Support Chart for US8000000B2

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| **No.** | **US8000000B2 Claim Text** | **US8000000B2 Matching Text** |
| 1.1 | A visual prosthesis apparatus comprising: | “**FIG. 1 shows a visual prosthesis apparatus.** The visual apparatus comprises, in combination, an implantable retinal stimulation system 1 and a video capture/transmission apparatus or visor embodied in visor/Glasses 5 . An exemplary retinal stimulation system 1 is shown in more detail in FIGS. 2 and 3 and an exemplary visor 5 is shown in more detail in FIGS. 6 and 7 . ” US8000000B2 at col. 4, ll. 48–54.  “FIG. 1 shows a visual prosthesis apparatus according to the present disclosure. ” US8000000B2 at col. 3, ll. 57–58.  “The visual prosthesis apparatus of FIG. 1 may operate in two modes: i) stand-alone mode and ii) communication mode. ” US8000000B2 at col. 8, ll. 29–31. |
| 1.2 | a camera for capturing a video image; | “According to a first aspect, a visual prosthesis apparatus comprising: a camera for capturing a video image; a video processing unit associated with the camera, the video processing unit configured to convert the video image to stimulation patterns; and a retinal stimulation system configured to stop stimulating neural tissue in a subject's eye based on the stimulation patterns when an error is detected in a forward telemetry received from the video processing unit. ” US8000000B2 at col. 2, l. 77–col. 3, l. 6.  “Referring to FIGS. 6 and 7 , the glasses 5 may comprise, for example, a frame 11 holding a camera 12 , an external coil 14 and a mounting system 16 for the external coil 14 . The mounting system 16 may also enclose the RF circuitry. **In this configuration, the video camera 12 captures live video.** The video signal is sent to an external Video Processing Unit (VPU) 20 (shown in FIGS. 9 , 11 and 12 and discussed below), which processes the video signal and subsequently transforms the processed video signal into electrical stimulation patterns or data. The electrical stimulation data are then sent to the external coil 14 that sends both data and power via radio-frequency (RF) telemetry to the coil 116 of the retinal stimulation system 1 , shown in FIGS. 2 and 3 . The coil 116 receives the RF commands which control the application specific integrated circuit (ASIC) which in turn delivers stimulation to the retina of the subject via a thin film electrode array (TFEA). In one aspect of an embodiment, light amplitude is recorded by the camera 12 . The VPU 20 may use a logarithmic encoding scheme to convert the incoming light amplitudes into the electrical stimulation patterns or data. These electrical stimulation patterns or data may then be passed on to the Retinal Stimulation System 1 , which results in the retinal cells being stimulated via the electrodes in the electrode array 2 (shown in FIGS. 2 , 3 and 8 ). In one exemplary embodiment, the electrical stimulation patterns or data being transmitted by the external coil 14 is binary data. The external coil 14 may contain a receiver and transmitter antennae and a radio-frequency (RF) electronics card for communicating with the internal coil 116 . ” US8000000B2 at col. 6, ll. 29–57.  “**Referring to FIGS. 1 , 2 and 10 , in the stand-alone mode, the video camera 12 , on the glasses 5 , captures a video image that is sent to the VPU 20 .** The VPU 20 processes the image from the camera 12 and transforms it into electrical stimulation patterns that are transmitted to the external coil 14 . The external coil 14 sends the electrical stimulation patterns and power via radio-frequency (RF) telemetry to the implanted retinal stimulation system 1 ( FIGS. 2 and 3 ). The internal coil 116 of the retinal stimulation system 1 receives the RF commands from the external coil 14 and transmits them to the electronics package 4 that in turn delivers stimulation to the retina via the electrode array 2 . Additionally, the retinal stimulation system 1 may communicate safety and operational status back to the VPU 20 by transmitting RF telemetry from the internal coil 116 to the external coil 14 . The visual prosthesis apparatus of FIG. 1 may be configured to electrically activate the retinal stimulation system 1 only when it is powered by the VPU 20 through the external coil 14 . The stand-alone mode may be used for clinical testing and/or at-home use by the subject. ” US8000000B2 at col. 8, ll. 33–51. |
