

What is claimed is:

1. A method of deception detection based upon ocular information of a subject, the method comprising the steps of:

- providing a standoff device configured to view the subject during an examination, the standoff device not in physical contact with the subject, wherein the standoff device has at least one video camera configured to record a close-up view of at least one eye of the subject, and wherein the standoff device has or is connected to a computing device;

- providing a cognitive state model configured to determine a high to a low cognitive load experienced by the subject, the cognitive load measuring the extent to which the subject is drawing on mental resources to formulate their response;

- providing an emotional state model configured to determine a high to a low state of arousal experienced by the subject, the state of arousal based upon the subject's nervous system activation;

- recording, via the at least one video camera, the ocular information of the at least one eye of the subject;

- establishing a baseline state of the ocular information of the at least one eye of the subject before questioning of the subject;

- asking a question of the subject and allowing the subject to answer the question;

- after asking the question and including the time of the subject answering the question, processing the ocular information to identify changes in ocular signals of the subject;

- evaluating, via the computing device, the cognitive state model and the emotional state model based solely on the changes in ocular signals and estimating a probability of the subject being either truthful or deceptive;

- determining a binary output of either truthfulness or deceptiveness; and

- displaying the binary output to an administrator.

2. The method of deception detection of claim 1, wherein the changes in ocular signals comprise any of the following: eye movement, gaze location X, gaze location Y, saccade rate, saccade peak velocity, saccade average velocity, saccade

amplitude, fixation duration, fixation entropy (spatial), gaze deviation (polar angle), gaze deviation (eccentricity), re-fixation, smooth pursuit, smooth pursuit duration, smooth pursuit average velocity, smooth pursuit amplitude, scan path (gaze trajectory over time), pupil diameter, pupil area, pupil symmetry, velocity (change in pupil diameter), acceleration (change in velocity), jerk (pupil change acceleration), pupillary fluctuation trace, constriction latency, dilation duration, spectral features, iris muscle features, iris muscle group identification, iris muscle fiber contractions, iris sphincter identification, iris dilator identification, iris sphincter symmetry, pupil and iris centration vectors, blink rate, blink duration, blink latency, blink velocity, partial blinks, blink entropy (deviation from periodicity), sclera segmentation, iris segmentation, pupil segmentation, stroma change detection, eyeball area (squinting), deformations of the stroma, iris muscle changes.

3. The method of deception detection of claim 1, wherein the step of estimating the probability of the subject being either truthful or deceptive comprises a plurality of estimates taken over a period of time during the subject's answer, wherein the plurality of estimates are weighted and combined to produce the binary output.
4. The method of deception detection of claim 1, wherein the at least one video camera captures frames at a rate of at least 100 frames per second.
5. The method of deception detection of claim 1, wherein the at least one video camera captures frames at a rate of at least 50 frames per second.
6. The method of deception detection of claim 1, wherein the at least one video camera captures frames at a rate of at least 30 frames per second.
7. The method of deception detection of claim 1, wherein the standoff device includes a second video camera configured to record the entirety of the subject's face.
8. The method of deception detection of claim 1, wherein the computing device is a cloud-based computing device disposed remote from the standoff device.

9. The method of deception detection of claim 1, wherein the computing device is part of the standoff device.
10. The method of deception detection of claim 1, wherein the computing device is separate from the standoff device.
11. The method of deception detection of claim 1, wherein, after asking the question of the subject and allowing the subject to answer the question, waiting a period of time and re-establishing the baseline state of the ocular information of the at least one eye of the subject before an additional question is asked of the subject.
12. The method of deception detection of claim 1, wherein an entire statement by the subject is evaluated as the answer to question.
13. The method of deception detection of claim 1, including the step of saving each binary output and each corresponding video recorded by the at least one video camera by the computing device.
14. A method of deception detection based upon ocular information of a subject, the method comprising the steps of:
- providing a standoff device configured to view the subject during an examination, the standoff device not in physical contact with the subject, wherein the standoff device has at least one video camera configured to record a close-up view of at least one eye of the subject, and wherein the standoff device has or is connected to a computing device;
 - providing a cognitive state model configured to determine a high to a low cognitive load experienced by the subject, the cognitive load measuring the extent to which the subject is drawing on mental resources to formulate their response;
 - providing an emotional state model configured to determine a high to a low state of arousal experienced by the subject, the state of arousal based upon the subject's nervous system activation;

