

SYSTEM AND METHOD FOR PROVIDING COMMAND SIGNALS FROM A CAPTURED IMAGE

Field of the Invention

5 This invention relates to a processing system. More particularly, this invention relates to using captured images to determine command signals for an application. Still more particularly, this invention relates to a system in which a camera captures an image of a user with a first set of markers proximate the head of the user and a second set of markers proximate a hand held device; and determines movement in a virtual reality environment
10 such as a game or other interactive application based on the positions of each group of markers.

Prior Art

 Virtual reality environments are used in a wide range of applications. Some
15 examples include, but are not limited to, video/computer games, simulators, and computer aided design tools. As technology has progressed, the virtual reality environments have become more robust and life-like. Most virtual reality environments now allow users to move an object or themselves around the environment with six degrees of freedom. This means that the object may be moved along any axis i.e. x (horizontal), y (vertical), and z
20 (zoom). The object may also rotate about any axis referred to as roll (along the z axis), pitch (about the x axis), and yaw (about the y axis). Additional degrees of freedoms may be added if the user is allowed to manipulate a second object, such as an extremity or a target for aiming a device. Furthermore, additional degrees of freedom allow a user to navigate and manipulate the same object concurrently without an implicit switch to change the
25 control of one to the other.

As virtual reality environments and technology have advanced, users want the “virtual reality” displayed to the user to more precisely mimic the motion of the user to take advantage of the detail of the environment and allow the user to be immersed in the virtual environment. In the past, several methods and systems have been used to track user movement. One common method is through the use of motion sensors connected to a tracked object and a second common method is the use of cameras to capture an image and determine motion based on the different positions of the object in the captured images.

Motion sensors are typically an accelerometer connected to an object such as a user’s head. One problem with the use of sensor is that they usually require wires or some other form of connection to a computer system. These connections may impede the user’s movement detracting from the enjoyment of the experience. These sensors are also extremely susceptible to wear and tear as the components are constantly used to take measurements. Finally, the precision of the measurements of the sensors can limit the user’s ability to move about the environment and perform certain tasks.

A second type of tracking system usually uses a camera to capture an image of the user and then detect movement by comparing positions of an object in the image in the position of the object in subsequent images. In one type of camera system, an image or an object is compared to an image of the object in a known position in relation to the camera. From the comparison, movement of the object can be determined. In a second type of camera system, an image is captured and complex mathematical models such as Hough transformations and Fast Perspective Transformations are used to determine motion. It is a problem that complex mathematic algorithms are needed in both of these systems to detect

the motion. Thus, either responsiveness to movement must be sacrificed or a large amount of processing and memory capacity of the system must be used. Secondly, as a great amount of resources are needed to detect motion, only motion of one object can be tracked in an image in these prior art systems.

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Thus, those skilled in the art are constantly striving to provide a motion tracking system for virtual reality environments that minimizes the use of computer resources while maximizing the responsiveness of the system to motion.

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Summary of the Invention

The above and other problems are solved and an advance in the art is made by systems and method that perform in accordance with this invention. A first advantage of this invention is that simple mathematical algorithms are used to detect motion. This minimizes the amount of computing resources needed to detect the motion and generate command signals. Thus, degradation of application speed is minimized and granularity of control is maximized. A second advantage is that the motion of more than one object may be tracked. Thus, the user is provided with more degrees of freedom of motion which in turns allows the user to control targeting or manipulation of a device as well as changing the perspective of the viewed display.

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A system for generating command signals from a captured image in accordance with this invention operates in the following manner. A camera or other image capture device captures an image of one or more objects. Each of the objects has a set of markers having a unique characteristic. Preferably, each set of these markers has a unique shape. The image is then transmitted to the system.

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The system receives the images and identifies all of the markers in the image. In some embodiments, the markers are identified by first identifying blobs of like-colored pixels. In still other embodiments, only blobs in a predetermined area of the image are
5 considered. "Compactness" values of each blob is then determined. From the "compactness" values, the markers are identified.

Once the markers are identified, the properties of the markers are determined and stored. Preferably, the properties include a centroid position of each of the markers. After
10 the properties of the markers are determined, the markers are grouped into shapes. In the preferred embodiment, the shapes are triangles made of a group of three markers. In some embodiments, the markers are grouped by markers having approximately the same "compactness" value and are grouped in order of ascending x or vertical values. After the markers have been sorted into groups representing each shape, the movements indicated by
15 each shape are determined. The movements measured include horizontal movement, vertical movement, zoom, roll, pitch and yaw.

Horizontal movement may be determined and stored in the following manner. In some embodiments, the horizontal movement is determined by determining an average
20 horizontal position of the markers and comparing the average horizontal position to the average horizontal position of the markers in a previous image. In some particular embodiments, the previous horizontal average is subtracted from the calculated average horizontal position to determine horizontal movement. In these embodiments, a negative number indicates leftward movement and a positive number indicates rightward movement.

Furthermore, no horizontal movement may be determined if the result is within a tolerance range in some embodiments.

Vertical movement may also be determined and stored in the following manner. In
5 some embodiments, the vertical movement is determined by determining an average vertical
position of the markers and comparing the average vertical position to the average vertical
position of the markers in a previous image. In some particular embodiments, the previous
vertical average is subtracted from the calculated average vertical position to determine
vertical movement. In these embodiments, a negative number indicates downward
10 movement and a positive number indicates upward movement. Furthermore, no vertical
movement may be determined if the result is within a tolerance range in some embodiments.

Zoom movement may also be determined and stored in the following manner. In
some embodiments, the zoom movement is determined by determining an area of the shape
15 made by markers and comparing the area of the shape to the area of the shape in a previous
image. In some particular embodiments, the previous area is subtracted from the calculated
area to determine zoom movement. In these embodiments, a negative number indicates
zoom-out movement and a positive number indicates zoom-in movement. Furthermore, no
zoom movement may be determined if the result is within a tolerance range in some
20 embodiments.

Pitch movement may also be determined and stored in the following manner. In
some embodiments, the pitch movement is determined by determining an angle proximate
the second or middle marker and comparing the calculated angle to the angle proximate the
25 second marker in a previous image. In some particular embodiments, the previous angle is

subtracted from the calculated angle and areas of the current and previous shape are compared to determine pitch movement. In these embodiments, a result of the subtraction of angle being greater than zero and subtraction of the areas being less than zero indicates a pitch down and a result of the subtraction of angle being greater than zero and subtraction of the areas being greater than zero indicates a pitch up.

Roll movement may also be determined and stored in the following manner. In some embodiments, the roll movement is determined by determining a change vertical position between the first and third markers of the shape and comparing the change in the current image to the change in vertical positions between the first and third markers of the shape in a previous image. In some particular embodiments, the previous change is subtracted from the calculated change to determine roll movement. In these embodiments, a negative number indicates roll left and a positive number indicates roll right. Furthermore, a result within a specific range may indicate no roll movement is detected.