| 1.3 | a video processing unit associated with the camera, | “**Referring to FIGS. 1 , 2 and 10 , in the stand-alone mode, the video camera 12 , on the glasses 5 , captures a video image that is sent to the VPU 20 .** The VPU 20 processes the image from the camera 12 and transforms it into electrical stimulation patterns that are transmitted to the external coil 14 . The external coil 14 sends the electrical stimulation patterns and power via radio-frequency (RF) telemetry to the implanted retinal stimulation system 1 ( FIGS. 2 and 3 ). The internal coil 116 of the retinal stimulation system 1 receives the RF commands from the external coil 14 and transmits them to the electronics package 4 that in turn delivers stimulation to the retina via the electrode array 2 . Additionally, the retinal stimulation system 1 may communicate safety and operational status back to the VPU 20 by transmitting RF telemetry from the internal coil 116 to the external coil 14 . The visual prosthesis apparatus of FIG. 1 may be configured to electrically activate the retinal stimulation system 1 only when it is powered by the VPU 20 through the external coil 14 . The stand-alone mode may be used for clinical testing and/or at-home use by the subject. ” US8000000B2 at col. 8, ll. 33–51.  “**As discussed above, the VPU 20 processes the image from the camera 12 and transforms the image into electrical stimulation patterns for the retinal stimulation system 1 .** Filters such as edge detection filters may be applied to the electrical stimulation patterns for example by the VPU 20 to generate, for example, a stimulation pattern based on filtered video data that the VPU 20 turns into stimulation data for the retinal stimulation system 1 . The images may then be reduced in resolution using a downscaling filter. In one exemplary embodiment, the resolution of the image may be reduced to match the number of electrodes in the electrode array 2 of the retinal stimulation system 1 . That is, if the electrode array has, for example, sixty electrodes, the image may be reduced to a sixty channel resolution. After the reduction in resolution, the image is mapped to stimulation intensity using for example a look-up table that has been derived from testing of individual subjects. Then, the VPU 20 transmits the stimulation parameters via forward telemetry to the retinal stimulation system 1 in frames that may employ a cyclic redundancy check (CRC) error detection scheme. ” US8000000B2 at col. 9, ll. 1–20.  “Referring to FIGS. 6 and 7 , the glasses 5 may comprise, for example, a frame 11 holding a camera 12 , an external coil 14 and a mounting system 16 for the external coil 14 . The mounting system 16 may also enclose the RF circuitry. In this configuration, the video camera 12 captures live video. **The video signal is sent to an external Video Processing Unit (VPU) 20 (shown in FIGS. 9 , 11 and 12 and discussed below), which processes the video signal and subsequently transforms the processed video signal into electrical stimulation patterns or data.** The electrical stimulation data are then sent to the external coil 14 that sends both data and power via radio-frequency (RF) telemetry to the coil 116 of the retinal stimulation system 1 , shown in FIGS. 2 and 3 . The coil 116 receives the RF commands which control the application specific integrated circuit (ASIC) which in turn delivers stimulation to the retina of the subject via a thin film electrode array (TFEA). In one aspect of an embodiment, light amplitude is recorded by the camera 12 . The VPU 20 may use a logarithmic encoding scheme to convert the incoming light amplitudes into the electrical stimulation patterns or data. These electrical stimulation patterns or data may then be passed on to the Retinal Stimulation System 1 , which results in the retinal cells being stimulated via the electrodes in the electrode array 2 (shown in FIGS. 2 , 3 and 8 ). In one exemplary embodiment, the electrical stimulation patterns or data being transmitted by the external coil 14 is binary data. The external coil 14 may contain a receiver and transmitter antennae and a radio-frequency (RF) electronics card for communicating with the internal coil 116 . ” US8000000B2 at col. 6, ll. 29–57. |
