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(54) **Title:** SYSTEMS, DEVICES, AND/OR METHODS FOR MANAGING ABERRATIONS

(57) **Abstract:** Certain exemplary embodiments can provide a system, machine, device, manufacture, circuit, composition of matter, and/or user interface adapted for and/or resulting from, and/or a method and/or machine-readable medium comprising machine-implementable instructions for, activities that can comprise and/or relate to, automatically tuning one or more variable-focus tunable lenses sufficiently to substantially reduce one or more higher order optical wavefront aberrations of an optical system.

Systems, Devices, and/or Methods for Managing Aberrations

Cross-References to Related Applications

- [1] This application claims priority to, and incorporates by reference herein in its entirety, International Patent Application PCT/US2012/25880, filed 21 February 2012.

Brief Description of the Drawings

- [2] A wide variety of potential practical and useful embodiments will be more readily understood through the following detailed description of certain exemplary embodiments, with reference to the accompanying exemplary drawings in which:
- [3] **FIG. 1** is a block diagram of an exemplary fluidic lens;
- [4] **FIG. 2** is a perspective view of an exemplary electro-optic lens;
- [5] **FIG. 3** is a cross-sectional view of the electro-optic lens shown in **FIG. 2**;
- [6] **FIG. 4** is a cross-sectional view of the electro-optic lens shown in **FIG. 2**;
- [7] **FIG. 5** is a cross-sectional view of the electro-optic lens shown in **FIG. 2**;
- [8] **FIG. 6** is a block diagram of an exemplary electro-optic lens;
- [9] **FIG. 7** is a block diagram of an exemplary optical system;
- [10] **FIG. 8** is a block diagram of an exemplary embodiment of a system;
- [11] **FIG. 9** is a flowchart of an exemplary embodiment of a method; and
- [12] **FIG. 10** is a block diagram of an exemplary embodiment of an information device.

Detailed Description

- [13] Certain exemplary embodiments can provide a system, machine, device, manufacture, circuit, composition of matter, and/or user interface adapted for and/or resulting from, and/or a method and/or machine-readable medium comprising machine-implementable instructions for, activities that can comprise and/or relate to, automatically tuning one or more variable-focus tunable lenses sufficiently to substantially reduce one or more higher order optical wavefront aberrations of an optical system.

- [14] Although stacking electro-optic lenses is one method for increasing the maximum optical power of an electro-optic lens module, there are other possible techniques that can be employed. These techniques can combine an electro-optic tunable liquid crystal lens with one or more other variable-focus lenses.
- [15] One type of tunable lens is a fluidic or liquid lens. These lenses can alter their shape by having a small pump push a working fluid, like water, into a cavity having a deformable membrane. As the membrane expands, the center thickness of the lens can increase, and accordingly, the optical power of the lens can increase. The reverse also can be achieved by causing the membrane to collapse inward, causing the center thickness to decrease, thereby creating negative optical power (i.e., diverging light rays after passing through the lens). Although these fluidic lenses are often able to provide many diopters of tunability, these lenses can have difficulty maintaining a high-quality spherical or parabolic shape, particularly at diameters great than 3 mm.
- [16] However, certain exemplary liquid crystal electro-optic lenses have demonstrated that they can be electrically driven to arbitrary aspheric shapes with high accuracy. Combining an electro-optic liquid crystal lens to correct the phase profile of an integrated liquid lens can provide high-power tunability over a wide range with the required accurate phase profile.
- [17] Other designs of an electro-optic liquid crystal lens can use various physical shapes to create a gradient in the electric field rather than multiple electrodes. These can vary from designs that have a non-constant thickness of liquid crystal, often a lens-shaped cavity, whereby the electric field is stronger where the liquid crystal thickness is weaker, creating a focusing gradient. Other lenses can insert various shapes of conductors or insulators into the gap between the substrates to tailor the shape of the electric field established in the liquid crystal cavity.

- [18] While these various approaches are capable of large retardances and higher optical powers, they are usually plagued with aberrations in the phase profile that increase with higher power or larger diameter. These aberrations can limit the image quality, restrict the maximum attainable aberration-free power, and/or limit the diameter of the lens to a few millimeters.
- [19] Combining an aberration-correcting multiple-electrode tunable lens with a lens based on one of these other electro-optic techniques can be another solution to providing the high optical power and short optical path along with a high-quality phase profile needed for an accurate imaging sensor system. Actual system designs may utilize more optical elements, as known to those skilled in the art of optical design. For example, the tunable lens and/or the electro-active lens can be an ophthalmic lens, such as a spectacle lens, an intra ocular lens, and/or a contact lens.
- [20] To illustrate at least some of the foregoing concepts, several exemplary drawings are now presented.
- [21] **FIG. 1** is a block diagram of an exemplary system 1000 comprising a fluidic lens 1100 onto which light rays 1200, 1300, 1400 are incident. If fluidic lens 1100 did not manifest spherical aberration, it would focus each of light rays 1200, 1300, 1400, and 1600 onto desired focal point 1500, but because fluidic lens 1100 experiences spherical aberration, it focuses light rays 1300 and 1400 onto desired focal point 1500, but focuses light rays 1200 and 1600 onto undesired focal point 1900.
- [22] **FIG. 2** is a perspective view of an exemplary electro-optic lens 2000, which can comprise at least one substrate 2100, on and/or attached to which can be one or more layers 2200 having one or more ring-like conductive electrodes 2300. Each of electrodes 2300 can be electrically coupled to a dedicated and/or semi-dedicated power source, terminal, and/or connector 2400, to which a predetermined voltage can be applied. For convenience, a second substrate, which can work in combination with substrate 2100 to sandwich electrodes 2300, is not shown.

- [23] **FIG. 3** is a cross-sectional view taken at section X-X of **FIG. 2**, showing an exemplary predetermined voltage pattern 3100 that can be applied to electrodes 2300, and showing the cross-sectional profile of an exemplary conventional optical lens 3500 that can cause a similar ~~diffraction~~ optical power pattern as lens 2000 with the predetermined voltage pattern 3100 applied.
- [24] **FIG. 4** is a cross-sectional view taken at section X-X of **FIG. 2**, showing an exemplary predetermined voltage pattern 4100 that can be applied to electrodes 2300, and showing the cross-sectional profile of an exemplary conventional optical lens 4500 that can cause a similar optical power pattern as lens 2000 with the predetermined voltage pattern 4100 applied.
- [25] **FIG. 5** is a cross-sectional view taken at section X-X of **FIG. 2**, showing an exemplary predetermined voltage pattern 5100 that can be applied to electrodes 2300, and showing the cross-sectional profile of an exemplary conventional optical lens 5500 that can cause a similar optical power pattern as lens 2000 with the predetermined voltage pattern 5100 applied.
- [26] **FIG. 6** is a block diagram showing how an exemplary conventional optical lens 5500 can refract incident light.
- [27] **FIG. 7** is a block diagram of an exemplary optical system 7000 that can combine fluidic lens 1100 of **FIG. 1** with electro-optical lens 2000 of **FIG. 2** (symbolized using the shape of conventional optical lens 5500, which can have a similar optical power). Because electro-optical lens 2000 can compensate for the spherical aberration of fluidic lens 1100, incident light rays 1200, 1300, 1400 are shown focused onto desired focal point 1500.
- [28] The method for correcting phase aberrations in an optical system can be a two-step process that can involve the measurement and/or the correction of the aberrations.

- [29] Typically, the measurement of optical aberrations requires a device known as a wavefront analyzer, a wavefront interferometer, an aberrometer, or a wavefront sensor. The most common of type is a Hartman-Shack interferometer, which has found much use in the ophthalmic industry recently to measure high-order aberrations of the human eye. Other methods include ray-tracing devices, Talbot and Talbot-Moiré devices, and Hartman-Moiré sensors. Advances in wavefront analyzers have led to very small, compact devices, capable of highly-accurate measurements of optical aberrations in optical systems, both biological and scientific, such as the Talbot system built by eVision of Roanoke, Virginia, USA and/or a WFS150-SC Shack-Hartmann Wavefront Sensor available from ThorLabs of Newton, New Jersey, USA.
- [30] These wavefront sensors can be placed in the optical path of an optical system and can measure a known light source as it passes through the system. The light source can be separate from the sensor, and can make a single pass through the optical system to be measured, or it can be part of the sensor, and can be reflected back through the optical system, making two passes through it. The sensor can compare the light wavefront before and after passing through the optical system, and can detect the aberrations imparted on the wavefront by the components in the optical system.
- [31] This measurement technique can be used in two ways: real-time or archival. In real time, the wavefront sensor can monitor the distorted wavefront and can send the measurement to a corrector, described below, which can use techniques explained below to correct the aberrated wavefront. The monitoring can be done iteratively and continuously, which might be necessary if the aberrations of the optical system are changing, for example, due to changes in environmental, ambient, and/or operating variables, such as temperature, humidity, and/or barometric pressure, changes in the optical power of the system, mechanical shock to the optical system, and/or fatigue of the fluidic membrane, etc. Alternatively, the wavefront sensor can measure the aberrations of the optical system as a function of optical power, operating cycles, membrane fatigue, and/or various environmental, ambient, and/or operating parameters, such as temperature, humidity, and/or barometric pressure, etc., and

archivally store them as a library in a memory device and/or data repository. Thus, the parameters of the system can be measured, and/or the correct and/or optimal aberration correction can be extracted from the library by the lens controller and the corrector can change appropriately.

- [32] After the aberrations of the optical system have been measured, a corrector can compensate for those aberrations on the wavefront. Several different types of aberration correctors can be employed to compensate for distorted wavefronts. Segmented mirrors, which can be tilted, panned, and/or pistoned, can be employed to correct for atmospheric distortion of laser beams which are propagated from the ground to space for communications and/or weaponry. Similar devices can be used in astronomy to correct images from distant stars and/or planets that have been distorted by atmospheric phenomena. Membrane “rubber” mirrors can be used to provide atmospheric compensation on beams of coherent light in terrestrial point-to-point laser communications systems. Membrane mirrors can be used to compensate for wavefront distortions of the eye’s optical system during ophthalmic surgery and/or retinal imaging.
- [33] The common feature of all these systems is that they can employ mirrors to perform the correction; hence, they are all reflective systems. Reflective systems typically involve longer optical paths and more complexity than transmissive systems, because the optical path is often “folded” or “turned”. Certain exemplary embodiments that utilize an electro-active variable-focus tunable liquid crystal lens can solve these problems because that lens is transmissive. That is, the light from the optical system can pass directly through the corrector lens instead of being reflected off a mirror.
- [34] The corrector can be an electro-active lens. The electro-active lens can be used to correct a fluidic lens, and can operate similarly to a membrane mirror. In the real-time correction mode, phase information about the aberrated wavefront radiating through the fluidic lens can be continuously transferred from the wavefront sensor to the electro-active corrector lens controller. The appropriate voltages then can be multiplexed to the electro-active lens’ electrodes, such that they correct the spatial phase profile of the aberrated wave, such as by negating

the aberrated aspects of the wave. Those skilled in the art of mathematical description of wavefront error often express the shapes of wavefronts in terms of a sequence of polynomials, such as one or more Fourier series, one or more Taylor series, and/or a set of Zernike Polynomials, and sometimes apply other fitting methods, such as fractals and/or singular value decomposition. For example, a detected positive value of the Fourth Order Zernike term (which often corresponds to spherical aberration), can be offset and/or corrected by a lens, such as an electro-active lens, that applies a negative spherical aberration, which also can be defined by a Fourth Order Zernike term, but with a negative and/or additive inverse value. That is, the numerically opposite value (e.g., -0.75) of a Zernike term that describes an aberrated wavefront (e.g., 0.75) can describe the required correction to that wavefront. A similar approach can be to apply a complex conjugate of the spatial phase profile of the aberrated wave via the electro-active lens. The electro-active lens thereby can compensate and/or cancel out the aberrations imparted to the wavefront from the imperfect fluidic lens. Moreover, if the aberrations imparted by the fluidic lens change temporally and/or spatially during operation, the wavefront sensor can register these changes and pass them on to the electro-active lens controller. Thus, the electro-active lens can continuously correct the distorted wave.