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Yaw movement may be determined and stored in the following manner. In some embodiments, yaw can be determined by the size of the angles proximate first and third marker in the image. In these embodiments, the size of the angles is determined and a yaw right movement is determined if the angle proximate the first marker is greater than the angle proximate the third marker and a yaw left is determined if the angle proximate the first marker is less than the angle proximate the third marker. In some embodiments, no yaw movement is determined if the difference between the angles is within a specified tolerance.

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Brief Descriptions of the Drawings

The above and other advantages and features of a system in accordance with this invention are described in the following Detailed Description and are shown in the following drawings:

Figure 1 illustrating a system for capturing images, generating command signals and providing the command signals to a second application in accordance with one embodiment of this invention;

Figure 2 illustrating a block diagram of components of a processing system that provides a system in accordance with one embodiment of this invention;

Figure 3 illustrating a flow diagram of a process for generating command signals from a captured in image in accordance with one embodiment of this invention;

Figure 4 illustrating a flow diagram of a process for detecting markers in accordance with one embodiment of this invention;

Figure 5 illustrating a flow diagram of a process for determining movements indicated by shapes in a captured image in accordance with one embodiment of this invention;

Figure 6 illustrating a flow diagram of a process for modifying parameters of the system in accordance with one embodiment of this invention;

Figures 7-18 illustrating views of images indicating different movements of a shape in accordance with one embodiment of this invention; and

Figure 19 illustrating a captured image from which markers are identified for two shapes and movement identifiers are determined for the shapes in accordance with one embodiment of this invention.

Detailed Description

This invention relates to using captured images to determine command signals for an application. Still more particularly, this invention relates to a system in which a camera captures an image of a user with a first set of marker proximate the head of the user and a
5 second markers proximate a hand held or other device; and determines movement in a virtual reality environment such as a game or other interactive applications based on the positions of each group of markers.

Figure 1 illustrates a system 100 that is executing applications to provide a software
10 application having a virtual reality component such as a game, simulator, or any other type of software platform. System 100 includes a computer system 105 including a processing unit, memory, and other devices as set forth below in figure 2. Although shown as a desktop computer in Figure 1, one skilled in the art will recognize that other types of computer systems are capable of executing the software described. Display 110 is a LCD,
15 analog display, and/or conventional television connected to a video port of computer system 105 to provide images transmitted from the processing system to a video driver as set forth in Figure 2. Keyboard 120 and other Input/ Output (I/O) device (Not shown) are also connected to peripheral ports of computer system 105 and are used to receive inputs from a user for use in the execution of the software loaded into the memory of the system. Camera
20 115 is a conventional camera that is connected to an I/O port of computer system 105 to capture images for use by software, including software in accordance with this invention.

One skilled in the art will recognize that although the embodiments set forth in this disclosure are described as if being executed by the processing system of computer 105, the
25 system in accordance with this invention can be executed by another processing system that

connects to an I/O port of computer 105 for communication with the virtual reality software being executed by computer 105. Furthermore, the processes performed by the system in accordance with this invention may be embodied in software instructions stored in memory or on a readable media; firmware; hardware; and any combination of the preceding formats
5 for use in the system.

One skilled in the art will also note that although the system is shown as executed by computer system 105. The processes may also be performed by separate processing systems such as a server or other connected systems that connected to system 105 over a
10 network. Furthermore, one skilled in the art will recognize that computer system 105 may be a video game console, simulator, or other processing system that provides the same functions as computer system 105.

To use the system in accordance with this invention, a user would have two or more
15 devices such as headgear 130 and hand device 140 affixed to the user. Each device 130,140 has a set of markers 135, 145 either emblazed on the outer surface or projected from affixed components. Each set of markers 135, 145 are laid-out on the outer surface in the representation of a shape. In figure 1, each of set of marker 135, 145 are set out in the shape of a triangle on the outer surface of devices. Although those skilled in the art will recognize
20 that other geometric shapes could be used. Preferably, the shapes provided have at least three distinct points and three distinct angles for use in motion determination in accordance with this invention.

Each set of markers 135, 145 must be discernible from one another. In this
25 embodiment, markers 135 are circles and markers 145 are triangles. However, one skilled in

the art will recognize that other shapes could be used. Furthermore, it is envisioned other features such as color, reflectivity, shape, and frequency could be used. In this embodiment, the markers are laser emitters that are easily found in an image. Although, Light Emitting Diodes, RF markers, and different colored areas may also be used without departing from
5 this invention.

As shown in Figure 1, the first device is head gear 130 that is affixed over the head of a user as glasses and/or goggles and includes markers 135. One marker 135 is affixed to each front side of head gear 130 and a marker 135 is also placed at the top center of the
10 head gear. Head gear 135 is used to track the head motion of the user. Thus, motion from head gear 135 will be used to control the view of the virtual reality environment in this embodiment of the invention.

The second device is hand held device 140. Hand held device 140 is a substantially
15 circular object held in the palm of a hand of the user. Markers 145 are set in a triangular formation about the perimeter of the circle. Device 140 is held facing the camera to allow the camera to capture an image of the markers. Since device 140 is hand held, it is envisioned it can be used to control the targeting of a weapon or in the use of grasping objects in the virtual reality environment. Only two example of device with markers are
20 given. One skilled in the art will recognize that there is no limit to the devices or positions of the markers that may be used in this in accordance with invention. Furthermore, although two devices are shown, one skilled in the art will recognize any number of devices may be tracked in accordance with this invention.

This invention includes processes for determining the motion of the objects from the markers on the objects. These processes are performed by processing systems executing the instructions for performing the processes set forth below. Figure 2 is a block diagram of a processing system that performs these processes in computer system 105 in this

5 embodiment. However, any processing system having similar components may be used.

One skilled in the art will recognize that the exact components of the system are left to those skilled in the art designing a system in accordance with this invention and that other components that perform the same functions may be used without departing from the system in accordance with this invention. Furthermore, one skilled in the art will recognize

10 that other embodiments that include the processes embodied in software, firmware or hardware are possible without departing from this invention.

Processing system 200 includes Central Processing Unit (CPU) 205. CPU 205 is a processor, microprocessor, or any combination of processors and microprocessors that

15 execute instructions to perform the processes in accordance with the present invention.

CPU 205 connects to memory bus 210 and Input/ Output (I/O) bus 215. Memory bus 210 connects CPU 205 to memories 220 and 225 to transmit data and instructions between the memories and CPU 205. I/O bus 215 connects CPU 205 to peripheral devices to transmit

data between CPU 205 and the peripheral devices. One skilled in the art will recognize that

20 I/O bus 215 and memory bus 210 may be combined into one bus or subdivided into many other busses and the exact configuration is left to those skilled in the art.