| 1.4 | the video processing unit configured to convert the video image to stimulation patterns, | “Referring to FIGS. 1 , 2 and 10 , in the stand-alone mode, the video camera 12 , on the glasses 5 , captures a video image that is sent to the VPU 20 . **The VPU 20 processes the image from the camera 12 and transforms it into electrical stimulation patterns that are transmitted to the external coil 14 .** The external coil 14 sends the electrical stimulation patterns and power via radio-frequency (RF) telemetry to the implanted retinal stimulation system 1 ( FIGS. 2 and 3 ). The internal coil 116 of the retinal stimulation system 1 receives the RF commands from the external coil 14 and transmits them to the electronics package 4 that in turn delivers stimulation to the retina via the electrode array 2 . Additionally, the retinal stimulation system 1 may communicate safety and operational status back to the VPU 20 by transmitting RF telemetry from the internal coil 116 to the external coil 14 . The visual prosthesis apparatus of FIG. 1 may be configured to electrically activate the retinal stimulation system 1 only when it is powered by the VPU 20 through the external coil 14 . The stand-alone mode may be used for clinical testing and/or at-home use by the subject. ” US8000000B2 at col. 8, ll. 33–51.  “**As discussed above, the VPU 20 processes the image from the camera 12 and transforms the image into electrical stimulation patterns for the retinal stimulation system 1 .** Filters such as edge detection filters may be applied to the electrical stimulation patterns for example by the VPU 20 to generate, for example, a stimulation pattern based on filtered video data that the VPU 20 turns into stimulation data for the retinal stimulation system 1 . The images may then be reduced in resolution using a downscaling filter. In one exemplary embodiment, the resolution of the image may be reduced to match the number of electrodes in the electrode array 2 of the retinal stimulation system 1 . That is, if the electrode array has, for example, sixty electrodes, the image may be reduced to a sixty channel resolution. After the reduction in resolution, the image is mapped to stimulation intensity using for example a look-up table that has been derived from testing of individual subjects. Then, the VPU 20 transmits the stimulation parameters via forward telemetry to the retinal stimulation system 1 in frames that may employ a cyclic redundancy check (CRC) error detection scheme. ” US8000000B2 at col. 9, ll. 1–20.  “Referring to FIGS. 6 and 7 , the glasses 5 may comprise, for example, a frame 11 holding a camera 12 , an external coil 14 and a mounting system 16 for the external coil 14 . The mounting system 16 may also enclose the RF circuitry. In this configuration, the video camera 12 captures live video. **The video signal is sent to an external Video Processing Unit (VPU) 20 (shown in FIGS. 9 , 11 and 12 and discussed below), which processes the video signal and subsequently transforms the processed video signal into electrical stimulation patterns or data.** The electrical stimulation data are then sent to the external coil 14 that sends both data and power via radio-frequency (RF) telemetry to the coil 116 of the retinal stimulation system 1 , shown in FIGS. 2 and 3 . The coil 116 receives the RF commands which control the application specific integrated circuit (ASIC) which in turn delivers stimulation to the retina of the subject via a thin film electrode array (TFEA). In one aspect of an embodiment, light amplitude is recorded by the camera 12 . The VPU 20 may use a logarithmic encoding scheme to convert the incoming light amplitudes into the electrical stimulation patterns or data. These electrical stimulation patterns or data may then be passed on to the Retinal Stimulation System 1 , which results in the retinal cells being stimulated via the electrodes in the electrode array 2 (shown in FIGS. 2 , 3 and 8 ). In one exemplary embodiment, the electrical stimulation patterns or data being transmitted by the external coil 14 is binary data. The external coil 14 may contain a receiver and transmitter antennae and a radio-frequency (RF) electronics card for communicating with the internal coil 116 . ” US8000000B2 at col. 6, ll. 29–57. |