- [35] In the archival correction mode, the required voltages to create the appropriate correction can be determined by creating a voltage vs. phase mapping of the electro-optic lens before actual use in the optical system. This can be done in the real-time correction mode as well, with a primary difference between the two modes being that in the real-time, the phase distortion can be measured directly by the analyzer, whereas, in the archival, the phase distortion can be inferred and/or determined based on the environmental and/or systems measurements and/or the corresponding stored data. More particularly, in a laboratory setting, measurements of the aberration phase map can be measured as a function of different environmental and/or operating conditions (e.g., temperature, humidity, barometric pressure, etc.). With the archival approach, however, the voltage arrays as a function of these operating parameters can be stored in a memory device and/or data repository, which potentially can be located in the optical system. During actual operation, the operating conditions

can be monitored and/or fed to the controller, which can retrieve the correct voltages necessary to correct the aberration and/or multiplex them to the electro-active corrector lens.

- [36] In the case of a variable-focus tunable lens with concentric, circularly symmetric electrodes, typically only radially symmetric distortions of the fluidic lens, such as spherical aberration, and asphericity, can be corrected. Alternatively, an accurate spherical fluidic lens can be coupled with such an electro-active lens to impart a parabolic phase profile for improved focusing. To correct other high-order aberrations that are not radially symmetric, other tunable lens designs, employing addressable electrodes comprising grid patterns (squares, triangles, hexagons, etc), can correct radial and/or azimuthal distortions of the wavefront.
- [37] **FIG. 8** is a block diagram of an exemplary embodiment of a system 8000, which can comprise a fluidic lens 8200, which can provide optical magnification in the system 8000, but at large diameters or optical powers, the fluidic lens 8200 can cause spherical aberration. A wavefront analyzer 8300, which can be located in the optical path of fluidic lens 1200, can measure a wavefront aberration, such as that produced by fluidic lens 8200, and, as a result of that measuring, can produce a wavefront aberration phase profile. A wave can be perturbed from an ideal, such as that of a plane wave, when different portions of the wave pass through a material with a varying refractive index or pass through a material of varying thickness. Spherical aberration, which results from a wave passing through a spherical lens, can be measured by measuring a phase profile of the wave front. This measurement is referred to as a wavefront aberration phase profile. A lens controller 8400, which can be communicatively coupled to wavefront analyzer 8300, can receive the wavefront aberration phase profile. Lens controller 8400 can map the received wavefront aberration phase profile to, for example, voltage settings for addressable electrodes on a communicatively coupled variable-focus tunable lens 8100, such as an electro-optical lens, that is located in the optical path of fluidic lens 8200 (i.e., variable-focus tunable lens 8100 can be located before and/or after fluidic lens 8200 in the optical path). With the received wavefront

aberration phase profile and the corresponding tuning settings, lens controller 8400 can tune variable focus tunable lens 8100 to eliminate the measured wavefront aberration. To speed up the tuning of variable focus tunable lens 8100 in response to future received wavefront aberration phase profiles, lens controller 8400 can store wavefront aberration phase profiles and/or corresponding settings and/or environmental variable measurements associated with tuning the variable-focus tunable lens 8100, and then rapidly recall and/or approximate appropriate tuning settings in response to receiving a given wavefront aberration phase profile. The fluidic lens 8200 can be communicatively coupled to lens controller 8400 so that the lens controller 8400 is able to obtain information about the optical power of the fluidic lens 8200, by setting the fluidic lens 8200 and/or by reading configuration settings of the fluidic lens 8200, in order to correctly tune the variable focus tunable lens 8100.

- [38] The optical power and/or higher order aberrations of fluidic lens 8200 can vary with changes in environmental variables such as humidity, barometric pressure, and/or temperature. Thus, lens controller 8400 can compare and/or correlate the wavefront aberration profile and/or tuning settings with measurements of those environmental variables. Said measurements can be obtained by lens controller 8400 from a communicatively coupled environmental sensor, such as temperature sensor 8500, humidity sensor 8700, and/or pressure sensor 8800. Lens controller 8400 can record such sensor measurements with the wavefront aberration phase profiles and/or tuning settings while the wavefront analyzer is attached, and/or the settings can be stored in the memory device of the lens controller 8400. Once measurements of environmental variables are associated with the wavefront aberration phase profiles, lens controller 8400 can operate variable-focus tunable lens 8100 without wavefront analyzer 8300 attached. That is, instead of retrieving wavefront aberration measurements directly from wavefront analyzer 8200, lens controller 8400 can look up the appropriate wavefront aberration phase profile in an archive of wavefront aberration phase profiles associated with the previously obtained measurements of wavefront aberration phase profiles and environmental variables. If the exact settings for the current sensor measurements are not available, lens controller 8400 can

interpolate or otherwise approximate an appropriate tuning setting given the existing aberration and environmental measurements and/or data. A sensed change to an environmental variable and/or a signal from a timer 8600 can prompt the lens controller to calculate, retrieve, and/or request measurement of the wavefront aberration phase profile from the wavefront analyzer 8300 using current measurements of the environmental variables. Such calculation can comprise measurement of environmental variables to determine if a new wavefront aberration phase profile is appropriate.

- [39] Variable-focus tunable lens 8100 can comprise an electro-optic lens, which can be comprised of a plurality of electrically addressable electrodes, each adapted to respond to a given input voltage by changing an optical power of at least a portion of the electro-optic lens. The electro-optic lens can be tuned to change the optical power of substantially any region of the wavefront, and thereby substantially negate nearly any detected higher order wavefront aberrations. Fluidic lens 8200 can have greater optical magnification range than the electro-optic lens, but can lack the speed and tunability of the electro-optic lens. Thus, the combination of fluidic lens 8200 and variable-focus tunable lens 8100 can provide rapid optical power adjustment, low power consumption, high optical fidelity due to reduced higher order wavefront aberrations, and/or low mechanical complexity. An information device 8900 and/or lens controller 8400 can be communicatively coupled to a network 8950. Information device 8900 can receive calculations and/or measurements of the wavefront aberration phase profile, and/or provide new wavefront aberration phase profile archival data to the lens controller 8400.
- [40] **FIG. 9** is a flowchart of an exemplary embodiment of a method 9000. At activity 9100, a measurement of an environmental variable can be provided to a hardware-based controller, such as a lens controller. At activity 9200, a wavefront analyzer can measure a wavefront aberration phase profile of an optical system. At activity 9300, the hardware-based controller and/or wavefront analyzer can correlate the measured environmental variable to the received wavefront aberration phase profiles, calculated wavefront aberration phase profiles, and/or archived wavefront aberration phase profiles. At activity

9400, a wavefront aberration phase profile can be created and/or retrieved from hardware-based memory by the hardware-based controller and/or the wavefront analyzer. At activity 9500, the lens controller and/or wavefront analyzer can create a complex conjugate and/or additive inverse Zernike terms of the wavefront aberration phase profile. At activity 9600, the complex conjugate and/or additive inverse Zernike terms of the wavefront aberration phase profile can be mapped by the lens controller to voltages that can be applied by the lens controller to the electrically addressable electrodes of the variable-focus tunable lens to substantially nullify the wavefront aberration phase profile of an optical system. At activity 9700, the hardware-based lens controller can tune the variable-focus tunable lens using previous measurements and/or calculations of the wavefront aberration phase profile of the optical system. At activity 9800, the resulting optical wavefront aberrations of the optical system can be substantially reduced.

- [41] **FIG. 10** is a block diagram of an exemplary embodiment of an information device 10000, which in certain operative embodiments can comprise, for example, lens controller 8400 of **FIG. 8**. Information device 10000 can comprise any of numerous transform circuits, which can be formed via any of numerous communicatively-, electrically-, magnetically-, optically-, fluidically-, and/or mechanically-coupled physical components, such as for example, one or more network interfaces 10100, one or more processors 10200, one or more memories 10300 containing instructions 10400, one or more input/output (I/O) devices 10500, and/or one or more user interfaces 10600 coupled to I/O device 10500, etc.
- [42] In certain exemplary embodiments, via one or more user interfaces 10600, such as a graphical user interface, a user can view a rendering of information related to researching, designing, modeling, creating, developing, building, manufacturing, operating, maintaining, storing, marketing, selling, delivering, selecting, specifying, requesting, ordering, receiving, returning, rating, and/or recommending any of the products, services, methods, user interfaces, and/or information described herein.

- [43] One example of an optical system that can benefit from certain concepts, devices, and/or technique described above is a phoropter (refractor, refractometer). A phoropter can employ standard fixed-focus lenses, electro-optic variable-focus lenses, and/or variable-focus fluidic lenses, etc.. Certain exemplary embodiments can measure the patient's high-order aberrations, as well as correct for them, during an examination. This can allow the patient to perceive the outcome of custom refractive surgery before undergoing the procedure.
- [44] Incorporating, for example, a combination of one or more variable fluidic lenses and one or more variable-electro-optic lenses with a wavefront analyzer can allow an eye care professional to simultaneously measure both conventional and high-order aberrations of the eye, whether they are caused by the cornea, crystalline lens, and/or ocular fluids, etc. A distorted phase profile output of the wavefront analyzer looking through the eye's optical system can be communicated to the lens controller, as shown in **FIG. 1**, and/or the appropriate data can be supplied to the one or more variable-focus lenses to correct the aberrated wavefront.
- [45] For example, a patient might suffer from positive spherical aberration where the optical power of the eye is greater at the periphery of the optical zone than in the center. This can be detected and/or quantified by a wavefront sensor, expressed in, for example, terms of Zernike Polynomials. A positive value of the Fourth Order Zernike term (which is spherical aberration), that is detected in the patient then can be offset and/or corrected by a lens with negative spherical aberration, which also can be defined by a Fourth Order Zernike Polynomial term, but with a negative value.