A non-volatile memory 220, such as a Read Only Memory (ROM), is connected to memory bus 210. Non-volatile memory 220 stores instructions and data needed to operate

25 various sub-systems of processing system 200 and to boot the system at start-up. One

skilled in the art will recognize that any number of types of memory may be used to perform this function.

A volatile memory 225, such as Random Access Memory (RAM), is also connected
5 to memory bus 210. Volatile memory 225 stores the instructions and data needed by CPU 205 to perform software instructions for processes such as the processes for providing a system in accordance with this invention. One skilled in the art will recognize that any number of types of memory may be used to provide volatile memory and the exact type used is left as a design choice to those skilled in the art.

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I/O device 230, keyboard 235, display 240, memory 245, network device 250 and any number of other peripheral devices connect to I/O bus 215 to exchange data with CPU 205 for use in applications being executed by CPU 205. I/O device 230 is any device (such as camera 115) that transmits and/or receives data from CPU 205. Keyboard 235 is a
15 specific type of I/O that receives user input and transmits the input to CPU 205. Display 240 receives display data from CPU 205 and display images on a screen for a user to see. Memory 245 is a device that transmits and receives data to and from CPU 205 for storing data to a media. Network device 250 connects CPU 205 to a network for transmission of data to and from other processing systems.

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This invention relates to providing control signals to an application based upon a captured image. The control signals are generated based upon the motion of the object in the captured images. Motion of the object is determined by the following processes executed by the processing system. Although, the processes of this embodiment are preferably encoded
25 using C++, one skilled in the art will recognize that other programming languages may be

used to encode the instructions without deviating from the process in accordance with the described embodiments of this invention.

Figure 3 illustrates a process 300 for generating command signals in accordance with one embodiment of this invention. Process 300 begins in step 305 by receiving a captured image. The image is captured by a camera and passed to process 300 in step 305. One example of a captured image is shown in Figure 19. In figure 19, an InfraRed (IR) filter is used to just detect the lasers of markers 135 and 145 of system 100. As can be seen a first set of markers 1910, 1915, and 1920 have a unique shape, in this case a triangle, and form first shape 1950 which is a triangle in this embodiment. A second set of markers 1925, 1930, and 1935 have a unique shape, in this case a circle, and form a second shape 1955 which is again a triangle.

After the image is received, the predetermined markers are identified in step 310. Thus, in image 1900, markers 1910, 1915, 1920, 1925, 1930, and 1935 are identified in step 310. Figure 4, described below, provides one exemplary process for identifying the markers, although other processes of identification may be used.

After the markers are identified, the markers are grouped into shapes in step 315. For example, in image 1900, the markers are grouped into shapes 1950 and 1955. In this embodiment, grouping is performed by storing the grouped markers for one shape into on data structure such as an array or a linked list. However, it is envisioned other grouping methods may be used. To ease calculations, the markers are grouped in order of ascending x or horizontal values in the data structure. This will facilitate calculations later, especially

in the case where shape 1950 and 1955 are triangles as in the described embodiments. One skilled in the art other methods may be used.

The motion identifiers for each shape are then determined in step 320. In this
5 embodiment, horizontal, vertical, zoom, roll, pitch and yaw are determined for each shape. Figure 5 illustrates a process for determine motion identifiers in accordance with one embodiment of this invention.

Once all of the motion identifiers are determined for each shape, the command
10 identifiers may be translated into command signals if an interface is required to allow communication between process 300 and the application requiring the signals in step 325. For example, the signals may be translated into signals expected from a joy stick, keyboard, mouse, or any other device from which the second application receives signals to continue processing. Alternatively, the calculation could be directly provided to application designed
15 to be directly compatible with a system in accordance with this invention. Process 300 then ends when command and/or determined motion identifiers are transmitted to the desired application in step 330.

Figure 4 illustrates process 400 for identifying the markers in step 310 of process
20 300 in accordance with one embodiment of this invention. Process 400 begins in step 405 by detecting blobs in the captured image. In this embodiment, blobs are groups of adjacent pixels having the same and/or substantially the same color. The determination is color value is well known and is left to those skilled in the art. Typically, blobs are a group of adjacent same color pixels of at least a certain size.

Once all of the blobs are detected, the properties for determining shapes from the blobs are calculated. In this embodiment, compactness of the blob is calculated. For purposes of this discussion, compactness is a measurement of how close all particles (in this case pixels) are from one another in the object. The compactness can be derived from
 5 perimeter and area (which may be established by counting the outer pixels (perimeter and total number of pixels (area) of the object. Typically, compactness is expressed as:

$$M = 4\pi(\text{area of object})/(\text{perimeter of object})^2$$

Where M is the compactness of the object.

Once, the compactness of a blob is known, it is compared to the compactness for the shapes
 10 of the markers. If compactness are equal or at least within an acceptable tolerance of being equal, the blob is identified as a marker. The desired properties for each found marker are then calculated and stored in step 420. For purposes of this embodiment, the centroid of each marker is found. The centroid is the center of the object also known as the center of gravity, and is found using common well known techniques. For purpose of the rest of the
 15 discussion, when location or position of marker is discussed, the location or position is referring to position of the centroid.

After the properties of the markers are determined, the markers are grouped into shapes. In this embodiment, the markers are grouped by equal or substantially equal
 20 compactness values which indicate identical shapes. For example, markers 1925, 1930, and 1935 of image 1900 are circles and have a compactness of approximately 1. Thus, they can be grouped together. Markers 1910, 1915, and 1920 are triangles which have a compactness of approximately, $\pi/3$. Further, the grouping may be done in order of ascending horizontal or x values as described above. After the markers are grouped process 400 ends.

Figure 5 illustrates process 500 which is one process for determining the motion identifiers in accordance with one embodiment of this invention. To facilitate the discussion of figure 5, Figures 7-18 are provided to show the motions of a shape based on a current and a prior image. For purposes of this discussion, the position of the shape in a prior image is shown in outline form and the position in the current image is shown in solid form. Furthermore, one skilled in the art will recognize that the following equations are given for a triangular shape. However, it is expected that one skilled in the art can and will modify these for use with other geometrical shapes using simple mathematics and geometry.

Also prior to starting, process 500 may determine if all of the markers for the shapes are in a region of interest 1905 in the image. A region of image may be any area of the captured image. This may be determined by discarding any blob including pixels outside the region of interest and then determining whether each determined shape has a complete number of markers. If a shape does not have a full number of markers, default signals such as the last set of determined signals may be used for signals generated from the motion of that shape. However, this is left as a design choice of those skilled in the art.