| 1.5 | the video processing unit is configured to stop transmitting the stimulation patterns to the retinal stimulation system when the retinal stimulation system does not transmit valid back telemetry data; | “The forward telemetry data (transmitted for example at 122.76 kHz) may be modulated onto the exemplary 3 MHz carrier using Amplitude Shift Keying (ASK), while the back telemetry data (transmitted for example at 3.8 kHz) may be modulated using Frequency Shift Keying (FSK) with, for example, 442 kHz and 457 kHz. The theoretical bit error rates can be calculated for both the ASK and FSK scheme assuming a ratio of signal to noise (SNR). The system disclosed in the present disclosure can be reasonably expected to see bit error rates of 10-5 on forward telemetry and 10-3 on back telemetry. These errors may be caught more than 99.998% of the time by both an ASIC hardware telemetry error detection algorithm and the VPU 20 's firmware. For the forward telemetry, this is due to the fact that a 16-bit cyclic redundancy check (CRC) is calculated for every 1024 bits sent to the ASIC within electronics package 4 of the Retinal Stimulation System 1 . The ASIC of the Retinal Stimulation System 1 verifies this CRC and handles corrupt data by entering a non-stimulating 'safe' state and reporting that a telemetry error was detected to the VPU 20 via back telemetry. During the 'safe' mode, the VPU 20 may attempt to return the implant to an operating state. This recovery may be on the order of milliseconds. The back telemetry words are checked for a 16-bit header and a single parity bit. For further protection against corrupt data being misread, the back telemetry is only checked for header and parity if it is recognized as properly encoded Bi-phase Mark Encoded (BPM) data. **If the VPU 20 detects invalid back telemetry data, the VPU 20 immediately changes mode to a 'safe' mode where the Retinal Stimulation System 1 is reset and the VPU 20 only sends non-stimulating data frames.** Back telemetry errors cannot cause the VPU 20 to do anything that would be unsafe. ” US8000000B2 at col. 10, l. 54–col. 11, l. 8.  “In one exemplary embodiment, the Low Power Mode may be implemented to save power for VPU 20 . The Low Power Mode may be entered, for example, anytime the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . Upon entry to the Low Power Mode, the VPU 20 turns off power to the Retinal stimulation system 1 . After that, and periodically, the VPU 20 turns power back on to the Retinal stimulation system 1 for an amount of time just long enough for the presence of the Retinal stimulation system 1 to be recognized via its back telemetry. If the Retinal stimulation system 1 is not immediately recognized, the controller again shuts off power to the Retinal stimulation system 1 . In this way, the controller 'polls' for the passive Retinal stimulation system 1 and a significant reduction in power used is seen when the Retinal stimulation system 1 is too far away from its controller device. FIG. 13 b depicts an exemplary block diagram 900 of the steps taken when the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . If the VPU 20 receives back telemetry from the Retinal stimulation system 1 (output "YES" of step 901 ), the Retinal stimulation system 1 may be provided with power and data (step 906 ). If the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 (output "NO" of step 901 ), the power to the Retinal stimulation system 1 may be turned off. After some amount of time, power to the Retinal stimulation system 1 may be turned on again for enough time to determine if the Retinal stimulation system 1 is again transmitting back telemetry (step 903 ). If the Retinal stimulation system 1 is again transmitting back telemetry (step 904 ), the Retinal stimulation system 1 is provided with power and data (step 906 ). **If the Retinal stimulation system 1 is not transmitting back telemetry (step 904 ), the power to the Retinal stimulation system 1 may again be turned off for a predetermined amount of time (step 905 ) and the process may be repeated until the Retinal stimulation system 1 is again transmitting back telemetry.** ” US8000000B2 at col. 12, ll. 29–63.  “ FIG. 13 b shows an exemplary block diagram of the steps taken when VPU does not receive back telemetry from the Retinal stimulation system. ” US8000000B2 at col. 4, ll. 25–27. |