Definitions

- [46] When the following phrases are used substantively herein, the accompanying definitions apply. These phrases and definitions are presented without prejudice, and, consistent with the application, the right to redefine these phrases via amendment during the prosecution of this application or any application claiming priority hereto is reserved. For the purpose of interpreting

a claim of any patent that claims priority hereto, each definition in that patent functions as a clear and unambiguous disavowal of the subject matter outside of that definition.

[47] **a** – at least one.

[48] **aberration** – one or more limitations and/or defects in an optical component, such as a lens and/or mirror, that is contacted by a plurality of light rays, such limitations and/or defects preventing the light rays from converging at one focus and potentially due to, e.g., the optical component comprising one or more surfaces that are not perfectly planar, such as one or more spherical surfaces.

[49] **activity** – an action, act, step, and/or process or portion thereof.

[50] **adapted to** – suitable, fit, and/or capable of performing a specified function.

[51] **adapter** – a device used to effect operative compatibility between different parts of one or more pieces of an apparatus or system.

[52] **address** – (n.) one or more identifiers, such as one or more symbols, characters, names, and/or numbers, used for identification in information transmission, storage, and/or retrieval, the one or more identifiers assignable to a specific physical, logical, and/or virtual machine, process, node, object, entity, record, data element, component, port, interface, location, link, route, circuit, and/or network; (v.) to locate, access, assign, and/or provide an identifier a specific physical, logical, and/or virtual machine, process, node, object, entity, record, data element, component, port, interface, location, link, route, circuit, and/or network.

[53] **addressable** – relating to and/or denoting a memory device in which substantially all storage locations can be separately accessed by machine-implementable instructions.

[54] **air pressure** – a measure of compression of air in a given state relative to a standard state.

[55] **analyzer** – a processor.

[56] **and/or** – either in conjunction with or in alternative to.

[57] **apparatus** – an appliance or device for a particular purpose

[58] **associate** – to join, connect together, and/or relate.

- [59] **automatic** - performed via an information device in a manner essentially independent of influence and/or control by a user. For example, an automatic light switch can turn on upon “seeing” a person in its “view”, without the person manually operating the light switch.
- [60] **Boolean logic** – a complete system for logical operations.
- [61] **by** – via and/or with the use and/or help of.
- [62] **calculate** – to determine something via mathematical and/or logical methods.
- [63] **can** – is capable of, in at least some embodiments.
- [64] **cause** – to bring about, provoke, precipitate, produce, elicit, be the reason for, result in, and/or effect.
- [65] **circle** – a line of constant non-zero curvature
- [66] **circuit** – a physical system comprising, depending on context: an electrically conductive pathway, an information transmission mechanism, and/or a communications connection, the pathway, mechanism, and/or connection established via a switching device (such as a switch, relay, transistor, and/or logic gate, etc.); and/or an electrically conductive pathway, an information transmission mechanism, and/or a communications connection, the pathway, mechanism, and/or connection established across two or more switching devices comprised by a network and between corresponding end systems connected to, but not comprised by the network.
- [67] **claim** – (n) an assertion of a right to and/or responsibility for something; (v) to assert a right to and/or responsibility for something.
- [68] **communication** – a transmission and/or exchange of information.
- [69] **complex** – an expression comprising a real component and/or an imaginary component.
- [70] **complex conjugate** – each of two complex numbers having their real parts identical and their imaginary parts of equal magnitude but opposite sign.
- [71] **composed** – (of elements) constitute and/or make up (a whole)
- [72] **comprises** – includes, but is not limited to, what follows.
- [73] **comprising** – including but not limited to.
- [74] **concentric** – having a common central axis.

- [75] **configure** – to make suitable or fit for a specific use or situation.
- [76] **conjugate** – a mathematical value or entity having a reciprocal relationship with another.
- [77] **connect** – to join and/or fasten together.
- [78] **containing** – including but not limited to.
- [79] **controller** – a device and/or set of machine-readable instructions for performing one or more predetermined and/or user-defined tasks. A controller can comprise any one or a combination of hardware, firmware, and/or software. A controller can utilize mechanical, pneumatic, hydraulic, electrical, magnetic, optical, informational, chemical, and/or biological principles, signals, and/or inputs to perform the task(s). In certain embodiments, a controller can act upon information by manipulating, analyzing, modifying, converting, transmitting the information for use by an executable procedure and/or an information device, and/or routing the information to an output device. A controller can be a central processing unit, a local controller, a remote controller, parallel controllers, and/or distributed controllers, etc. The controller can be a general-purpose microcontroller, such the Pentium IV series of microprocessor manufactured by the Intel Corporation of Santa Clara, California, and/or the HC08 series from Motorola of Schaumburg, Illinois. In another embodiment, the controller can be an Application Specific Integrated Circuit (ASIC) or a Field Programmable Gate Array (FPGA) that has been designed to implement in its hardware and/or firmware at least a part of an embodiment disclosed herein.
- [80] **convert** – to transform, adapt, and/or change.
- [81] **couple** – to join, connect, and/or link together in some fashion.
- [82] **create** – to make, form, produce, generate, bring into being, and/or cause to exist.
- [83] **data** – distinct pieces of information, usually formatted in a special or predetermined way and/or organized to express concepts, and/or represented in a form suitable for processing by an information device.
- [84] **data structure** – an organization of a collection of data that allows the data to be manipulated effectively and/or a logical relationship among

data elements that is designed to support specific data manipulation functions. A data structure can comprise meta data to describe the properties of the data structure. Examples of data structures can include: array, dictionary, graph, hash, heap, linked list, matrix, object, queue, ring, stack, tree, and/or vector.

- [85] **define** – to establish the outline, form, and/or structure of.
- [86] **determine** – to find out, obtain, calculate, decide, deduce, ascertain, and/or come to a decision, typically by investigation, reasoning, and/or calculation.
- [87] **deviation** – a variation relative to a standard, expected value, and/or expected range of values.
- [88] **device** – a machine, manufacture, and/or collection thereof.
- [89] **digital** – non-analog and/or discrete.
- [90] **electro-active** – a branch of technology concerning the interaction between various properties and electrical and/or electronic states of materials and/or involving components, devices, systems, and/or processes that operate by modifying the certain properties of a material by applying to it an electrical and/or magnetic field. Sub-branches of this technology include, but are not limited to, electro-optics.
- [91] **electro-active element** – a component that utilizes an electro-active effect, such as an electro-active filter, reflector, lens, shutter, liquid crystal retarder, active (i.e., non-passive) polarity filter, electro-active element that is movable via an electro-active actuator, and/or conventional lens movable by an electro-active actuator.
- [92] **electro-optic** – a branch of technology concerning the interaction between the optical and the electronic states of materials and/or involving components, devices, systems, and/or processes that operate by modifying the optical properties of a material by applying to it an electrical field.
- [93] **electrode** – a conductor through which electrons enter and/or leave an object, substance, and/or region.
- [94] **environment** – surrounding conditions and/or external conditions that affect a specified system during its lifetime.

- [95] **environmental variable** – a variable concerning a situation around a machine and/or predetermined thing.
- [96] **estimate** – (n) a calculated value approximating an actual value; (v) to calculate and/or determine approximately and/or tentatively.
- [97] **fluid** – a gas and/or liquid.
- [98] **from** – used to indicate a source, origin, and/or location thereof.
- [99] **further** – in addition.
- [100] **generate** – to create, produce, give rise to, and/or bring into existence.
- [101] **grid** – a network of lines, real or conceptual, that cross each other to form a series of regular shapes.
- [102] **hardware-based** – adapted to utilize one or more non-human physical components comprised by a system such as an information device.
- [103] **have** – to be made up of; comprise.
- [104] **having** – including but not limited to.
- [105] **higher** – greater than.
- [106] **human-machine interface** – hardware and/or software adapted to render information to a user and/or receive information from the user; and/or a user interface.
- [107] **humidity** – a quantity representing the amount of water vapor in the atmosphere or a gas.
- [108] **ideal** – representing an optimum, whether abstract, hypothetical, and/or real.
- [109] **including** – including but not limited to.
- [110] **incorporate** – to comprise.
- [111] **information device** – any device capable of processing data and/or information, such as any general purpose and/or special purpose computer, such as a personal computer, workstation, server, minicomputer, mainframe, supercomputer, computer terminal, laptop, tablet computer (such as an iPad-like device), wearable computer, Personal Digital Assistant (PDA), mobile terminal, Bluetooth device, communicator, “smart” phone (such as an iPhone-like device), messaging service (e.g., Blackberry) receiver, pager, facsimile, cellular telephone, traditional telephone, telephonic device, embedded controller, programmed microprocessor or microcontroller and/or peripheral

integrated circuit elements, ASIC or other integrated circuit, hardware electronic logic circuit such as a discrete element circuit, and/or programmable logic device such as a PLD, PLA, FPGA, or PAL, or the like, etc. In general, any device on which resides a finite state machine capable of implementing at least a portion of a method, structure, and/or or graphical user interface described herein may be used as an information device. An information device can comprise components such as one or more network interfaces, one or more processors, one or more memories containing instructions, and/or one or more input/output (I/O) devices, one or more user interfaces coupled to an I/O device, etc. In information device can be a component of and/or augment another device, such as an appliance, machine, tool, robot, vehicle, television, printer, “smart” utility meter, etc.

- [112] **initialize** – to prepare something for use and/or some future event.
- [113] **input/output (I/O) device** - any device adapted to provide input to, and /or receive output from, an information device. Examples can include an audio, visual, haptic, olfactory, and/or taste-oriented device, including, for example, a monitor, display, projector, overhead display, keyboard, keypad, mouse, trackball, joystick, gamepad, wheel, touchpad, touch panel, pointing device, microphone, speaker, video camera, camera, scanner, printer, switch, relay, haptic device, vibrator, tactile simulator, and/or tactile pad, potentially including a port to which an I/O device can be attached or connected.
- [114] **install** – to connect or set in position and prepare for use.
- [115] **instructions** – directions, which can be implemented as hardware, firmware, and/or software, the directions adapted to perform a particular operation and/or function via creation and/or maintenance of a predetermined physical circuit.
- [116] **internal** – inner parts and/or features of a specified object.
- [117] **lens** – a piece of transparent substance, often glass and/or plastic, having two opposite surfaces either both curved or one curved and one plane, used in an optical device for changing the convergence and/or focal point of light rays; and/or an optical device that transmits light and is adapted to cause the light to refract, concentrate, and/or diverge. A lens

can be an ophthalmic lens, such as a spectacle lens, an intra ocular lens, and/or a contact lens.