recording, via the at least one video camera, the ocular information of the at least one eye of the subject;

establishing a baseline state of the ocular information of the at least one eye of the subject before questioning of the subject;

asking a question of the subject and allowing the subject to answer the question;

after asking the question and including the time of the subject answering the question, processing the ocular information to identify changes in ocular signals of the subject;

evaluating, via the computing device, the cognitive state model and the emotional state model based solely on the changes in ocular signals and estimating a probability of the subject being either truthful or deceptive;

determining a binary output of either truthfulness or deceptiveness; and
displaying the binary output to an administrator;

wherein the step of estimating the probability of the subject being either truthful or deceptive comprises a plurality of estimates taken over a period of time during the subject's answer, wherein the plurality of estimates are weighted and combined to produce the binary output.

15. A method of deception detection based upon ocular information of a subject, the method comprising the steps of:

providing a standoff device configured to view the subject during an examination, the standoff device not in physical contact with the subject, wherein the standoff device has at least one video camera configured to record a close-up view of at least one eye of the subject, and wherein the standoff device has or is connected to a computing device;

providing a cognitive state model configured to determine a high to a low cognitive load experienced by the subject, the cognitive load measuring the extent to which the subject is drawing on mental resources to formulate their response;

providing an emotional state model configured to determine a high to a low state of arousal experienced by the subject, the state of arousal based upon the subject's nervous system activation;

- recording, via the at least one video camera, the ocular information of the at least one eye of the subject;
- establishing a baseline state of the ocular information of the at least one eye of the subject before questioning of the subject;
- asking a question of the subject and allowing the subject to answer the question;
- after asking the question and including the time of the subject answering the question, processing the ocular information to identify changes in ocular signals of the subject;
- evaluating, via the computing device, the cognitive state model and the emotional state model based solely on the changes in ocular signals and estimating a probability of the subject being either truthful or deceptive;
- determining a binary output of either truthfulness or deceptiveness; displaying the binary output to an administrator; and
- saving each binary output and each corresponding video recorded by the at least one video camera by the computing device.

16. A method of assessing operational risk based upon ocular information of a subject, the method comprising the steps of:

- providing a video camera configured to record a close-up view of at least one eye of the subject;
- providing an electronic display screen configured to display a plurality of images to the subject;
- providing a computing device electronically connected to the video camera and the electronic display;
- displaying, via the electronic display, at least one oculomotor task;
- recording, via the video camera, the ocular information of the at least one eye of the subject during the at least one oculomotor task;
- processing, via the computing device, the ocular information to identify changes in ocular signals of the subject through the use of convolutional neural networks;

evaluating, via the computing device, the changes in ocular signals from the convolutional neural networks combined with the at least one oculomotor task corresponding to the changes in ocular signals by a machine learning algorithm;

determining, via the machine learning algorithm, a duty fitness result for the subject;

wherein the duty fitness result is either fit for duty, unfit for duty or more information needed; and

displaying, to the subject and/or to a supervisor, the duty fitness result for the subject.