Process 500 begins in step 505 by selecting an object for determination of motion identifiers. The determinations of the motion identifiers begin in step 510 by determining and storing horizontal movement. Figure 7 illustrates left horizontal movement in which present shape 705 is shifted to the left past of shape 700. Figure 8 then shows present image 805 shifted to the right of past shape 800. One will note that the size of the shapes does not change. Thus, the shift can be determined by comparing the average x or horizontal position of the markers in the present image to the average x or horizontal position of markers in a previous image as shown in the following equation:

$$\text{Movement_horizontal} = (q1x+q2x+q3x)/3 - (p1x+p2x+p3x)/3$$

Where: q_{nx} = the horizontal position of the nth marker in a shape in the current image, q;

p_{nx} = the horizontal position of the nth marker in the shape in past image, p.

In this measurement, a negative number shows movement left and a positive number shows

5 movement right. To prevent subtle movements from causing movement detection, a

tolerance range of for example $-0.5 < \text{horizontal movement} < 0.5$ may indicate no horizontal

movement. It is possible that this tolerance is adjustable by the user or an application

receiving the command using a process such as the process shown in figure 6 and described

below. However, these are left to those skilled in the art making and/or using a system in

10 accordance with this invention.

Vertical movement is determined and stored in step 515. Figure 9 illustrates upward

vertical movement in which present shape 905 is shifted up from shape 900. Figure 10 then

shows present image 1005 shifted to downward from past shape 1000. One will note that

15 the size of the shapes does not change. Thus, the shift can be determined by comparing the

average y or vertical position of the markers in the present image to the average y or vertical

position of markers in a previous image as shown in the following equation:

$$\text{Movement_vertical} = (q1y+q2y+q3y)/3 - (p1y+p2y+p3y)/3$$

Where: q_{ny} = the vertical position of the nth marker in a shape in the current image, q; p_{ny}

20 = the vertical position of the nth marker in the shape in past image p.

In this measurement, a negative number shows downward movement and a positive number

shows movement upward. To prevent subtle movements from causing movement detection,

a tolerance range of for example $-0.5 < \text{vertical movement} < 0.5$ may indicate no horizontal

movement. It is possible that this tolerance is adjustable by the user or an application

25 receiving the command using a process such as the process shown in figure 6 and described

below. However, these are left to those skilled in the art making and/or using a system in accordance with this invention.

Zoom movement is determined and stored in step 520. Figure 11 illustrates zoom-
 5 out or backing away from the screen in which present shape 1105 is smaller shape 1100.

Figure 12 then shows present image 1205 zooming in or coming closer to the screen in which present shape 1205 is larger than past shape 1200. One will note that the area of the shapes change. Thus, the zoom can be determined by comparing the average area of the shape formed by the markers in the present image and previous image as shown in the

10 following equations:

First area is determined for the shape in each of the present and previous image using the following equations:

$$Ma = \sqrt{(m1x - m2x)^2 + (m1y - m2y)^2}$$

$$mb = \sqrt{(m3x - m2x)^2 + (m3y - m2y)^2}$$

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$$mc = \sqrt{(m1x - m3x)^2 + (m1y - m3y)^2}$$

$$ms = 0.5 * (ma + mb + mc)$$

$$marea = (ms * (ms - ma) * (ms - mb) * (ms - mc))$$

where a, b, and c equal sides of the shape; m= image p or q; q being current image and p being the previous image; x being horizontal position and y being vertical position.

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Once the area of the shape from the current image (qarea) and the area of the shape from the previous image (parea) are determined, zoom is determined in accordance with the following equation:

$$Zoom = qarea - parea$$

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In this measurement, a negative number shows zoom-out movement and a positive number shows zoom-in movement. To prevent subtle movements from causing movement detection, a tolerance range of for example $-0.5 < \text{zoom} < 0.5$ may indicate no zoom movement. It is possible that this tolerance is adjustable by the user or an application receiving the command using a process such as the process shown in figure 6 and described below. However, these are left to those skilled in the art making and/or using a system in accordance with this invention.

Pitch movement is determined and stored in step 525. Figure 13 illustrates pitch back or upwards in which present shape 1305 has larger shapes at the bottom and a smaller shape on top than shape 1305. Figures 14 then shows pitch forward or down where present image 1405 has a larger top marker and smaller bottom markers than past shape 1400. As the top and bottom shapes are smaller, one will also notice the shape of the triangles formed changed. Thus, pitch can be determined by the size of the angle proximate the top or second marker in each image. Therefore, comparison of this angle can indicate pitch. Thus, the following equations can be used to find pitch. First the length of the sides of the shape in each of the present and previous image are determined using the following equations:

$$ma = \sqrt{(m1x - m2x)^2 + (m1y - m2y)^2}$$

$$mb = \sqrt{(m3x - m2x)^2 + (m3y - m2y)^2}$$

$$mc = \sqrt{(m1x - m3x)^2 + (m1y - m3y)^2}$$

where a, b, and c equal sides of the shape; m= image p or q; q being current image and p being the previous image; x being horizontal position and y being vertical position. After the sides are determined the arccosine of the sides is used to determine the angle proximate the second marker using the following equation:

$$mangle2 = \arccos((ma^2 + mb^2 - mc^2) / (2 * ma * mb))$$

Where angle is the size of the angle; m again is the image for which the angle in shape is being determined.

Once the angles are found, pitch is determined in the following manner:

5 pitch = pangle-qangle

Then

 If (pitch >0) and ((p2_area-q2_area) >0)

 pitch = pitch_up

 else (pitch >0) and ((p2_area-q2_area) <0)

10 pitch = pitch_down

where q2_area equals area of the second marker in the current image and p2_area equals area of the second marker in the previous image.

15 Roll movement is determined and stored in step 530. Figure 15 illustrates left roll movement in which present shape 1505 is tilted leftward from shape 1500. Figure 16 then shows right roll movement where the present image 1605 titled rightward from past shape 1600. One will note that the size of the shapes does not change. Thus, the shift can be determined by comparing the average y or vertical change of the first and third markers in
20 the present image to the average y or vertical change of first and third markers in a previous image as shown in the following equation:

$$\text{Movement_roll} = (q1y - q3y) - (p1y - p3y)$$

Where: qny= the vertical position of the nth marker in a shape in the current image, q; pny
25 = the vertical position of the nth marker in the shape in past image p.

In this measurement, a negative number shows left roll movement and a positive number shows right roll movement. To prevent subtle movements from causing movement detection, a tolerance range of for example $-.5 < \text{vertical movement} < .5$ may indicate no horizontal movement. It is possible that this tolerance is adjustable by the user or an application receiving the command using a process such as the process shown in figure 6 and described below. However, these are left to those skilled in the making and using a system in accordance with this invention.