[118] **logic gate** – a physical device adapted to perform a logical operation on one or more logic inputs and to produce a single logic output, which is manifested physically. Because the output is also a logic-level value, an output of one logic gate can connect to the input of one or more other logic gates, and via such combinations, complex operations can be performed. The logic normally performed is Boolean logic and is most commonly found in digital circuits. The most common implementations of logic gates are based on electronics using resistors, transistors, and/or diodes, and such implementations often appear in large arrays in the form of integrated circuits (a.k.a., IC's, microcircuits, microchips, silicon chips, and/or chips). It is possible, however, to create logic gates that operate based on vacuum tubes, electromagnetics (e.g., relays), mechanics (e.g., gears), fluidics, optics, chemical reactions, and/or DNA, including on a molecular scale. Each electronically-implemented logic gate typically has two inputs and one output, each having a logic level or state typically physically represented by a voltage. At any given moment, every terminal is in one of the two binary logic states (“false” (a.k.a., “low” or “0”) or “true” (a.k.a., “high” or “1”), represented by different voltage levels, yet the logic state of a terminal can, and generally does, change often, as the circuit processes data. . Thus, each electronic logic gate typically requires power so that it can source and/or sink currents to achieve the correct output voltage. Typically, machine-implementable instructions are ultimately encoded into binary values of “0”s and/or “1”s and, are typically written into and/or onto a memory device, such as a “register”, which records the binary value as a change in a physical property of the memory device, such as a change in voltage, current, charge, phase, pressure, weight, height, tension, level, gap, position, velocity, momentum, force, temperature, polarity, magnetic field, magnetic force, magnetic orientation, reflectivity, molecular linkage, molecular weight, etc. An exemplary register might store a value of “01101100”, which encodes a total of 8 “bits” (one byte), where each value of either “0” or

“1” is called a “bit” (and 8 bits are collectively called a “byte”). Note that because a binary bit can only have one of two different values (either “0” or “1”), any physical medium capable of switching between two saturated states can be used to represent a bit. Therefore, any physical system capable of representing binary bits is able to represent numerical quantities, and potentially can manipulate those numbers via particular encoded machine-implementable instructions. This is one of the basic concepts underlying digital computing. At the register and/or gate level, a computer does not treat these “0”s and “1”s as numbers per se, but typically as voltage levels (in the case of an electronically-implemented computer), for example, a high voltage of approximately +3 volts might represent a “1” or “logical true” and a low voltage of approximately 0 volts might represent a “0” or “logical false” (or vice versa, depending on how the circuitry is designed). These high and low voltages (or other physical properties, depending on the nature of the implementation) are typically fed into a series of logic gates, which in turn, through the correct logic design, produce the physical and logical results specified by the particular encoded machine-implementable instructions. For example, if the encoding request a calculation, the logic gates might add the first two bits of the encoding together, produce a result “1” (“0” + “1” = “1”), and then write this result into another register for subsequent retrieval and reading. Or, if the encoding is a request for some kind of service, the logic gates might in turn access or write into some other registers which would in turn trigger other logic gates to initiate the requested service.

[119] **logical** – a conceptual representation.

[120] **machine-implementable instructions** – directions adapted to cause a machine, such as an information device, to perform one or more particular activities, operations, and/or functions via forming a particular physical circuit. The directions, which can sometimes form an entity called a “processor”, “kernel”, “operating system”, “program”, “application”, “utility”, “subroutine”, “script”, “macro”, “file”, “project”, “module”, “library”, “class”, and/or “object”, etc., can be embodied and/or encoded as machine code, source code, object code,

compiled code, assembled code, interpretable code, and/or executable code, etc., in hardware, firmware, and/or software.

- [121] **machine-readable medium** – a physical structure from which a machine, such as an information device, computer, microprocessor, and/or controller, etc., can store and/or obtain one or more machine-implementable instructions, data, and/or information. Examples include a memory device, punch card, player-piano scroll, etc.
- [122] **magnification** – the magnifying power of a device.
- [123] **manage** – to exert control over.
- [124] **mathematical** – of or relating to mathematics
- [125] **may** – is allowed and/or permitted to, in at least some embodiments.
- [126] **measurement** – a value of a variable, the value determined by manual and/or automatic observation.
- [127] **memory device** – an apparatus capable of storing, sometimes permanently, machine-implementable instructions, data, and/or information, in analog and/or digital format. Examples include at least one non-volatile memory, volatile memory, register, relay, switch, Random Access Memory, RAM, Read Only Memory, ROM, flash memory, magnetic media, hard disk, floppy disk, magnetic tape, optical media, optical disk, compact disk, CD, digital versatile disk, DVD, and/or raid array, etc. The memory device can be coupled to a processor and/or can store and provide instructions adapted to be executed by processor, such as according to an embodiment disclosed herein.
- [128] **method** – one or more acts that are performed upon subject matter to be transformed to a different state or thing and/or are tied to a particular apparatus, said one or more acts not a fundamental principal and not pre-empting all uses of a fundamental principal.
- [129] **model** – a mathematical and/or schematic description of an entity and/or system.
- [130] **more** – additional.
- [131] **multiple** – more than one.
- [132] **network** – a communicatively coupled plurality of nodes, communication devices, and/or information devices. Via a network, such nodes and/or devices can be linked, such as via various wireline

and/or wireless media, such as cables, telephone lines, power lines, optical fibers, radio waves, and/or light beams, etc., to share resources (such as printers and/or memory devices), exchange files, and/or allow electronic communications therebetween. A network can be and/or can utilize any of a wide variety of sub-networks and/or protocols, such as a circuit switched, public-switched, packet switched, connection-less, wireless, virtual, radio, data, telephone, twisted pair, POTS, non-POTS, DSL, cellular, telecommunications, video distribution, cable, radio, terrestrial, microwave, broadcast, satellite, broadband, corporate, global, national, regional, wide area, backbone, packet-switched TCP/IP, IEEE 802.03, Ethernet, Fast Ethernet, Token Ring, local area, wide area, IP, public Internet, intranet, private, ATM, Ultra Wide Band (UWB), Wi-Fi, BlueTooth, Airport, IEEE 802.11, IEEE 802.11a, IEEE 802.11b, IEEE 802.11g, X-10, electrical power, 3G, 4G, multi-domain, and/or multi-zone sub-network and/or protocol, one or more Internet service providers, one or more network interfaces, and/or one or more information devices, such as a switch, router, and/or gateway not directly connected to a local area network, etc., and/or any equivalents thereof.

- [133] **network interface** – any physical and/or logical device, system, and/or process capable of coupling an information device to a network. Exemplary network interfaces comprise a telephone, cellular phone, cellular modem, telephone data modem, fax modem, wireless transceiver, communications port, Ethernet card, cable modem, digital subscriber line interface, bridge, hub, router, or other similar device, software to manage such a device, and/or software to provide a function of such a device.
- [134] **normal** – the usual, average, and/or typical state and/or condition.
- [135] **one** – a singular item.
- [136] **operation** – a series of actions in performing a function.
- [137] **optical** – of or relating to light, sight, and/or a visual representation.
- [138] **optical communication** – an optical conveyance of information from one location to another.

- [139] **optical system** – a combination of two or more optical elements adapted to communicate optically. Optical elements can comprise synthetic elements such as static or electro-active mirrors, glass lenses, and/or electro-optic lenses, etc., and/or non-synthetic elements such as a retina, cornea, aqueous humour, vitreous humour, and/or organic lenses, etc.
- [140] **order** – a sequence.
- [141] **packet** – a generic term for a bundle of data organized in a specific way for transmission, such as within and/or across a network, such as a digital packet-switching network, and comprising the data to be transmitted and certain control information, such as a destination address.
- [142] **pattern** – a form and/or sequence arranged in and/or constituting a definite repeating occurrence.
- [143] **perceptible** – capable of being perceived by the human senses.
- [144] **phase** – a relationship in time between successive states and/or cycles of an oscillating and/or repeating system (such as an alternating electric current, one or more light waves, and/or a sound wave) and: a fixed reference point; the states of another system; and/or the cycles of another system.
- [145] **photon** – a particle representing a quantum of light and/or other electromagnetic radiation, the particle having zero rest mass and carrying energy proportional to the frequency of the radiation.
- [146] **physical** – tangible, real, and/or actual.
- [147] **physically** – existing, happening, occurring, acting, and/or operating in a manner that is tangible, real, and/or actual.
- [148] **plurality** – the state of being plural and/or more than one.
- [149] **point** – (n.) a defined physical and/or logical location in at least a two-dimensional system and/or an element in a geometrically described set and/or a measurement or representation of a measurement having a time coordinate and a non-time coordinate. (v.) to indicate a position and/or direction of.
- [150] **polynomial** – a mathematical combination of terms, such as $4x^2+3x-7$, where $4x^2$ is the leading term, 7 is a constant term, and the exponent on a term can be said to describe its “degree” or “order”.

- [151] **power** – a measure of an ability of a vision system, eye, lens, and/or lens-assisted eye, to refract, magnify, separate, converge, and/or diverge; and/or a general term that may refer to any power such as effective, equivalent, dioptric, focal, refractive, surface, and/or vergence power.
- [152] **pre-** – a prefix that precedes an activity that has occurred beforehand and/or in advance.
- [153] **predetermined** – established in advance.
- [154] **probability** – a quantitative representation of a likelihood of an occurrence.
- [155] **processor** – a machine that utilizes hardware, firmware, and/or software and is physically adaptable to perform, via Boolean logic operating on a plurality of logic gates that form particular physical circuits, a specific task defined by a set of machine-implementable instructions. A processor can utilize mechanical, pneumatic, hydraulic, electrical, magnetic, optical, informational, chemical, and/or biological principles, mechanisms, adaptations, signals, inputs, and/or outputs to perform the task(s). In certain embodiments, a processor can act upon information by manipulating, analyzing, modifying, and/or converting it, transmitting the information for use by machine-implementable instructions and/or an information device, and/or routing the information to an output device. A processor can function as a central processing unit, local controller, remote controller, parallel controller, and/or distributed controller, etc. Unless stated otherwise, the processor can be a general-purpose device, such as a microcontroller and/or a microprocessor, such the Pentium family of microprocessor manufactured by the Intel Corporation of Santa Clara, California. In certain embodiments, the processor can be dedicated purpose device, such as an Application Specific Integrated Circuit (ASIC) or a Field Programmable Gate Array (FPGA) that has been designed to implement in its hardware and/or firmware at least a part of an embodiment disclosed herein. A processor can reside on and use the capabilities of a controller.
- [156] **profile** – a graphical and/or other representation of information relating to a particular characteristic of something, and/or a quantified form of: a

record; a representation; an outline; and/or a description of an object, structure, and/or surface.