| 1.6 | and a retinal stimulation system configured to stop stimulating neural tissue in a subject's eye, | “Referring to FIGS. 1 , 2 and 10 , in the stand-alone mode, the video camera 12 , on the glasses 5 , captures a video image that is sent to the VPU 20 . **The VPU 20 processes the image from the camera 12 and transforms it into electrical stimulation patterns that are transmitted to the external coil 14 .** The external coil 14 sends the electrical stimulation patterns and power via radio-frequency (RF) telemetry to the implanted retinal stimulation system 1 ( FIGS. 2 and 3 ). The internal coil 116 of the retinal stimulation system 1 receives the RF commands from the external coil 14 and transmits them to the electronics package 4 that in turn delivers stimulation to the retina via the electrode array 2 . Additionally, the retinal stimulation system 1 may communicate safety and operational status back to the VPU 20 by transmitting RF telemetry from the internal coil 116 to the external coil 14 . The visual prosthesis apparatus of FIG. 1 may be configured to electrically activate the retinal stimulation system 1 only when it is powered by the VPU 20 through the external coil 14 . The stand-alone mode may be used for clinical testing and/or at-home use by the subject. ” US8000000B2 at col. 8, ll. 33–51.  “Referring to FIGS. 6 and 7 , the glasses 5 may comprise, for example, a frame 11 holding a camera 12 , an external coil 14 and a mounting system 16 for the external coil 14 . The mounting system 16 may also enclose the RF circuitry. In this configuration, the video camera 12 captures live video. The video signal is sent to an external Video Processing Unit (VPU) 20 (shown in FIGS. 9 , 11 and 12 and discussed below), which processes the video signal and subsequently transforms the processed video signal into electrical stimulation patterns or data. The electrical stimulation data are then sent to the external coil 14 that sends both data and power via radio-frequency (RF) telemetry to the coil 116 of the retinal stimulation system 1 , shown in FIGS. 2 and 3 . The coil 116 receives the RF commands which control the application specific integrated circuit (ASIC) which in turn delivers stimulation to the retina of the subject via a thin film electrode array (TFEA). In one aspect of an embodiment, light amplitude is recorded by the camera 12 . The VPU 20 may use a logarithmic encoding scheme to convert the incoming light amplitudes into the electrical stimulation patterns or data. **These electrical stimulation patterns or data may then be passed on to the Retinal Stimulation System 1 , which results in the retinal cells being stimulated via the electrodes in the electrode array 2 (shown in FIGS. 2 , 3 and 8 ).** In one exemplary embodiment, the electrical stimulation patterns or data being transmitted by the external coil 14 is binary data. The external coil 14 may contain a receiver and transmitter antennae and a radio-frequency (RF) electronics card for communicating with the internal coil 116 . ” US8000000B2 at col. 6, ll. 29–57. |
| 1.7 | and return an error signal to the video processing unit, | “The forward telemetry data (transmitted for example at 122.76 kHz) may be modulated onto the exemplary 3 MHz carrier using Amplitude Shift Keying (ASK), while the back telemetry data (transmitted for example at 3.8 kHz) may be modulated using Frequency Shift Keying (FSK) with, for example, 442 kHz and 457 kHz. The theoretical bit error rates can be calculated for both the ASK and FSK scheme assuming a ratio of signal to noise (SNR). The system disclosed in the present disclosure can be reasonably expected to see bit error rates of 10-5 on forward telemetry and 10-3 on back telemetry. These errors may be caught more than 99.998% of the time by both an ASIC hardware telemetry error detection algorithm and the VPU 20 's firmware. For the forward telemetry, this is due to the fact that a 16-bit cyclic redundancy check (CRC) is calculated for every 1024 bits sent to the ASIC within electronics package 4 of the Retinal Stimulation System 1 . **The ASIC of the Retinal Stimulation System 1 verifies this CRC and handles corrupt data by entering a non-stimulating 'safe' state and reporting that a telemetry error was detected to the VPU 20 via back telemetry.