Yaw movement is determined and stored in step 535. Figure 17 illustrates yaw right movement in which present shape 1705 has a larger shape at the bottom right and a smaller shape on the bottom left than shape 1700. Figure 18 then shows yaw left where present image 1805 has a larger marker on the bottom left and smaller marker on the bottom right than past shape 1800. As the bottom shapes are change, one will also notice the shape of the triangles formed changed. Thus, yaw can be determined by the size of the angle proximate first and third marker in the image. Therefore, comparison of these angles can indicate yaw. Thus, the following equations can be used to find yaw. First the length of the sides of the shape in each of the present and previous image are determined using the following equations:

$$ma = \sqrt{(m1x - m2x)^2 + (m1y - m2y)^2}$$

$$mb = \sqrt{(m3x - m2x)^2 + (m3y - m2y)^2}$$

$$mc = \sqrt{(m1x - m3x)^2 + (m1y - m3y)^2}$$

where a, b, and c equal sides of the shape; m= image p or q; q being current image and p being the previous image; x being horizontal position and y being vertical position. After

the sides are determined the arccosine of the sides is used to determine the angle proximate the second marker using the following equation:

$$\text{pangle1} = \arccos((ma^2 + mc^2 - mb^2) / (2 * ma * mc))$$

$$\text{pangle3} = \arccos((mc^2 + mb^2 - ma^2) / (2 * mb * mc))$$

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Where angle is the size of the angle; m again is the image for which the angle in shape is being determined and the number indicates the marker proximate the angle. Pangle 1 and pangle 3 are then compared if Pangle 1 is greater right yaw movement is determined and if pangle 3 is greater then yaw left is indicated.

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After all of the movement identifiers are determined for a shape, process 500 determines if identifiers for another shape must be calculated in step 540. If more shape remain, process 500 repeats from step 505 other process 500 ends.

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Process 600 illustrates an exemplary process for changing any parameters intolerance factors or translations. In this embodiment, process 600 is invoked when a specific key command or button is received by the processor. Process 600 begins in step 605 by displaying the current settings. In step 610, a user inputs a modification to the parameters. This may be done by entering a numeric value or sliding a displayed power bar to the desired setting. In step 615, the setting is received. The new setting is stored in step 620. After the new setting is stored, process 600 waits for new command in step 625 or may end.

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The above is a description of an exemplary embodiment of a system for generating control signals using a captured image. It is envisioned that this invention is particularly

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useful in a virtual reality environment. However, it may have other applications. It is envisioned that those skilled in the art can and will design alternative embodiments of this invention that infringe on the invention as defined in the claims set forth below.

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What is claimed is:

1. A system for commands to an application being executed in a software system comprising:

5 circuitry configured to receive a captured image;

circuitry configured to identify a first plurality of markers in said captured image, wherein said circuitry configured to identify markers comprises:

circuitry configured to detect a plurality of blobs in said captured images,

circuitry configured to calculate properties for each of said plurality of blobs,

10 circuitry configured to identify each of said first plurality of markers from said properties of said blob,

circuitry configured to determine properties of each of said plurality of markers,

15 circuitry configured to store said determined properties for each of said plurality of markers;

circuitry configured to arrange said first plurality of markers in a first shape;

circuitry configured to determine a first plurality of command identifiers from said first shape; and

20 circuitry configured to translate said first plurality of command identifiers into command signals.

2. The system of claim 1 wherein circuitry configured to calculate said properties for each of said plurality of blobs comprises:

circuitry configured to determine compactness each of said plurality of blobs wherein compactness is a measure of relative distance between a plurality of pixels in said blob.

5 3. The system of claim 2 wherein circuitry configured to calculate said properties for each of said plurality of blobs comprises:

 circuitry configured to determine an area of said blob; and

 circuitry configured to determine a perimeter measurement of said blob.

10 4. The system of claim 1 wherein said circuitry configured to determine properties for each of said plurality of markers comprises:

 circuitry configured to calculate a centroid for each of said plurality of markers wherein said centroid includes a vertical position and a horizontal position in said captured image.

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 5. The system of claim 4 wherein said shape includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said circuitry configured to determine a plurality of command identifiers from said shape comprises:

20 circuitry configured to determine whether each of said first, second and third ones of said plurality of shape are with an area of interest in said captured image; and

 circuitry configured to provide a previous set of command identifiers in response to not all of said first, second, and third ones of said plurality of markers being within said area of interest.

6. The system of claim 4 wherein said shape includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said circuitry configured to determine a plurality of command identifiers from said shape comprises:

- 5 circuitry configured to determine horizontal movement of said shape; and
 circuitry configured to store said horizontal movement.

7. The system of claim 6 wherein said circuitry configured to determine said horizontal movement comprise:

- 10 circuitry configured to determine an average horizontal position of said first, second and third ones of said plurality of markers; and
 circuitry configured to compare said average horizontal position to a previous average horizontal position of said first, second, and third ones of said plurality of markers determined for a previous image.

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8. The system of claim 4 wherein said shape includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said circuitry configured to determine a plurality of command identifiers from said shape comprises:

- 20 circuitry configured to determine vertical movement of said shape; and
 circuitry configured to store said vertical movement.

9. The system of claim 8 wherein said circuitry configured to determine said vertical movement comprises:

circuitry configured to determine an average vertical position of said first, second and third ones of said plurality of markers; and

circuitry configured to compare said average vertical position to a previous average vertical position of said first, second, and third ones of said plurality of markers determined
5 for a previous image.

10. The system of claim 4 wherein said shape includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said circuitry configured to determine a plurality of command
10 identifiers from said shape comprises:

circuitry configured to determine zoom movement of said shape; and
circuitry configured to store said zoom movement.

11. The system of claim 10 wherein said circuitry configured to determine said
15 zoom movement comprise:

circuitry configured to determine an area of said shape defined by said first, second and third ones of said plurality of markers; and

circuitry configured to compare said area of said shape to a previous area of said shape defined by said first, second, and third ones of said plurality of markers determined
20 for a previous image.

12. The system of claim 4 wherein said shape includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said circuitry configured to determine a plurality of command
25 identifiers from said shape comprises:

circuitry configured to determine pitch movement of said shape; and
circuitry configured to store said pitch movement.

13. The system of claim 12 wherein said circuitry configured to determine said
5 pitch movement comprises:

circuitry configured to determine an angle proximate said second one of said
plurality of markers, and

circuitry configured to compare said angle to a previous angle proximate said
second one of said plurality of markers determined for a previous image.

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14. The system of claim 4 wherein said shape includes a first one of said
plurality of markers, a second one of said plurality of markers, and a third one of said
plurality of markers and said circuitry configured to determine a plurality of command
identifiers from said shape comprises:

15 circuitry configured to determine roll movement of said shape; and
circuitry configured to store said roll movement.

15. The system of claim 14 wherein said circuitry configured to determine said
roll movement comprise:

20 circuitry configured to determine a change in vertical position of said first and third
ones of said plurality of markers; and

circuitry configured to compare said change vertical position to a previous change in
vertical position of said first and third ones of said plurality of markers determined for a
previous image.