- [157] **project** – to calculate, estimate, and/or predict.
- [158] **prompt** – to advise and/or remind.
- [159] **provide** – to furnish, supply, give, and/or make available.
- [160] **receive** – to get as a signal, take, acquire, and/or obtain.
- [161] **recommend** – to suggest, praise, commend, and/or endorse.
- [162] **reduce** – to make and/or become lesser and/or smaller.
- [163] **render** – to, e.g., physically, chemically, biologically, electronically, electrically, magnetically, optically, acoustically, fluidically, and/or mechanically, etc., transform information into a form perceptible to a human as, for example, data, commands, text, graphics, audio, video, animation, and/or hyperlinks, etc., such as via a visual, audio, and/or haptic, etc., means and/or depiction, such as via a display, monitor, electric paper, ocular implant, cochlear implant, speaker, vibrator, shaker, force-feedback device, stylus, joystick, steering wheel, glove, blower, heater, cooler, pin array, tactile touchscreen, etc.
- [164] **repeatedly** – again and again; repetitively.
- [165] **representation** – an approximation, equivalent, mathematical characterization, rendering, image, and/or likeness of something.
- [166] **request** – to express a desire for and/or ask for.
- [167] **response** – a reaction, reply, and/or answer to an influence and/or impetus.
- [168] **result** – an outcome and/or consequence of a particular action, operation, and/or course.
- [169] **revise** – to modify and/or change in a manner that results in a new version.
- [170] **same** – substantially identical; not substantially different; substantially unchanged; and/or of an identical type.
- [171] **select** – to make a choice or selection from alternatives.
- [172] **sensor** – a device adapted to automatically sense, perceive, detect, and/or measure a physical property (e.g., pressure, temperature, flow, mass, heat, light, sound, humidity, proximity, position, velocity, vibration, loudness, voltage, current, capacitance, resistance, inductance,

magnetic flux, and/or electro-magnetic radiation, etc.) and convert that physical quantity into a signal. Examples include position sensors, proximity switches, strain gages, photo sensors, thermocouples, level indicating devices, speed sensors, accelerometers, electrical voltage indicators, electrical current indicators, on/off indicators, and/or flowmeters, etc.

- [173] **server** – an information device and/or a process running thereon, that is adapted to be communicatively coupled to a network and that is adapted to provide at least one service for at least one client, i.e., for at least one other information device communicatively coupled to the network and/or for at least one process running on another information device communicatively coupled to the network. One example is a file server, which has a local drive and services requests from remote clients to read, write, and/or manage files on that drive. Another example is an e-mail server, which provides at least one program that accepts, temporarily stores, relays, and/or delivers e-mail messages. Still another example is a database server, which processes database queries. Yet another example is a device server, which provides networked and/or programmable: access to, and/or monitoring, management, and/or control of, shared physical resources and/or devices, such as information devices, printers, modems, scanners, projectors, displays, lights, cameras, security equipment, proximity readers, card readers, kiosks, POS/retail equipment, phone systems, residential equipment, HVAC equipment, medical equipment, laboratory equipment, industrial equipment, machine tools, pumps, fans, motor drives, scales, programmable logic controllers, sensors, data collectors, actuators, alarms, annunciators, and/or input/output devices, etc.

- [174] **set** – a related plurality.

- [175] **signal** – (v) to communicate; (n) one or more automatically detectable variations in a physical variable, such as a pneumatic, hydraulic, acoustic, fluidic, mechanical, electrical, magnetic, optical, chemical, and/or biological variable, such as power, energy, pressure, flowrate, viscosity, density, torque, impact, force, frequency, phase, voltage, current, resistance, magnetomotive force, magnetic field intensity,

magnetic field flux, magnetic flux density, reluctance, permeability, index of refraction, optical wavelength, polarization, reflectance, transmittance, phase shift, concentration, and/or temperature, etc., that can encode information, such as machine-implementable instructions for activities and/or one or more letters, words, characters, symbols, signal flags, visual displays, and/or special sounds, etc., having prearranged meaning. Depending on the context, a signal and/or the information encoded therein can be synchronous, asynchronous, hard real-time, soft real-time, non-real time, continuously generated, continuously varying, analog, discretely generated, discretely varying, quantized, digital, broadcast, multicast, unicast, transmitted, conveyed, received, continuously measured, discretely measured, processed, encoded, encrypted, multiplexed, modulated, spread, de-spread, demodulated, detected, de-multiplexed, decrypted, and/or decoded, etc.

- [176] **similar** – related in appearance, structure, activities, properties, and/or function.
- [177] **special purpose computer** – a computer and/or information device comprising a processor device having a plurality of logic gates, whereby at least a portion of those logic gates, via implementation of specific machine-implementable instructions by the processor, experience a change in at least one physical and measurable property, such as a voltage, current, charge, phase, pressure, weight, height, tension, level, gap, position, velocity, momentum, force, temperature, polarity, magnetic field, magnetic force, magnetic orientation, reflectivity, molecular linkage, molecular weight, etc., thereby directly tying the specific machine-implementable instructions to the logic gate's specific configuration and property(ies). In the context of an electronic computer, each such change in the logic gates creates a specific electrical circuit, thereby directly tying the specific machine-implementable instructions to that specific electrical circuit.
- [178] **special purpose processor** – a processor device, having a plurality of logic gates, whereby at least a portion of those logic gates, via implementation of specific machine-implementable instructions by the processor, experience a change in at least one physical and measurable

property, such as a voltage, current, charge, phase, pressure, weight, height, tension, level, gap, position, velocity, momentum, force, temperature, polarity, magnetic field, magnetic force, magnetic orientation, reflectivity, molecular linkage, molecular weight, etc., thereby directly tying the specific machine-implementable instructions to the logic gate's specific configuration and property(ies). In the context of an electronic computer, each such change in the logic gates creates a specific electrical circuit, thereby directly tying the specific machine-implementable instructions to that specific electrical circuit.

- [179] **state** – a qualitative and/or quantitative description of condition.
- [180] **stimulus** – a thing that rouses activity and/or energy in something.
- [181] **store** – to place, hold, and/or retain data, typically in a memory.
- [182] **substantially** – to a great extent and/or degree.
- [183] **sufficiently** – to a degree necessary to achieve a predetermined result.
- [184] **support** – to bear the weight of, especially from below.
- [185] **surface** – any face and/or outer boundary of a body, object, and/or thing.
- [186] **switch** – (v) to: form, open, and/or close one or more circuits; form, complete, and/or break an electrical and/or informational path; select a path and/or circuit from a plurality of available paths and/or circuits; and/or establish a connection between disparate transmission path segments in a network (or between networks); (n) a physical device, such as a mechanical, electrical, and/or electronic device, that is adapted to switch.
- [187] **system** – a collection of mechanisms, devices, machines, articles of manufacture, processes, data, and/or instructions, the collection designed to perform one or more specific functions.
- [188] **temperature** – measure of the average kinetic energy of the molecules in a sample of matter, expressed in terms of units or degrees designated on a standard scale.
- [189] **term** – a component of a polynomial, the component formed from one or more variables raised to whole-number exponents and not appearing in the denominator of any fractions.

- [190] **timer** – a device that measures or records the amount of time taken by, and/or required to complete, a process and/or one or more activities.
- [191] **timestamp** – a quantitative representation of a time associated with an event.
- [192] **transform** – to change in measurable: form, appearance, nature, and/or character.
- [193] **transmit** – to send as a signal, provide, furnish, and/or supply.
- [194] **tunable** – capable of being tuned.
- [195] **tune** – to adjust and/or adapt a specified optic in a manner which cannot be characterized by a simple scalar quantity to a particular purpose and/or situation. In the present embodiment the adjustment includes changing one or more electrical properties at one or more addressable electrodes of an electro-active lens, the electrical properties comprising voltage, current, resistance, and/or magnetic flux, etc, the addressable electrodes corresponding to a specific region of the specified optic.
- [196] **user interface** - any device for rendering information to a user and/or requesting information from the user. A user interface includes at least one of textual, graphical, audio, video, animation, and/or haptic elements. A textual element can be provided, for example, by a printer, monitor, display, projector, etc. A graphical element can be provided, for example, via a monitor, display, projector, and/or visual indication device, such as a light, flag, beacon, etc. An audio element can be provided, for example, via a speaker, microphone, and/or other sound generating and/or receiving device. A video element or animation element can be provided, for example, via a monitor, display, projector, and/or other visual device. A haptic element can be provided, for example, via a very low frequency speaker, vibrator, tactile stimulator, tactile pad, simulator, keyboard, keypad, mouse, trackball, joystick, gamepad, wheel, touchpad, touch panel, pointing device, and/or other haptic device, etc. A user interface can include one or more textual elements such as, for example, one or more letters, number, symbols, etc. A user interface can include one or more graphical elements such as, for example, an image, photograph, drawing, icon, window, title bar, panel, sheet, tab, drawer, matrix, table, form, calendar, outline view,

frame, dialog box, static text, text box, list, pick list, pop-up list, pull-down list, menu, tool bar, dock, check box, radio button, hyperlink, browser, button, control, palette, preview panel, color wheel, dial, slider, scroll bar, cursor, status bar, stepper, and/or progress indicator, etc. A textual and/or graphical element can be used for selecting, programming, adjusting, changing, specifying, etc. an appearance, background color, background style, border style, border thickness, foreground color, font, font style, font size, alignment, line spacing, indent, maximum data length, validation, query, cursor type, pointer type, auto-sizing, position, and/or dimension, etc. A user interface can include one or more audio elements such as, for example, a volume control, pitch control, speed control, voice selector, and/or one or more elements for controlling audio play, speed, pause, fast forward, reverse, etc. A user interface can include one or more video elements such as, for example, elements controlling video play, speed, pause, fast forward, reverse, zoom-in, zoom-out, rotate, and/or tilt, etc. A user interface can include one or more animation elements such as, for example, elements controlling animation play, pause, fast forward, reverse, zoom-in, zoom-out, rotate, tilt, color, intensity, speed, frequency, appearance, etc. A user interface can include one or more haptic elements such as, for example, elements utilizing tactile stimulus, force, pressure, vibration, motion, displacement, temperature, etc.

- [197] **variable** – (n) a property, parameter, and/or characteristic capable of assuming any of an associated set of values; and/or (adj.) likely to change and/or vary; subject to variation; and/or changeable.
- [198] **variable-focus** – having the quality of adjustable focus in a single specified optic.
- [199] **via** – by way of and/or utilizing.
- [200] **wavefront** – a surface containing points affected in substantially the same way by a wave at a substantially predetermined time.
- [201] **Zernike polynomials** – a sequence of polynomials that are commonly used to describe wavefronts and/or to describe aberrations of an optical component from an ideal spherical shape, those aberrations resulting in refraction errors. Zernike polynomials are one of an infinite number

of complete sets of polynomials in two variables, such as rho and theta, that are orthogonal in a continuous fashion over the interior of a unit circle.