17. The method of assessing operational risk of claim 16, wherein the changes in ocular signals comprise any of the following: eye movement, gaze location X, gaze location Y, saccade rate, saccade peak velocity, saccade average velocity, saccade amplitude, fixation duration, fixation entropy (spatial), gaze deviation (polar angle), gaze deviation (eccentricity), re-fixation, smooth pursuit, smooth pursuit duration, smooth pursuit average velocity, smooth pursuit amplitude, scan path (gaze trajectory over time), pupil diameter, pupil area, pupil symmetry, velocity (change in pupil diameter), acceleration (change in velocity), jerk (pupil change acceleration), pupillary fluctuation trace, constriction latency, dilation duration, spectral features, iris muscle features, iris muscle group identification, iris muscle fiber contractions, iris sphincter identification, iris dilator identification, iris sphincter symmetry, pupil and iris centration vectors, blink rate, blink duration, blink latency, blink velocity, partial blinks, blink entropy (deviation from periodicity), sclera segmentation, iris segmentation, pupil segmentation, stroma change detection, eyeball area (squinting), deformations of the stroma, iris muscle changes.

18. The method of assessing operational risk of claim 17, wherein the at least one oculomotor task comprises any of the following: pupillary light reflex, optokinetic reflex, horizontal gaze nystagmus, smooth pursuit, gaze calibration or startle response.

19. The method of assessing operational risk of claim 17, wherein the electronic display screen is that of a smart phone, a tablet, a laptop screen, a desktop screen or an electronic screen.

20. The method of assessing operational risk of claim 17, wherein the video camera, the electronic display screen and the computing device are all contained as a smart phone or as a tablet.

21. A method of assessing operational risk based upon ocular information of a subject, the method comprising the steps of:

- providing a video camera configured to passively record a close-up view of at least one eye of the subject;

- providing a computing device electronically connected to the video camera and the electronic display;

- recording, via the video camera, the ocular information of the at least one eye of the subject;

- processing, via the computing device, the ocular information to identify changes in ocular signals of the subject through the use of convolutional neural networks;

- evaluating, via the computing device, the changes in ocular signals from the convolutional neural networks by a machine learning algorithm;

- determining, via the machine learning algorithm, a duty fitness result for the subject;

- wherein the duty fitness result is either fit for duty, unfit for duty or more information needed; and

- displaying, to the subject and/or to a supervisor, the duty fitness result for the subject.

22. The method of assessing operational risk of claim 6, wherein the changes in ocular signals comprise any of the following: eye movement, gaze location X, gaze location Y, saccade rate, saccade peak velocity, saccade average velocity, saccade amplitude, fixation duration, fixation entropy (spatial), gaze deviation (polar angle), gaze deviation (eccentricity), re-fixation, smooth pursuit, smooth pursuit duration,

smooth pursuit average velocity, smooth pursuit amplitude, scan path (gaze trajectory over time), pupil diameter, pupil area, pupil symmetry, velocity (change in pupil diameter), acceleration (change in velocity), jerk (pupil change acceleration), pupillary fluctuation trace, constriction latency, dilation duration, spectral features, iris muscle features, iris muscle group identification, iris muscle fiber contractions, iris sphincter identification, iris dilator identification, iris sphincter symmetry, pupil and iris centration vectors, blink rate, blink duration, blink latency, blink velocity, partial blinks, blink entropy (deviation from periodicity), sclera segmentation, iris segmentation, pupil segmentation, stroma change detection, eyeball area (squinting), deformations of the stroma, iris muscle changes.

23. The method of assessing operational risk of claim 22, wherein the duty fitness result relates to a level of intoxication of the subject.

24. The method of assessing operational risk of claim 22, wherein the duty fitness result relates to a level of impairment of the subject.

25. The method of assessing operational risk of claim 22, wherein the duty fitness result relates to a level of fatigue of the subject.

26. The method of assessing operational risk of claim 22, wherein the duty fitness result relates to a level of anxiety and/or stress of the subject.

