. The system of claim 1 wherein, visual elements, being specific unique identification symbols, are used in the configuration images to facilitate assessing ones of the identity, relative position rotation and color of the displays, these visual elements being ones of: embedded QR codes; specific corner markers; to facilitate spatial location of corners of the display; specific edge markers; linear patterns across the canvas as a way of assessing continuity across bezel edges between different displays; individual pixels at the edge of each display are illuminated to ensure they are visible within the canvas providing an edge-check method; specific color(s) as a means of assessing color uniformity between multiple ones of the displays; QR code indicating embedded display identity within the image lines proximal to display edges indicating display edges; markers proximal to display corners indicating display corners; solid blocks of color depicting color characteristics; settings; corner and edge markers depicting relative display size; a sequence of lines spanning the multiple displays within the video wall canvas facilitating precise positioning of displays; a uniform color across all displays.

14. The system of claim 1, where the image analysis software corrects for planar spatial analysis based on the position and angle of the camera.

15. The system of claim 1, where the display information received from the display via the control module includes display sizing and resolution information. The automated image analysis module further comprising used this sizing and resolution information to assist in paring ones of the depicted displays.

16. The system of claim 1, where several images are used in rotation to precisely determine alignment, the images comprising:
    at least one an identification image to determine the identity of each display;
    at least one a corner coordinates image to determine the spacing rotation and placement of displays;
    at least one color calibration images to match and calibrate color amongst multiple displays.

17. The system of claim 1, further comprising error checks being performed on captured image data either prior to or after sending for analysis, where checks and feedback to the camera operator form part of the are performed on the captured image and error messages are generated for output to the user, said detected errors conditions comprising ones of:
    the detected number of displays in the captured image not matching the detected number of displays in communication with the server the incidence-angle of the captured image deviating too far from the recommended 90 deg angle;
    the clarity, contrast, and resolution of the captured image being sub-optimal for automated detection routines;
    captured image being too far or too close to the video wall; light or flash reflections being too strong for image detection.

18. A computer implemented method of adjusting, within a video-wall canvas, ones of identity, placement, color characteristics and configuration of individual ones of a plurality of displays by a control module in communication with each of said plurality of displays, the control module also being in communication with an image analysis module, the image analysis module also being in communication with a digital camera device, in order to facilitate the operation of said plurality of displays as a video-wall, the method comprising:
    detecting the plurality of displays;
    retrieving information from said displays;
    generating of unique configuration images, the configuration images having been designed to communicate, via computerized image analysis, ones of the corresponding display's identity, edges and corners, placement within the canvas and color calibration;
    creating a test canvas based on said configuration images for outputting said unique configuration images to individual ones of the plurality of displays;
outputting the said test canvas to the displays capturing via
the digital camera device digital images of the plurality
of displays including the unique configuration images
output thereupon;
retrieving by the image analysis module over a network
said digital images for analysis;
analyzing, by the image analysis module, of the received
digital images;
pairing ones of the depicted displays in digital camera
images to corresponding ones of the plurality of displays;
deriving individual display mapping data relative to ones of
identity, position, placement, rotation, settings and color
for ones of the displays within the video wall;
adjusting in response to the analyzing said identification,
placement, and configuration for individual ones of the
plurality of displays;
storage said settings in computer readable memory;
applying the updated settings to facilitate uniformity of
output through an updated canvas.

19. The method of claim 18, further comprising a Graphi-
cal User Interface (GUI) consisting of a user interacting with
a web-page being rendered by a web-browser running on a
web-browsing device comprising a digital camera, the web-
browser in communication with the control module, being
configured to request the user to grant camera access and
capture digital images of the plurality of displays.

20. A computer-readable medium storing one or more
computer-readable instructions configured to cause one or
more processors to:
- display, via a control module in communication with each
  of a plurality of
  displays, unique configuration images, said images
designed to be interpretable via computerized image
analysis of their captured output, to provide information
on ones of identity, edges, corners, color
characteristics, settings, size and placement of individual
displays in the form of a test canvas;
receive, via the control module, display information from
individual ones of the plurality of displays;
receive, via the control module, images from a digital cam-
era device configured to capture, and send for analysis,
digital images depicting ones of the plurality of displays
including the unique configuration images output there-
upon at the time of capture;
delivery via the control module both said digital images and
the said test canvas as displayed to an automated image
analysis module, for analysis of the digital camera
images;
analyze the images in the automated image analysis mod-
ule, said analyzing comprising:
- isolating image data from the unique configuration
  images output thereupon;
pairing ones of the depicted displays in digital camera
  images to corresponding ones of the plurality of displays;
deriving individual display mapping data relative to
  ones of identity, position, placement, rotation, settings
  and color for ones of the displays within the
  physical arrangement;
retrieve, via the control module, the individual display
mapping data write, via the control module, configuration
file to permanent storage.

* * * * *