[202] **Zernike term** – a term of a Zernike polynomial, such as a Z4 value of 0.8 microns, meaning a fourth degree or order Zernike spherical aberration term having value of 0.8 microns.

Note

[203] Various substantially and specifically practical and useful exemplary embodiments of the claimed subject matter are described herein, textually and/or graphically, including the best mode, if any, known to the inventor(s), for implementing the claimed subject matter by persons having ordinary skill in the art. Any of numerous possible variations (e.g., modifications, augmentations, embellishments, refinements, and/or enhancements, etc.), details (e.g., species, aspects, nuances, and/or elaborations, etc.), and/or equivalents (e.g., substitutions, replacements, combinations, and/or alternatives, etc.) of one or more embodiments described herein might become apparent upon reading this document to a person having ordinary skill in the art, relying upon his/her expertise and/or knowledge of the entirety of the art and without exercising undue experimentation. The inventor(s) expects skilled artisans to implement such variations, details, and/or equivalents as appropriate, and the inventor(s) therefore intends for the claimed subject matter to be practiced other than as specifically described herein. Accordingly, as permitted by law, the claimed subject matter includes and covers all variations, details, and equivalents of that claimed subject matter. Moreover, as permitted by law, every combination of the herein described characteristics, functions, activities, substances, and/or structural elements, and all possible variations, details, and equivalents thereof, is encompassed by the claimed subject matter unless otherwise clearly indicated herein, clearly and specifically disclaimed, or otherwise clearly contradicted by context.

[204] The use of any and all examples, or exemplary language (e.g., “such as”) provided herein, is intended merely to better illuminate one or more embodiments and does not pose a limitation on the scope of any claimed subject

matter unless otherwise stated. No language herein should be construed as indicating any non-claimed subject matter as essential to the practice of the claimed subject matter.

[205] Thus, regardless of the content of any portion (e.g., title, field, background, summary, description, abstract, drawing figure, etc.) of this document, unless clearly specified to the contrary, such as via explicit definition, assertion, or argument, or clearly contradicted by context, with respect to any claim, whether of this document and/or any claim of any document claiming priority hereto, and whether originally presented or otherwise:

[206] there is no requirement for the inclusion of any particular described characteristic, function, activity, substance, or structural element, for any particular sequence of activities, for any particular combination of substances, or for any particular interrelationship of elements;

[207] no described characteristic, function, activity, substance, or structural element is “essential”;

[208] any two or more described substances can be mixed, combined, reacted, separated, and/or segregated;

[209] any described characteristics, functions, activities, substances, and/or structural elements can be integrated, segregated, and/or duplicated;

[210] any described activity can be performed manually, semi-automatically, and/or automatically;

[211] any described activity can be repeated, any activity can be performed by multiple entities, and/or any activity can be performed in multiple jurisdictions; and

[212] any described characteristic, function, activity, substance, and/or structural element can be specifically excluded, the sequence of activities can vary, and/or the interrelationship of structural elements can vary.

[213] The use of the terms “a”, “an”, “said”, “the”, and/or similar referents in the context of describing various embodiments (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context.

- [214] The terms “comprising,” “having,” “including,” and “containing” are to be construed as open-ended terms (i.e., meaning “including, but not limited to,”) unless otherwise noted.
- [215] When any number or range is described herein, unless clearly stated otherwise, that number or range is approximate. Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value and each separate subrange defined by such separate values is incorporated into the specification as if it were individually recited herein. For example, if a range of 1 to 10 is described, that range includes all values therebetween, such as for example, 1.1, 2.5, 3.335, 5, 6.179, 8.9999, etc., and includes all subranges therebetween, such as for example, 1 to 3.65, 2.8 to 8.14, 1.93 to 9, etc.
- [216] When any phrase (i.e., one or more words) appearing in a claim is followed by a drawing element number, that drawing element number is exemplary and non-limiting on claim scope.
- [217] No claim of this document is intended to invoke paragraph six of 35 USC 112 unless the precise phrase “means for” is followed by a gerund.
- [218] Any information in any material (e.g., a United States patent, United States patent application, book, article, etc.) that has been incorporated by reference herein, is incorporated by reference herein in its entirety to its fullest enabling extent permitted by law yet only to the extent that no conflict exists between such information and the other statements and drawings set forth herein. In the event of such conflict, including a conflict that would render invalid any claim herein or seeking priority hereto, then any such conflicting information in such material is specifically not incorporated by reference herein.

[219] Within this document, and during prosecution of any patent application related hereto, any reference to any claimed subject matter is intended to reference the precise language of the then-pending claimed subject matter at that particular point in time only.

[220] Accordingly, every portion (e.g., title, field, background, summary, description, abstract, drawing figure, etc.) of this document, other than the claims themselves and any provided definitions of the phrases used therein, is to be regarded as illustrative in nature, and not as restrictive. The scope of subject matter protected by any claim of any patent that issues based on this document is defined and limited only by the precise language of that claim (and all legal equivalents thereof) and any provided definition of any phrase used in that claim, as informed by the context of this document.

What is claimed is:

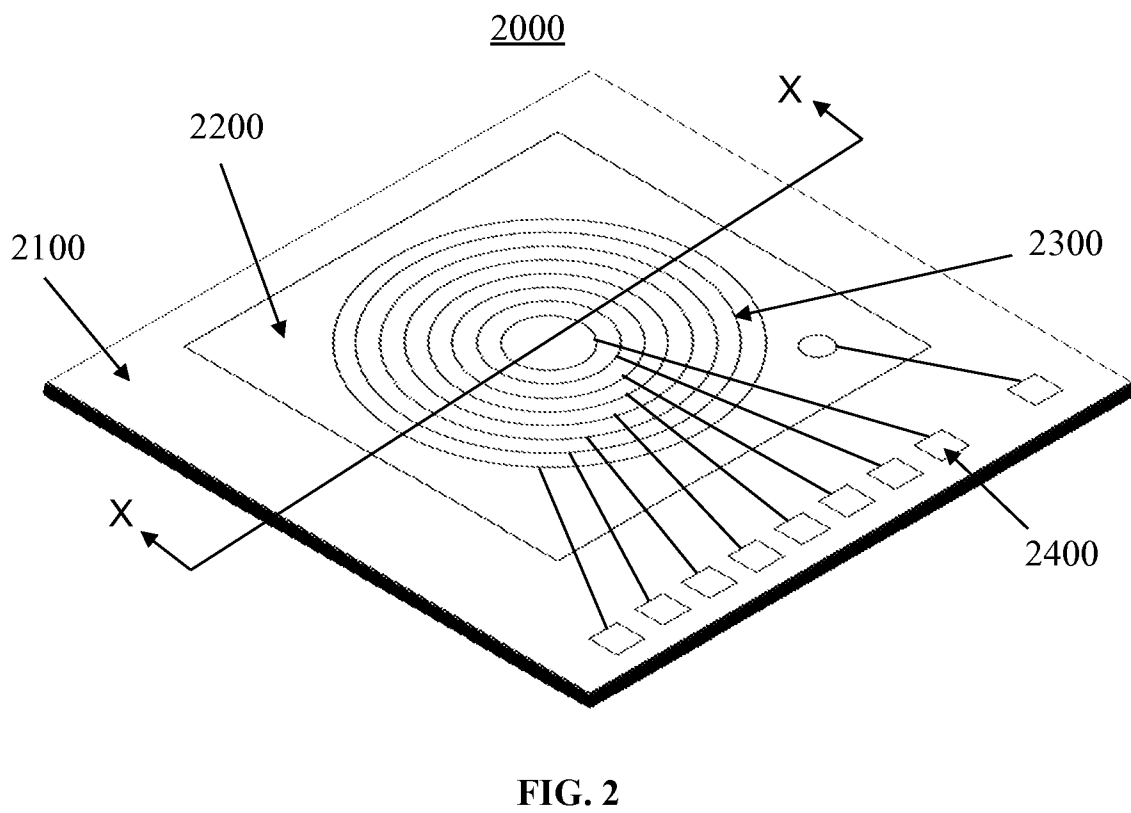
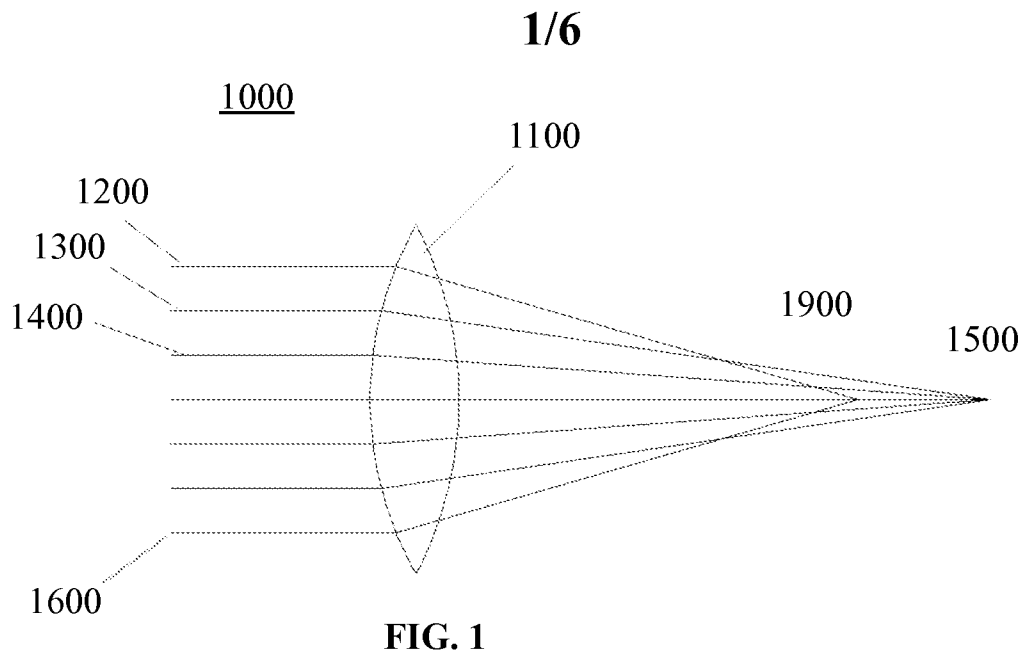
1. A system comprising:
 - an optical system comprising a fluidic lens and at least one variable-focus tunable lens in optical communication with the fluidic lens; and
 - a hardware-based lens controller adapted to automatically, in response to a measurement provided by one or more sensors, tune the at least one variable-focus tunable lens sufficiently to substantially reduce one or more higher order optical wavefront aberrations of the optical system.
2. The system of claim 1, further comprising:
 - a wavefront analyzer adapted to create a measurement of a wavefront aberration phase profile of the optical system.
3. The system of claim 1, further comprising:
 - a wavefront analyzer adapted to provide, to the lens controller, a measurement of a wavefront aberration phase profile, a Zernike term describing the measurement, an additive inverse of a Zernike term describing the measurement, a Zernike term describing a required correction of the measurement, a complex conjugate of the measurement, a reference to the measurement, and/or a reference to the complex conjugate of the measurement.
4. The system of claim 1, further comprising:
 - a sensor adapted to provide, in response to an environmental stimulus and/or a prompting from a timer and/or the lens controller, a measurement of an environmental variable, the measurement comprising temperature, air pressure and/or humidity.
5. The system of claim 1, further comprising:
 - a sensor adapted to provide, in response to stimulus resulting from normal operation of the optical system and/or the lens controller, a measurement of an internal state of the optical system.