27. A method of assessing a mental state of a subject based upon ocular information of the subject, the method comprising the steps of:

- providing a video camera configured to passively record a close-up view of at least one eye of the subject;

- providing a computing device electronically connected to the video camera and the electronic display;

- recording, via the video camera, the ocular information of the at least one eye of the subject;

processing, via the computing device, the ocular information to identify changes in ocular signals of the subject through the use of convolutional neural networks;

evaluating, via the computing device, the changes in ocular signals from the convolutional neural networks by a machine learning algorithm;

determining, via the machine learning algorithm, the mental state for the subject; and

displaying, to the subject and/or to a supervisor, the mental state for the subject.

28. The method of assessing the mental state of claim 27, wherein the changes in ocular signals comprise any of the following: eye movement, gaze location X, gaze location Y, saccade rate, saccade peak velocity, saccade average velocity, saccade amplitude, fixation duration, fixation entropy (spatial), gaze deviation (polar angle), gaze deviation (eccentricity), re-fixation, smooth pursuit, smooth pursuit duration, smooth pursuit average velocity, smooth pursuit amplitude, scan path (gaze trajectory over time), pupil diameter, pupil area, pupil symmetry, velocity (change in pupil diameter), acceleration (change in velocity), jerk (pupil change acceleration), pupillary fluctuation trace, constriction latency, dilation duration, spectral features, iris muscle features, iris muscle group identification, iris muscle fiber contractions, iris sphincter identification, iris dilator identification, iris sphincter symmetry, pupil and iris centration vectors, blink rate, blink duration, blink latency, blink velocity, partial blinks, blink entropy (deviation from periodicity), sclera segmentation, iris segmentation, pupil segmentation, stroma change detection, eyeball area (squinting), deformations of the stroma, iris muscle changes.

29. The method of assessing the mental state of claim 28, wherein the mental state relates to a level of intoxication of the subject.

30. The method of assessing the mental state of claim 28, wherein the mental state relates to a level of impairment of the subject.

31. The method of assessing the mental state of claim 28, wherein the mental state relates to a level of fatigue of the subject.

32. The method of assessing the mental state of claim 28, wherein the mental state relates to a level of anxiety and/or stress of the subject.

33. A method to optimize learning based upon ocular information of a subject, the method comprising the steps of:

- providing a video camera configured to record a close-up view of at least one eye of the subject;

- providing a first electronic display configured to display a plurality of educational subject matter to the subject;

- providing a second electronic display configured to display an output to an instructor;

- providing a computing device electronically connected to the video camera, the first electronic display and the second electronic display;

- recording, via the video camera, the ocular information of the at least one eye of the subject while learning the plurality of educational subject matter;

- processing, via the computing device, the ocular information to identify changes in ocular signals of the subject through the use optimized algorithms;

- providing a cognitive state model configured to determine a low to a high cognitive load experienced by the subject, the cognitive load measuring the extent to which the subject is drawing on mental resources;

- evaluating, via the computing device, the cognitive state model based on the changes in the ocular signals and determining a probability of the low to the high cognitive load experienced by the subject; and

- displaying, via the second electronic display, the probability of the low to the high cognitive load experienced by the subject to the instructor.

34. The method to optimize learning of claim 33, including the steps of, via the computing device, establishing a location of the first electronic display in relation to the at least one eye of the subject; determining from the changes in ocular signals a subject's gazing location in relation to the plurality of educational subject matter;

linking the subject's gaze location of the plurality of the educational subject matter and the changes in ocular signals to the subject's cognitive load; and displaying, via the second electronic display to the instructor, the subject's cognitive load in relation to the plurality of educational subject matter.

35. The method to optimize learning of claim 33, including the step of isolating a pupil dilation of the subject resulting from changes in cognitive load from changes in ambient luminance by utilizing a power spectral density frequency transformation.

36. The method to optimize learning of claim 33, including the steps of providing an optimal learning scale model having a learning scale for the subject based upon a representative population or a subject's prior data, the learning scale ranging from under stimulated to overwhelmed; evaluating, via the computing device, the changes in ocular signals to determine the subject's position along the learning scale; and displaying, via the second display to the instructor, the subject's position along the learning scale.