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16. The system of claim 4 wherein said shape includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said circuitry configured to determine a plurality of command identifiers from said shape comprises:

- 5 circuitry configured to determine yaw movement of said shape; and
 circuitry configured to store said pitch movement.

17. The system of claim 16 wherein said circuitry configured to determine said yaw movement comprises:

- 10 circuitry configured to determine an angle proximate said first one of said plurality of markers; and
 circuitry configured to compare said angle to a previous angle proximate said first one of said plurality of markers determined for a previous image.

- 15 18. A system for commands to an application being executed in a software system comprising:

 circuitry configured to receive a captured image, wherein said captured image includes a plurality of groups of said plurality of markers wherein each of said plurality of groups form one of a plurality shapes wherein said plurality of shapes include said first
20 shape, said plurality of groups include said first plurality of markers;

 circuitry configured to identify a first plurality of markers in said captured image, wherein said circuitry configured to identify a first plurality of markers in said captured image comprises:

 circuitry configured to identify each of said plurality of markers,

circuitry configured to arrange said plurality of markers into said plurality of groups of markers each defining one of said plurality of shapes,

circuitry configured to arrange said first plurality of markers in a first shape;

5 circuitry configured to determine a first plurality of command identifiers from said first shape; and

circuitry configured to translate said first plurality of command identifiers into command signals.

10 19. The system of claim 18 further comprises:

circuitry configured to transmit said command signals to a second application.

20. The system of claim 18 wherein said circuitry configured to identify markers comprises:

15 circuitry configured to detect a plurality of blobs in said captured images;

circuitry configured to calculate properties for each of said plurality of blobs;

circuitry configured to identify each of said plurality of markers from said properties of each of said blobs;

circuitry configured to determine properties of each of said plurality of markers;

20 circuitry configured to group said plurality of markers into said plurality of groups of markers each identifying one of said plurality of shapes; and

circuitry configured to store said determined properties for each of said plurality of markers.

21. The system of claim 20 wherein said circuitry configured to calculate said properties for each of said plurality of blobs comprises:

circuitry configured to measure compactness of each of said plurality of blobs wherein compactness is the proximity of all pixels in a blob to one another.

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22. The system of claim 20 wherein said circuitry configured to determine properties for each of said plurality of markers comprises:

circuitry configured to calculate a centroid for each of said plurality of markers wherein said centroid includes a vertical position and a horizontal position in said captured
10 image.

23. The system of claim 22 wherein said circuitry configured to determine said plurality of command identifiers comprise:

circuitry configured to determine command identifiers for each of said plurality of
15 shapes; and

circuitry configured to save each of said plurality of groups representing each of said plurality of shapes as prior shapes from previous image in response to determining said plurality of command identifiers.

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24. The system of claim 23 wherein said each of said plurality of groups of shape includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said circuitry configured to determine a plurality of command identifiers from said shape comprises:

circuitry configured to determine whether each of said first, second and third ones of said plurality of markers of a particular group representing are within an area of interest in said captured image; and

5 circuitry configured to provide a previous set of command identifiers for said shape in response to not all of said first, second, and third ones of said plurality of markers of said particular group being within said area of interest.

25. The system of claim 23 wherein each of said plurality of groups representing a shape includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said circuitry configured to
10 determine a plurality of command identifiers from said shape comprises:

circuitry configured to determine horizontal movement of said shape; and

circuitry configured to store said horizontal movement.

15 26. The system of claim 25 wherein said circuitry configured to determine said horizontal movement comprises:

circuitry configured to determine an average horizontal position of said first, second and third ones of said plurality of markers; and

20 circuitry configured to compare said average horizontal position to a previous average horizontal position of said first, second, and third ones of said plurality of markers determined for a previous image.

27. The system of claim 26 wherein circuitry configured to compare said average horizontal position comprises:

circuitry configured to subtract said previous horizontal average from said average horizontal position and wherein a negative number indicates left movement and a positive number indicates right movement.

5 28. The system of claim 27 wherein no horizontal movement is determined if the result is within a tolerance range.

29. The system of claim 23 wherein each of said plurality of groups representing a shape includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said circuitry configured to
10 determine a plurality of command identifiers from said shape comprises:

 circuitry configured to determine vertical movement of said shape; and

 circuitry configured to store said vertical movement.

15 30. The system of claim 29 wherein said circuitry configured to determine said vertical movement comprises:

 circuitry configured to determine an average vertical position of said first, second and third ones of said plurality of markers; and

 circuitry configured to compare said average vertical position to a previous average
20 vertical position of said first, second, and third ones of said plurality of markers determined for a previous image.

31. The system of claim 30 wherein said circuitry configured to determine said vertical movement comprises:

circuitry configured to determine an average vertical position of said first, second and third ones of said plurality of markers; and

circuitry configured to compare said average vertical position to a previous average vertical position of said first, second, and third ones of said plurality of markers determined
5 for a previous image.

32. The system of claim 31 wherein said circuitry configured to compare said average horizontal position comprises:

circuitry configured to subtract said previous vertical average from said average
10 vertical position and wherein a negative number indicates downward movement and a positive number indicates upward movement.

33. The system of claim 32 wherein no vertical movement is determined if the result is within a tolerance range.

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34. The system of claim 23 wherein each of said plurality of groups representing one of said plurality of shapes includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said circuitry configured to determine a plurality of command identifiers from said shape comprises:

20 circuitry configured to determine zoom movement of said shape; and
circuitry configured to store said zoom movement.

35. The system of claim 34 wherein said circuitry configured to determine said zoom movement comprises:

circuitry configured to determine an area of said shape defined by said first, second and third ones of said plurality of markers; and

circuitry configured to compare said area of said shape to a previous area of said shape defined by said first, second, and third ones of said plurality of markers determined
5 for a previous image.

36. The system of claim 35 wherein said circuitry configured to to compare said areas comprises:

circuitry configured to subtract said previous area from said area and wherein a
10 negative number indicates zoom out and a positive number indicates zoom-in.

37. The system of claim 36 wherein no zoom movement is determined if the result is within a tolerance range.

15 38. The system of claim 23 wherein each of said plurality of groups representing one of said plurality of shapes includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said circuitry configured to determine a plurality of command identifiers from said shape comprises:

circuitry configured to determine pitch movement of said shape; and
20 circuitry configured to store said pitch movement.

39. The system of claim 38 wherein said circuitry configured to determine said pitch movement comprises:

circuitry configured to determine an angle proximate said second one of said
25 plurality of markers; and

circuitry configured to compare said angle to a previous angle proximate said second one of said plurality of markers determined for a previous image.