6. The system of claim 1, further comprising:
a sensor adapted to provide, in response to stimulus resulting from normal operation of the optical system and/or the lens controller, a measurement of a state of the optical system, the measurement comprising an optical magnification power of the optical system and/or a wavefront aberration phase profile of the optical system.
7. The system of claim 1, further comprising:
a refractor comprising the lens controller, the at least one variable-focus tunable lens, and the fluidic lens.
8. The system of claim 1, wherein:
the lens controller is adapted to change a wavefront aberration phase profile of the optical system in response to input provided via a network from an information device.
9. The system of claim 1, wherein:
the lens controller is adapted to cause the at least one variable-focus tunable lens to change a wavefront aberration phase profile of the optical system.
10. The system of claim 1, wherein:
the lens controller is adapted to provide to the at least one variable-focus tunable lens one or more of: a complex conjugate of a wavefront aberration phase profile of the optical system, a Zernike term describing the wavefront aberration phase profile, and a Zernike term describing a required correction of the wavefront aberration phase profile, .
11. The system of claim 1, wherein:
the at least one variable-focus tunable lens is tuned by incorporating a complex conjugate of a wavefront aberration phase profile of the optical system, a Zernike term describing the wavefront aberration phase profile, and/or a Zernike term describing a required correction of the wavefront aberration phase profile.

12. The system of claim 1, wherein:
 - a revised wavefront aberration phase profile of the optical system incorporates a complex conjugate of an unrevised wavefront aberration phase profile of the optical system, a Zernike term describing the unrevised wavefront aberration phase profile, and/or a Zernike term describing a required correction of the unrevised wavefront aberration phase profile.
13. The system of claim 1, wherein:
 - the at least one variable-focus tunable lens is an electro-active lens.
14. The system of claim 1, wherein:
 - the at least one variable-focus tunable lens is an electro-optic lens.
15. The system of claim 1, wherein:
 - the at least one variable-focus tunable lens is an electro-optic lens that is comprised of multiple addressable electrodes.
16. The system of claim 1, wherein:
 - a tuning adjustment of the at least one variable-focus lens is predetermined.
17. The system of claim 1, wherein:
 - a tuning adjustment of the at least one variable-focus lens is stored in a memory device and/or stored on the memory device.
18. The system of claim 1, wherein:
 - the at least one variable-focus tunable lens is comprised of one or more addressable electrodes, a spatial configuration of the addressable electrodes comprising grid-like patterns including but not limited to squares, triangles, hexagons, and/or concentric circles.

19. A method comprising:
 - automatically, via a hardware-based lens controller, tuning at least one variable-focus tunable lens sufficiently to substantially reduce one or more higher order optical wavefront aberrations of an optical system.
20. The method of claim 19, further comprising:
 - via a hardware-based lens controller, substantially the reducing higher order optical wavefront aberrations of the optical system in response to a measurement provided by one or more sensors.
21. The method of claim 19, further comprising:
 - creating a representation of the wavefront aberration phase profile of the optical system in response to receiving:
 - an environmental stimulus;
 - a prompting from a timer;
 - a prompting from the lens controller;
 - a command from an information device; and/or
 - a measurement of an environmental variable, the measurement comprising temperature, air pressure and/or humidity.
22. The method of claim 19, further comprising:
 - creating a representation of the wavefront aberration phase profile of the optical system in response to a stimulus resulting from normal operation of the optical system and/or normal operation of the lens controller, the stimulus comprising an optical magnification power of the optical system, and/or a wavefront aberration phase profile of the system.
23. The method of claim 19, further comprising:
 - creating a representation of the wavefront aberration phase profile of the optical system via a measurement by a wavefront analyzer and/or a calculation from mathematical model.

24. The method of claim 19, further comprising:
tuning the at least one variable-focus tunable lens by incorporating, into an existing tuning of the variable-focus tunable lens, a complex conjugate of the wavefront aberration phase profile of the optical system, a Zernike term describing the wavefront aberration phase profile, and/or a Zernike term describing a required correction of the wavefront aberration phase profile.
25. The method of claim 19, further comprising:
tuning the at least one variable-focus tunable lens by tuning the electrical properties of one or more addressable electrodes, a spatial configuration of the addressable electrodes comprising grid-like patterns including but not limited to squares, triangles, hexagons, and/or concentric circles.
26. The method of claim 19, further comprising:
adapting a refractor to comprise the hardware-based lens controller, the at least one variable-focus tunable lens, and a fluidic lens.
27. The method of claim 19, wherein:
the sensor is a wavefront analyzer.



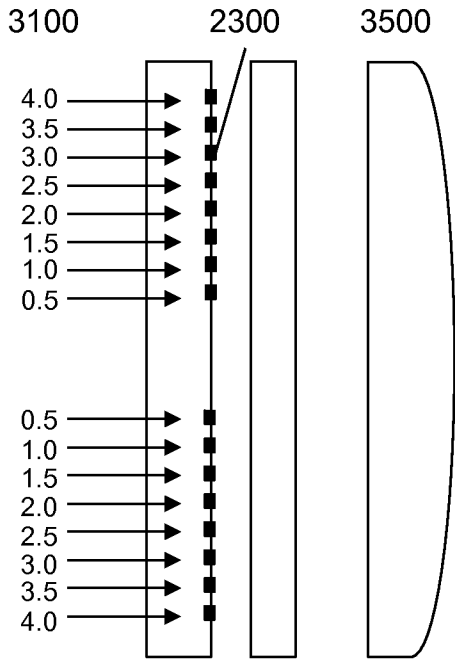


FIG. 3

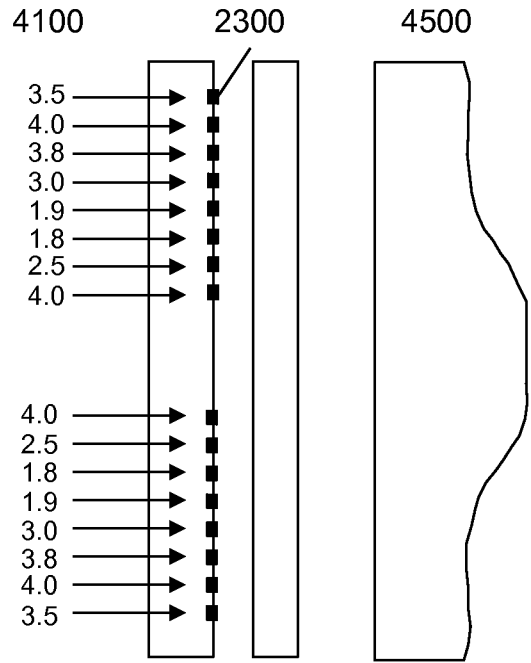


FIG. 4

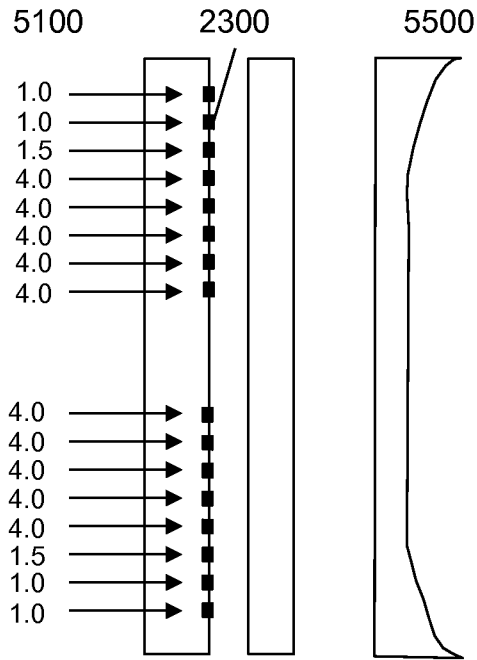


FIG. 5

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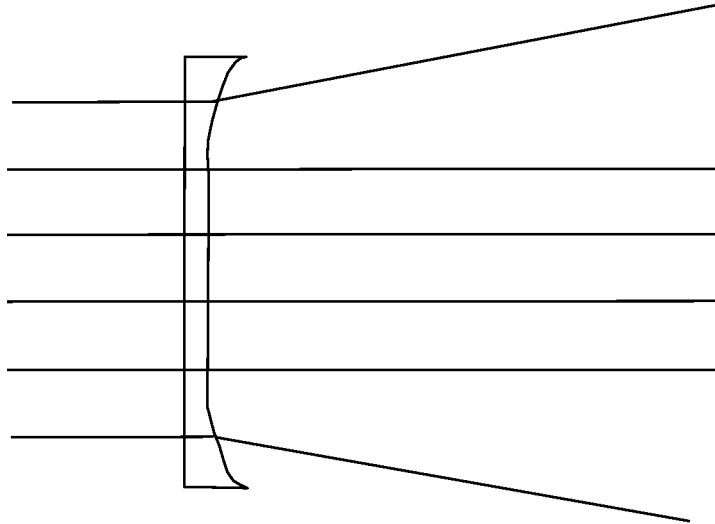