37. The method to optimize learning of claim 33, including the steps of providing a memory formation model configured to determine a strength of short-term and/or long-term memories; evaluating, via the computing the device, the changes in ocular signals to determine the subject's strength of the short-term and/or the long-term memories in relation to the plurality of educational subject matter; and displaying, via the second display to the instructor, the subject's strength of the short-term and/or the long-term memories in relation to the plurality of educational subject matter.

38. The method to optimize learning of claim 33, wherein the changes in ocular signals comprise any of the following: eye movement, gaze location X, gaze location Y, saccade rate, saccade peak velocity, saccade average velocity, saccade amplitude, fixation duration, fixation entropy (spatial), gaze deviation (polar angle), gaze deviation (eccentricity), re-fixation, smooth pursuit, smooth pursuit duration, smooth pursuit average velocity, smooth pursuit amplitude, scan path (gaze trajectory over time), pupil diameter, pupil area, pupil symmetry, velocity (change in pupil diameter), acceleration (change in velocity), jerk (pupil change acceleration),

pupillary fluctuation trace, constriction latency, dilation duration, spectral features, iris muscle features, iris muscle group identification, iris muscle fiber contractions, iris sphincter identification, iris dilator identification, iris sphincter symmetry, pupil and iris centration vectors, blink rate, blink duration, blink latency, blink velocity, partial blinks, blink entropy (deviation from periodicity), sclera segmentation, iris segmentation, pupil segmentation, stroma change detection, eyeball area (squinting), deformations of the stroma, iris muscle changes.

39. The method to optimize learning of claim 33, wherein the step of recording, via the video camera, the ocular information of the at least one eye of the subject while learning the plurality of educational subject matter also includes recording, via the camera, a facial expression and/or a posture of the subject while learning the plurality of educational subject matter.

40. A method to measure a cognitive load based upon ocular information of a subject, the method comprising the steps of:

- providing a video camera configured to record a close-up view of at least one eye of the subject;

- providing a computing device electronically connected to the video camera and the electronic display;

- recording, via the video camera, the ocular information of the at least one eye of the subject;

- processing, via the computing device, the ocular information to identify changes in ocular signals of the subject through the use of convolutional neural networks;

- evaluating, via the computing device, the changes in ocular signals from the convolutional neural networks by a machine learning algorithm;

- determining, via the machine learning algorithm, the cognitive load for the subject; and

- displaying, to the subject and/or to a supervisor, the cognitive load for the subject.

41. The method to optimize learning of claim 40, wherein the changes in ocular signals comprise any of the following: eye movement, gaze location X, gaze location Y, saccade rate, saccade peak velocity, saccade average velocity, saccade amplitude, fixation duration, fixation entropy (spatial), gaze deviation (polar angle), gaze deviation (eccentricity), re-fixation, smooth pursuit, smooth pursuit duration, smooth pursuit average velocity, smooth pursuit amplitude, scan path (gaze trajectory over time), pupil diameter, pupil area, pupil symmetry, velocity (change in pupil diameter), acceleration (change in velocity), jerk (pupil change acceleration), pupillary fluctuation trace, constriction latency, dilation duration, spectral features, iris muscle features, iris muscle group identification, iris muscle fiber contractions, iris sphincter identification, iris dilator identification, iris sphincter symmetry, pupil and iris centration vectors, blink rate, blink duration, blink latency, blink velocity, partial blinks, blink entropy (deviation from periodicity), sclera segmentation, iris segmentation, pupil segmentation, stroma change detection, eyeball area (squinting), deformations of the stroma, iris muscle changes.