40. The system of claim 39 wherein said circuitry configured to compare said
5 average horizontal position comprises instructions for subtracting said previous angle proximate said second one of said plurality of markers from said angle proximate said second one of said plurality of markers wherein a result greater than zero indicates pitch and said circuitry configured to determine said pitch further comprise:

circuitry configured to subtract a previous area of said second one of said plurality
10 of markers from an area of said second one of said plurality of markers wherein a number is greater than zero indicates pitch-up and a negative number indicates pitch-down.

41. The system of claim 40 wherein no pitch movement is determined if the result is within a tolerance range.

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42. The system of claim 23 wherein each of said plurality of groups of markers representing one of said plurality of shapes includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said circuitry configured to determine a plurality of command identifiers from said shape
20 comprises:

circuitry configured to determine roll movement of said shape; and
circuitry configured to store said roll movement.

43. The system of claim 42 wherein said circuitry configured to determine said
25 roll movement comprises:

circuitry configured to determine a change in vertical position of said first and third ones of said plurality of markers; and

circuitry configured to compare said change vertical position to a previous change in vertical position of said first and third ones of said plurality of markers determined for a
5 previous image.

44. The system of claim 43 wherein said circuitry configured to compare said vertical positions of said first and third ones of said plurality of markers comprises:

circuitry configured to subtract said previous change vertical position from said
10 change in vertical position and wherein a negative number indicates a left roll movement and a positive number indicates right roll movement.

45. The system of claim 44 wherein no roll movement is determined if the result is within a tolerance range.

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46. The system of claim 23 wherein each of said plurality of groups of markers representing one of said plurality of shapes includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said circuitry configured to determine a plurality of command identifiers from said shape
20 comprises:

circuitry configured to determine yaw movement of said shape; and

circuitry configured to store said pitch movement.

47. The system of claim 46 wherein said circuitry configured to determine said
25 yaw movement comprises:

circuitry configured to determine an angle proximate said first one of said plurality of markers; and

circuitry configured to compare said angle to a previous angle proximate said first one of said plurality of markers determined for a previous image.

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48. The system of claim 47 wherein if said previous angle is greater than said angle a yaw right is determined and if said previous angle is less than said angle a yaw left is determined.

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49. The system of claim 47 wherein no yaw movement is determined if the result is within a tolerance range.

50. A method performed by a processing device for providing commands to an application comprising:

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receiving a captured image;

identifying a first plurality of markers in said captured image, wherein said step of identifying markers comprises:

detecting a plurality of blobs in said captured images,

calculating properties for each of said plurality of blobs,

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identifying each of said first plurality of markers from said properties of said blob,

determining properties of each of said plurality of markers,

storing said determined properties for each of said plurality of markers,

arranging said first plurality of markers in a first shape;

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determining a first plurality of command identifiers from said first shape; and

translating said first plurality of command identifiers into command signals.

51. The method of claim 50 wherein said instructions to calculate said properties for each of said plurality of blobs comprise:

5 determining a compactness of each of said plurality of blobs wherein compactness is a measure of relative distance between a plurality of pixels in said blob.

52. The method of claim 51 wherein step of calculating said properties for each of said plurality of blobs comprises:

10 determining an area of each of said plurality of blobs; and
determining a perimeter measurement of each of said plurality of blobs.

53. The method of claim 50 wherein said step of determining properties for each of said plurality of markers comprises:

15 calculating a centroid for each of said plurality of markers wherein said centroid includes a vertical position and a horizontal position in said captured image.

54. The method of claim 53 wherein said shape includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said step of determining a plurality of command identifiers from said shape comprises:

determining whether each of said first, second and third ones of said plurality of shape are within an area of interest in said captured image; and

20 providing a previous set of command identifiers in response to not all of said first, second, and third ones of said plurality of markers being within said area of interest.

55. The method of claim 53 wherein said shape includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said instructions to determine a plurality of command identifiers from said shape comprise:

5 determining horizontal movement of said shape, and
 storing said horizontal movement.

56. The method of claim 55 wherein said step for determining said horizontal movement comprises:

10 determining an average horizontal position of said first, second and third ones of said plurality of markers; and
 comparing said average horizontal position to a previous average horizontal position of said first, second, and third ones of said plurality of markers determined for a previous image.

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57. The method of claim 53 wherein said shape includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said step of determining a plurality of command identifiers from said shape comprise:

20 determining vertical movement of said shape, and
 storing said vertical movement.

58. The method of claim 57 wherein said step for determining said vertical movement comprises:

determining an average vertical position of said first, second and third ones of said plurality of markers; and

comparing said average vertical position to a previous average vertical position of said first, second, and third ones of said plurality of markers determined for a previous
5 image.

59. The method of claim 53 wherein said shape includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said step for determining a plurality of command identifiers from
10 said shape comprises:

determining zoom movement of said shape; and
storing said zoom movement.

60. The method of claim 59 wherein said step of determining said zoom
15 movement comprise:

determining an area of said shape defined by said first, second and third ones of said plurality of markers; and

comparing said area of said shape to a previous area of said shape defined by said first, second, and third ones of said plurality of markers determined for a previous image.

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61. The method of claim 53 wherein said shape includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said step for determining a plurality of command identifiers from said shape comprises:

25 determining pitch movement of said shape, and

storing said pitch movement.

62. The method of claim 61 wherein said step for determining said pitch movement comprises:

- 5 determining an angle proximate said second one of said plurality of markers; and
 comparing said angle to a previous angle proximate said second one of said plurality of markers determined for a previous image.

63. The method of claim 53 wherein said shape includes a first one of said
10 plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said step for determining a plurality of command identifiers from said shape comprises:

- determining roll movement of said shape; and
 storing said roll movement.

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64. The method of claim 63 wherein said step for determining said roll movement comprises:

- determining a change in vertical position of said first and third ones of said plurality of markers, and

- 20 comparing said change vertical position to a previous change in vertical position of said first and third ones of said plurality of markers determined for a previous image.

65. The method of claim 53 wherein said shape includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said

plurality of markers and said step for determining a plurality of command identifiers from said shape comprises:

determining yaw movement of said shape; and
storing said pitch movement.

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66. The method of claim 65 wherein said instructions for determining said yaw movement comprises:

determining an angle proximate said first one of said plurality of markers; and
comparing said angle to a previous angle proximate said first one of said plurality

10 of markers determined for a previous image.

67. A method performed by a processing device for providing commands to an application comprising:

receiving a captured image, wherein said captured image includes a plurality of
15 groups of plurality of markers wherein each of said plurality of groups form one of a plurality shapes wherein said plurality of shapes include said first shape, said plurality of groups include said first plurality of markers;

identifying a first plurality of markers in said captured image, wherein said step of identifying a first plurality of markers comprises:

20 identifying each of said plurality of markers,

arranging said plurality of markers into said plurality of groups of markers
each defining one of said plurality of shapes,

arranging said first plurality of markers in a first shape;

25 determining a first plurality of command identifiers from said first shape; and

translating said first plurality of command identifiers into command signals.