FIG. 6

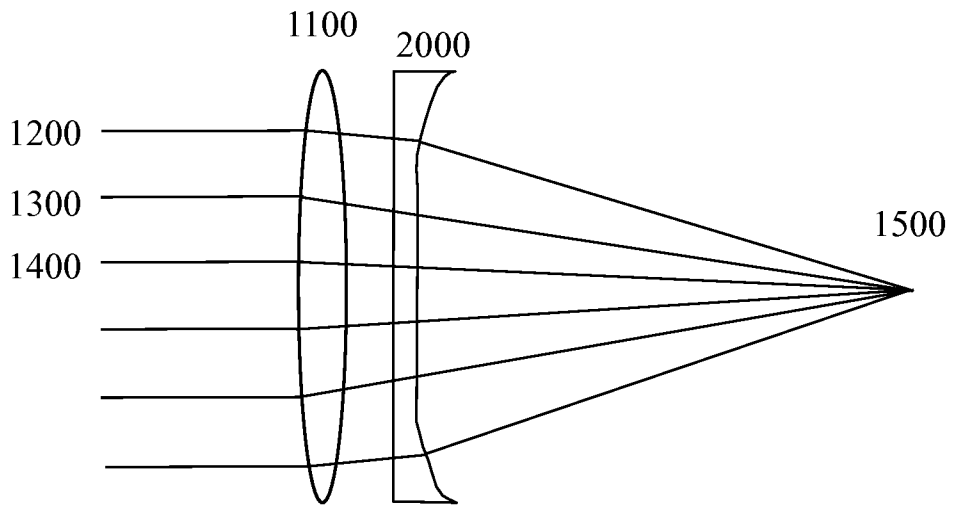


FIG. 7

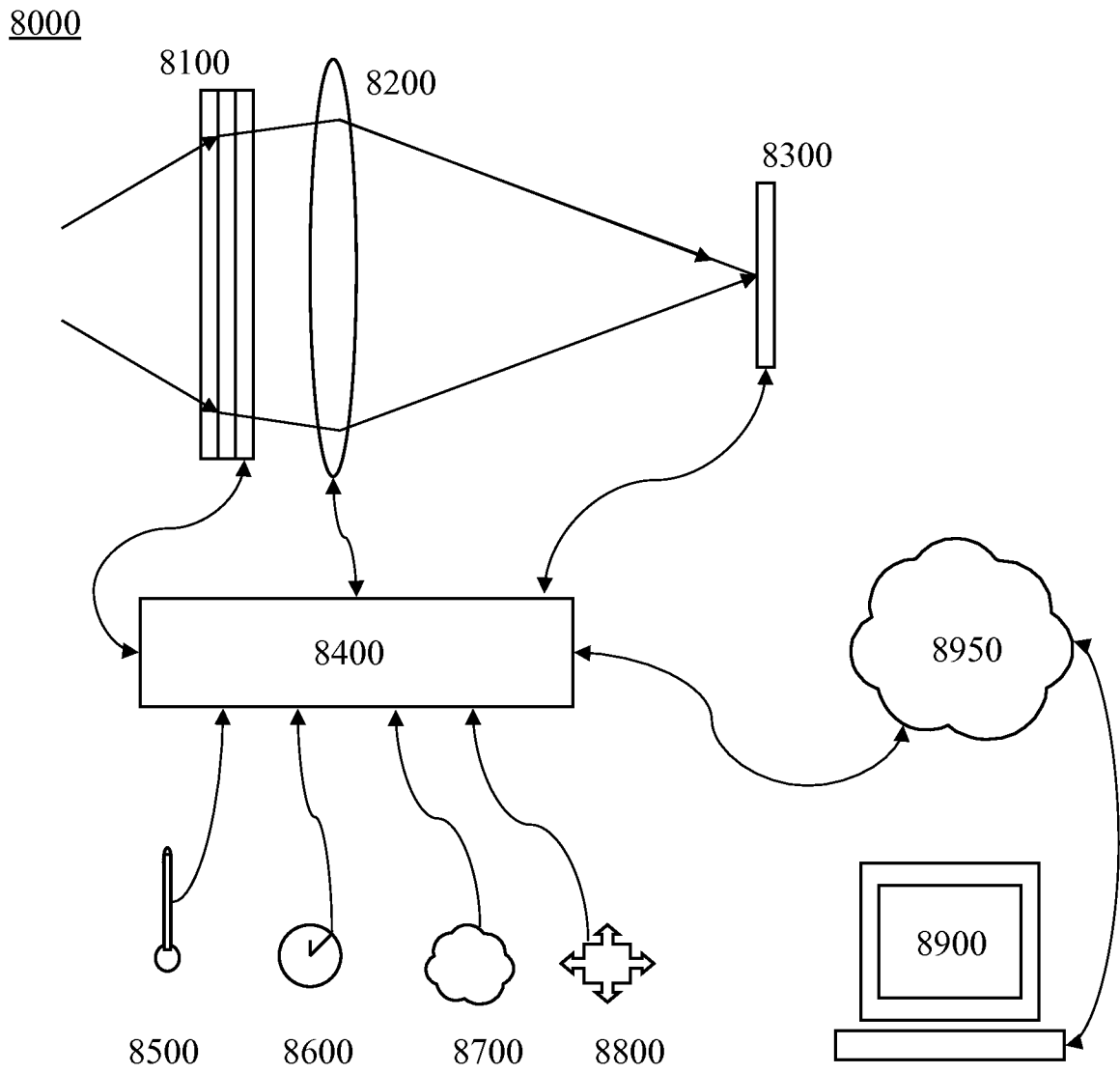
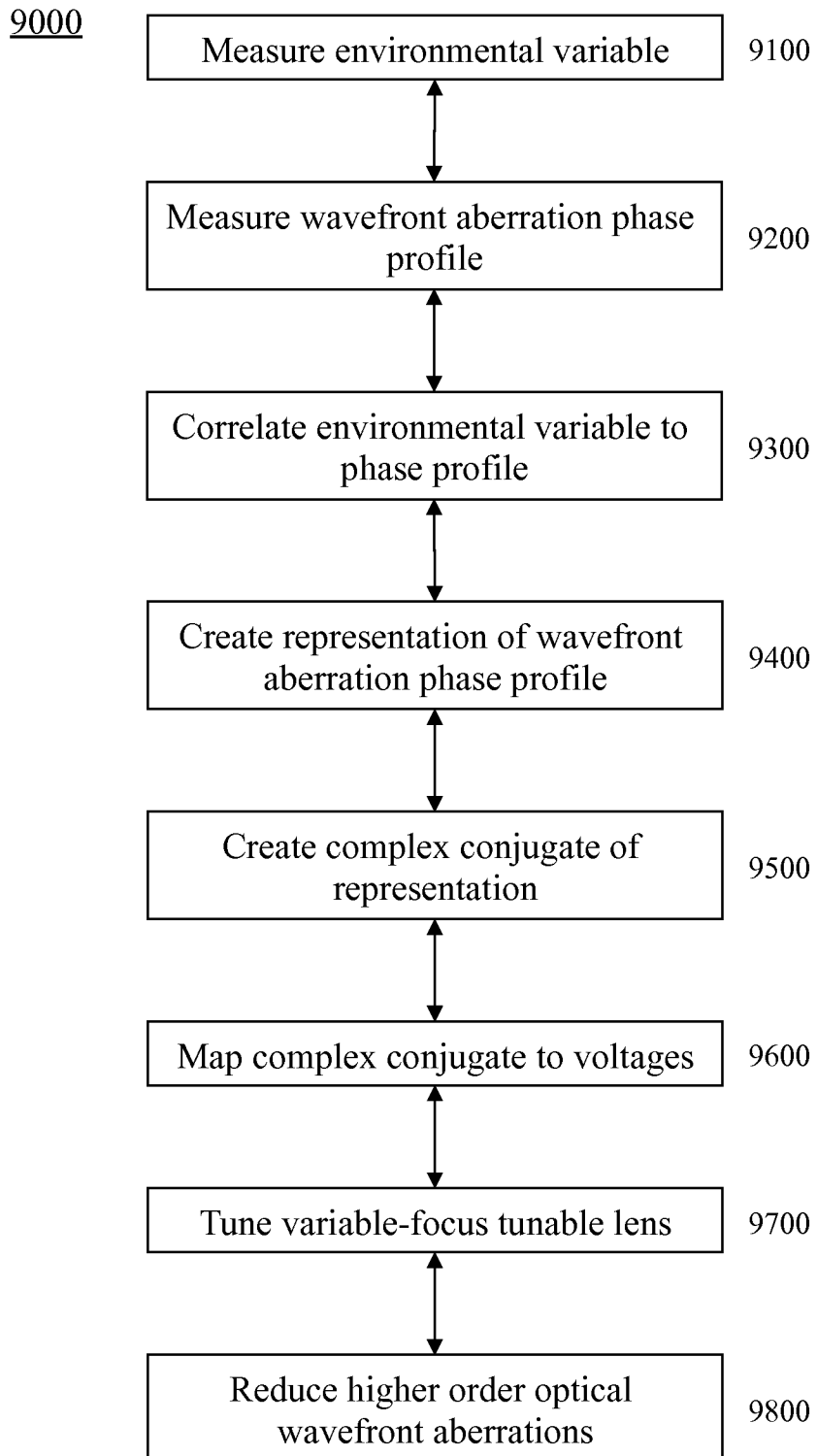


FIG. 8

5/6**FIG. 9**

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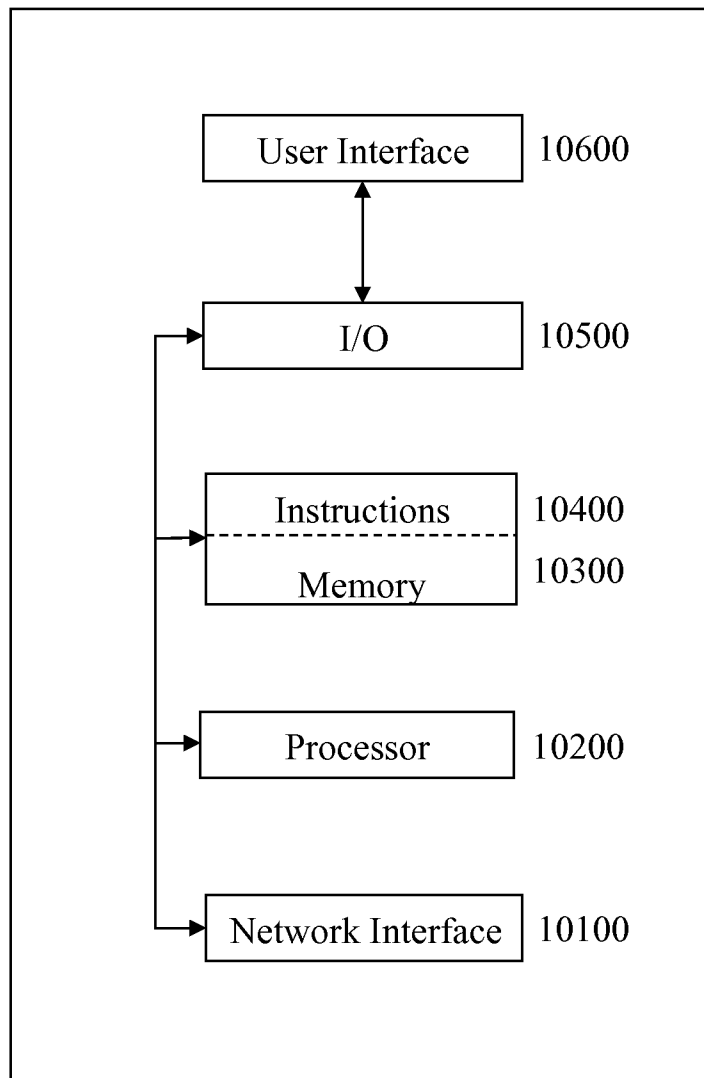


FIG. 10