** During the 'safe' mode, the VPU 20 may attempt to return the implant to an operating state. This recovery may be on the order of milliseconds. The back telemetry words are checked for a 16-bit header and a single parity bit. For further protection against corrupt data being misread, the back telemetry is only checked for header and parity if it is recognized as properly encoded Bi-phase Mark Encoded (BPM) data. If the VPU 20 detects invalid back telemetry data, the VPU 20 immediately changes mode to a 'safe' mode where the Retinal Stimulation System 1 is reset and the VPU 20 only sends non-stimulating data frames. Back telemetry errors cannot cause the VPU 20 to do anything that would be unsafe. ” US8000000B2 at col. 10, l. 54–col. 11, l. 8.  “In order to supply power and data to the Retinal stimulation system 1 , the VPU 20 may drive the external coil 14 , for example, with a 3 MHz signal. **To protect the subject, the retinal stimulation system 1 may comprise a failure detection circuit to detect direct current leakage and to notify the VPU 20 through back telemetry so that the visual prosthesis apparatus can be shut down.** ” US8000000B2 at col. 10, ll. 47–53. |
| 1.8 | based on the stimulation patterns when an error is detected in a forward telemetry received from the video processing unit. | “The forward telemetry data (transmitted for example at 122.76 kHz) may be modulated onto the exemplary 3 MHz carrier using Amplitude Shift Keying (ASK), while the back telemetry data (transmitted for example at 3.8 kHz) may be modulated using Frequency Shift Keying (FSK) with, for example, 442 kHz and 457 kHz. The theoretical bit error rates can be calculated for both the ASK and FSK scheme assuming a ratio of signal to noise (SNR). The system disclosed in the present disclosure can be reasonably expected to see bit error rates of 10-5 on forward telemetry and 10-3 on back telemetry. These errors may be caught more than 99.998% of the time by both an ASIC hardware telemetry error detection algorithm and the VPU 20 's firmware. For the forward telemetry, this is due to the fact that a 16-bit cyclic redundancy check (CRC) is calculated for every 1024 bits sent to the ASIC within electronics package 4 of the Retinal Stimulation System 1 . **The ASIC of the Retinal Stimulation System 1 verifies this CRC and handles corrupt data by entering a non-stimulating 'safe' state and reporting that a telemetry error was detected to the VPU 20 via back telemetry.** During the 'safe' mode, the VPU 20 may attempt to return the implant to an operating state. This recovery may be on the order of milliseconds. The back telemetry words are checked for a 16-bit header and a single parity bit. For further protection against corrupt data being misread, the back telemetry is only checked for header and parity if it is recognized as properly encoded Bi-phase Mark Encoded (BPM) data. If the VPU 20 detects invalid back telemetry data, the VPU 20 immediately changes mode to a 'safe' mode where the Retinal Stimulation System 1 is reset and the VPU 20 only sends non-stimulating data frames. Back telemetry errors cannot cause the VPU 20 to do anything that would be unsafe. ” US8000000B2 at col. 10, l. 54–col. 11, l. 8.  “In order to supply power and data to the Retinal stimulation system 1 , the VPU 20 may drive the external coil 14 , for example, with a 3 MHz signal. **To protect the subject, the retinal stimulation system 1 may comprise a failure detection circuit to detect direct current leakage and to notify the VPU 20 through back telemetry so that the visual prosthesis apparatus can be shut down.** ” US8000000B2 at col. 10, ll. 47–53. |
| 2.1 | The visual prosthesis apparatus of claim 1 , |  |
| 2.2 | wherein the retinal stimulation system is configured to notify the video processing unit of the error. | “In order to supply power and data to the Retinal stimulation system 1 , the VPU 20 may drive the external coil 14 , for example, with a 3 MHz signal. **To protect the subject, the retinal stimulation system 1 may comprise a failure detection circuit to detect direct current leakage and to notify the VPU 20 through back telemetry so that the visual prosthesis apparatus can be shut down.** ” US8000000B2 at col. 10, ll. 47–53.  “In addition, the VPU 20 may also take action when notified of the LOSS OF SYNC mode 950 . **As soon as the Retinal Stimulation System 1 enters the LOSS OF SYNC mode 950 , the Retinal Stimulation System 1 reports this fact to the VPU 20 through back telemetry.