42. A method to measure a short-term and/or a long-term memory encoding based upon ocular information of a subject, the method comprising the steps of:

- providing a video camera configured to record a close-up view of at least one eye of the subject;

- providing a computing device electronically connected to the video camera and the electronic display;

- recording, via the video camera, the ocular information of the at least one eye of the subject;

- processing, via the computing device, the ocular information to identify changes in ocular signals of the subject through the use of convolutional neural networks;

- evaluating, via the computing device, the changes in ocular signals from the convolutional neural networks by a machine learning algorithm;

- determining, via the machine learning algorithm, the cognitive load for the subject; and

- displaying, to the subject and/or to a supervisor, the cognitive load for the subject.

43. The method to measure the short-term and/or the long-term memory encoding of claim 42, wherein the changes in ocular signals comprise any of the following: eye movement, gaze location X, gaze location Y, saccade rate, saccade peak velocity, saccade average velocity, saccade amplitude, fixation duration, fixation entropy (spatial), gaze deviation (polar angle), gaze deviation (eccentricity), re-fixation, smooth pursuit, smooth pursuit duration, smooth pursuit average velocity, smooth pursuit amplitude, scan path (gaze trajectory over time), pupil diameter, pupil area, pupil symmetry, velocity (change in pupil diameter), acceleration (change in velocity), jerk (pupil change acceleration), pupillary fluctuation trace, constriction latency, dilation duration, spectral features, iris muscle features, iris muscle group identification, iris muscle fiber contractions, iris sphincter identification, iris dilator identification, iris sphincter symmetry, pupil and iris centration vectors, blink rate, blink duration, blink latency, blink velocity, partial blinks, blink entropy (deviation from periodicity), sclera segmentation, iris segmentation, pupil segmentation, stroma change detection, eyeball area (squinting), deformations of the stroma, iris muscle changes.

44. A method of discovering relationships between iris physiology and cognitive states and/or emotional states of a subject, the method comprising the steps of:

- providing a computing device;
- providing a video camera configured to record a close-up view of at least one eye of the subject;
- providing a first light configured to be held to a skin of a lower eyelid of the subject allowing light to shine out from within the at least one eye;
- providing a second light configured to not be in contact with the subject located a distance apart from the subject and configured to illuminate a stroma of the at least one eye of the subject;
- wherein the first light and the second light are electronically synced together and configured to flash alternatively;
- engaging the user in a plurality of tasks, each task of the plurality of tasks configured to be cognitively or emotionally evocative;

recording, via the video camera, ocular information comprising responses in the iris musculature and corresponding distortions in the stroma due to the cognitive state and/or the emotional state of the subject produced by the plurality of tasks;

processing, via the computing device, the ocular information to identify correlations between the responses in the iris musculature and the distortions in the stroma through the use optimized algorithms; and

identifying, via the computing device, at least one predictive distortion in the stroma capturable solely with a visible-spectrum camera correlating to a predicted responses in the iris musculature when the subject was in the cognitive state and/or the emotional state produced by the plurality of tasks.

45. The method of discovering relationships of claim 44, wherein the first light comprises a NIR LED.

46. The method of discovering relationships of claim 44, wherein the second light comprises a NIR LED.

47. The method of discovering relationships of claim 44, wherein the first light and the second light are configured to flash alternatively.

48. The method of discovering relationships of claim 44, wherein the first light comprises a 150mw NIR LED.

49. The method of discovering relationships of claim 44, wherein the second light comprises a 150mw NIR LED.

50. The method of discovering relationships of claim 44, wherein the first light and the second light are configured to flash alternatively at 160Hz producing a resultant effect of 80Hz.

51. The method of discovering relationships of claim 1, further including a method of generating near infrared images from visible light images, the method comprising the steps of:

providing a visible spectrum video camera configured to record the close-up view of the at least one eye of the subject;

recording, via the visible spectrum video camera, the ocular information comprising the distortions in the stroma due to the cognitive state and/or the emotional state of the subject;

predicting, via the computing device, an infrared image of the at least one eye of the subject through a generative adversarial network using the ocular information from the visible spectrum video camera;

wherein the predicting, via the computing device, utilizes the at least one predictive distortion in the stroma for creating the infrared image.