68. The method of claim 67 further comprising:
transmitting said command signals to a second application.

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69. The system of claim 67 wherein step for identifying markers comprises:
detecting a plurality of blobs in said captured images;
calculating properties for each of said plurality of blobs;
identifying each of said plurality of markers from said properties of each of said

10 blobs;

determining properties of each of said plurality of markers;
grouping said plurality of markers into said plurality of groups of markers each
identifying one of said plurality of shapes; and
storing said determined properties for each of said plurality of markers.

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70. The method of claim 69 wherein said step calculating said properties for
each of said plurality of blobs comprises:

measuring compactness of each of said plurality of blobs wherein compactness is the
proximity of all pixels in a blob to one another.

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71. The method of claim 69 wherein said step for determining properties for
each of said plurality of markers comprises:

calculating a centroid for each of said plurality of markers wherein said centroid
includes a vertical position and a horizontal position in said captured image.

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72. The method of claim 71 wherein said step for determining said plurality of command identifiers comprises:

determining command identifiers for each of said plurality of shapes;

storing each of said plurality of groups representing each of said plurality of shapes

5 as prior shapes from previous image in response to determining said plurality of command identifiers.

73. The system of claim 71 wherein said each of said plurality of groups of shape includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said step determining a plurality of command identifiers from said shape comprises:

determining whether each of said first, second and third ones of said plurality of markers of a particular group representing are with an area of interest in said captured image; and

15 providing a previous set of command identifiers for said shape in response to not all of said first, second, and third ones of said plurality of markers of said particular group being within said area of interest.

74. The method of claim 71 wherein each of said plurality of groups representing a shape includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said step of determining a plurality of command identifiers from said shape comprises:

determining horizontal movement of said shape; and

storing said horizontal movement.

75. The method of claim 74 wherein said step for determining said horizontal movement comprises:

determining an average horizontal position of said first, second and third ones of said plurality of markers; and

5 comparing said average horizontal position to a previous average horizontal position of said first, second, and third ones of said plurality of markers determined for a previous image.

76. The method of claim 75 wherein said step comparing said average horizontal position comprises:

subtracting said previous horizontal average from said average horizontal position and wherein a negative number indicates left movement and a positive number indicates right movement.

15 77. The method of claim 76 wherein no horizontal movement is determined if the result is within a tolerance range.

78. The method of claim 71 wherein each of said plurality of groups representing a shape includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said method for determining a plurality of command identifiers from said shape comprises:

determining vertical movement of said shape; and

storing said vertical movement.

79. The method of claim 78 wherein said step for determining said vertical movement comprises:

determining an average vertical position of said first, second and third ones of said plurality of markers; and

5 comparing said average vertical position to a previous average vertical position of said first, second, and third ones of said plurality of markers determined for a previous image.

80. The method of claim 79 wherein said step for determining said vertical movement comprises:

determining an average vertical position of said first, second and third ones of said plurality of markers, and

15 comparing said average vertical position to a previous average vertical position of said first, second, and third ones of said plurality of markers determined for a previous image.

81. The method of claim 80 wherein said step for comparing said average horizontal position comprises:

20 subtracting said previous vertical average from said average vertical position and wherein a negative number indicates downward movement and a positive number indicates upward movement.

82. The method of claim 81 wherein no vertical movement is determined if the result is within a tolerance range.

83. The method of claim 71 wherein each of said plurality of groups representing one of said plurality of shapes includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and said step for determining a plurality of command identifiers from said shape comprise:

5 determining zoom movement of said shape, and
storing said zoom movement.

84. The method of claim 83 wherein said step for determining said zoom movement comprises:

10 determining an area of said shape defined by said first, second and third ones of said plurality of markers, and

comparing said area of said shape to a previous area of said shape defined by said first, second, and third ones of said plurality of markers determined for a previous image.

15 85. The method of claim 84 wherein said step for comparing said areas comprises:

subtracting said previous area from said area and wherein a negative number indicates zoom out and a positive number indicates zoom-in.

20 86. The method of claim 85 wherein no zoom movement is determined if the result is within a tolerance range.

87. The method of claim 71 wherein each of said plurality of groups representing one of said plurality of shapes includes a first one of said plurality of markers, a second one

of said plurality of markers, and a third one of said plurality of markers and said step for determining a plurality of command identifiers from said shape comprises:

determining pitch movement of said shape; and
storing said pitch movement.

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88. The method of claim 87 wherein said step for determining said pitch movement comprises:

determining an angle proximate said second one of said plurality of markers; and
comparing said angle to a previous angle proximate said second one of said plurality

10 of markers determined for a previous image.

89. The method of claim 88 wherein said step for comparing said average horizontal position comprises instructions for subtracting said previous angle proximate said second one of said plurality of markers from said angle proximate said second one of said plurality of markers wherein a result greater than zero indicates pitch and said step for determining said pitch further comprises:

subtracting a previous area of said second one of said plurality of markers from an area of said second one of said plurality of markers wherein a number is greater than zero indicates pitch-up and a negative number indicates pitch-down.

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90. The method of claim 89 wherein no pitch movement is determined if the result is within a tolerance range.

91. The method of claim 71 wherein each of said plurality of groups of markers representing one of said plurality of shapes includes a first one of said plurality of markers,

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a second one of said plurality of markers, and a third one of said plurality of markers and said step for determining a plurality of command identifiers from said shape comprises:

determining roll movement of said shape; and
storing said roll movement.

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92. The method of claim 91 wherein said step for determining said roll movement comprises:

determining a change in vertical position of said first and third ones of said plurality of markers; and

10 comparing said change vertical position to a previous change in vertical position of said first and third ones of said plurality of markers determined for a previous image.

93. The method of claim 92 wherein said step for comparing said vertical positions of said first and third ones of said plurality of markers comprises:

15 subtracting said previous change vertical position from said change in vertical position and wherein a negative number indicates a left roll movement and a positive number indicates right roll movement.

94. The method of claim 93 wherein no roll movement is determined if the result
20 is within a tolerance range.

95. The method of claim 71 wherein each of said plurality of groups of markers representing one of said plurality of shapes includes a first one of said plurality of markers, a second one of said plurality of markers, and a third one of said plurality of markers and
25 said step for determining a plurality of command identifiers from said shape comprises:

determining yaw movement of said shape; and
storing said pitch movement.

5 96. The method of claim 95 wherein said step for determining said yaw
movement comprises:
determining an angle proximate said first one of said plurality of markers; and
comparing said angle to a previous angle proximate said first one of said plurality of
markers determined for a previous image.

10 97. The method of claim 96 wherein if said previous angle is greater than said
angle a yaw right is determined and if said previous angle is less than said angle a yaw left
is determined.

15 98. The method of claim 97 wherein no yaw movement is determined if the
result is within a tolerance range.