** When the VPU 20 detects that the Retinal Stimulation System 1 is in LOSS OF SYNC mode 950 , the VPU 20 may start to send 'safe' data frames to the Retinal Stimulation System 1 . 'Safe' data is data in which no stimulation output is programmed and the power to the stimulation drivers is also programmed to be off. The VPU 20 will not send data frames to the Retinal Stimulation System 1 with stimulation commands until the VPU 20 first receives back telemetry from the Retinal Stimulation System 1 indicating that the Retinal Stimulation System 1 has exited the LOSS OF SYNC mode 950 . After several unsuccessful retries by the VPU 20 to take the implant out of LOSS OF SYNC mode 950 , the VPU 20 will enter a Low Power Mode (described below) in which the implant is only powered for a very short time. In this time, the VPU 20 checks the status of the implant. If the implant continues to report a LOSS OF SYNC mode 950 , the VPU 20 turns power off to the Retinal Stimulation System 1 and tries again later. Since there is no possibility of the implant electronics causing damage when it is not powered, this mode is considered very safe. ” US8000000B2 at col. 11, ll. 32–55.  “One typical application of neural tissue stimulation is in the rehabilitation of the blind. **Some forms of blindness involve selective loss of the light sensitive transducers of the retina.** Other retinal neurons remain viable, however, and may be activated in the manner described above by placement of a prosthetic electrode device on the inner (toward the vitreous) retinal surface (epiretinal). This placement must be mechanically stable, minimize the distance between the device electrodes and the visual neurons, and avoid undue compression of the visual neurons. ” US8000000B2 at col. 2, ll. 25–34. |
| 3.1 | The visual prosthesis apparatus of claim 2 , |  |
| 3.2 | wherein the video processing unit is configured to stop transmitting the forward telemetry to the retinal stimulation system for stimulating neural tissue in the subject's eye until the error is resolved. | “The forward telemetry data (transmitted for example at 122.76 kHz) may be modulated onto the exemplary 3 MHz carrier using Amplitude Shift Keying (ASK), while the back telemetry data (transmitted for example at 3.8 kHz) may be modulated using Frequency Shift Keying (FSK) with, for example, 442 kHz and 457 kHz. The theoretical bit error rates can be calculated for both the ASK and FSK scheme assuming a ratio of signal to noise (SNR). The system disclosed in the present disclosure can be reasonably expected to see bit error rates of 10-5 on forward telemetry and 10-3 on back telemetry. These errors may be caught more than 99.998% of the time by both an ASIC hardware telemetry error detection algorithm and the VPU 20 's firmware. For the forward telemetry, this is due to the fact that a 16-bit cyclic redundancy check (CRC) is calculated for every 1024 bits sent to the ASIC within electronics package 4 of the Retinal Stimulation System 1 . **The ASIC of the Retinal Stimulation System 1 verifies this CRC and handles corrupt data by entering a non-stimulating 'safe' state and reporting that a telemetry error was detected to the VPU 20 via back telemetry.** During the 'safe' mode, the VPU 20 may attempt to return the implant to an operating state. This recovery may be on the order of milliseconds. The back telemetry words are checked for a 16-bit header and a single parity bit. For further protection against corrupt data being misread, the back telemetry is only checked for header and parity if it is recognized as properly encoded Bi-phase Mark Encoded (BPM) data. If the VPU 20 detects invalid back telemetry data, the VPU 20 immediately changes mode to a 'safe' mode where the Retinal Stimulation System 1 is reset and the VPU 20 only sends non-stimulating data frames. Back telemetry errors cannot cause the VPU 20 to do anything that would be unsafe. ” US8000000B2 at col. 10, l. 54–col. 11, l. 8.  “In order to supply power and data to the Retinal stimulation system 1 , the VPU 20 may drive the external coil 14 , for example, with a 3 MHz signal. **To protect the subject, the retinal stimulation system 1 may comprise a failure detection circuit to detect direct current leakage and to notify the VPU 20 through back telemetry so that the visual prosthesis apparatus can be shut down.** ” US8000000B2 at col. 10, ll. 47–53.  “In one exemplary embodiment, the VPU 20 is in constant communication with the retinal stimulation system 1 through forward and backward telemetry. In this document, the forward telemetry refers to transmission from VPU 20 to the retinal stimulation system 1 and the backward telemetry refers to transmissions from the Retinal stimulation system 1 to the VPU 20 . During the initial setup, the VPU 20 may transmit null frames (containing no stimulation information) until the VPU 20 synchronizes with the Retinal stimulation system 1 via the back telemetry. **In one embodiment, an audio alarm may be used to indicate whenever the synchronization has been lost.** ” US8000000B2 at col. 10, ll. 35–46. |
| 4.1 | The visual prosthesis apparatus of claim 2 , |  |
| 4.2 | wherein the video processing unit is configured to limit power transmitted to the retinal stimulation system. | “According to a third aspect, a method for limiting power consumption in a visual prosthesis apparatus comprising a retinal stimulation system and a video processing unit is disclosed, the method comprising: determining if the retinal stimulation system is transmitting a back telemetry to the video processing unit; and transmitting power and data to the retinal stimulation system only as long as the retinal stimulation system transmits the back telemetry. ” US8000000B2 at col. 3, ll. 14–21.  “According to a fifth aspect, a method for limiting power consumption in a visual prosthesis apparatus comprising a retinal stimulation system and a video processing unit is disclosed, the method comprising: a) transmitting power and data via forward telemetry to the retinal stimulation system; b) determining if the retinal stimulation system is transmitting a back telemetry to the video processing unit; c) stop transmitting the power and the data via forward telemetry to the retinal stimulation system when the retinal stimulation system does not transmit the back telemetry; d) transmitting the power to the retinal stimulation system for a predetermined amount of time; e) determining if the retinal stimulation system is transmitting the back telemetry during the predetermined amount of time; f) stop transmitting power to the retinal stimulation system when the retinal stimulation system does not transmit the back telemetry during the predetermined amount of time; and g) repeating features d) through f) until the retinal stimulation system transmits the back telemetry. ” US8000000B2 at col. 3, ll. 35–53.  “In one exemplary embodiment, the Low Power Mode may be implemented to save power for VPU 20 . The Low Power Mode may be entered, for example, anytime the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . Upon entry to the Low Power Mode, the VPU 20 turns off power to the Retinal stimulation system 1 . After that, and periodically, the VPU 20 turns power back on to the Retinal stimulation system 1 for an amount of time just long enough for the presence of the Retinal stimulation system 1 to be recognized via its back telemetry. If the Retinal stimulation system 1 is not immediately recognized, the controller again shuts off power to the Retinal stimulation system 1 . In this way, the controller 'polls' for the passive Retinal stimulation system 1 and a significant reduction in power used is seen when the Retinal stimulation system 1 is too far away from its controller device. FIG. 13 b depicts an exemplary block diagram 900 of the steps taken when the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . If the VPU 20 receives back telemetry from the Retinal stimulation system 1 (output "YES" of step 901 ), the Retinal stimulation system 1 may be provided with power and data (step 906 ). If the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 (output "NO" of step 901 ), the power to the Retinal stimulation system 1 may be turned off. After some amount of time, power to the Retinal stimulation system 1 may be turned on again for enough time to determine if the Retinal stimulation system 1 is again transmitting back telemetry (step 903 ). If the Retinal stimulation system 1 is again transmitting back telemetry (step 904 ), the Retinal stimulation system 1 is provided with power and data (step 906 ). **If the Retinal stimulation system 1 is not transmitting back telemetry (step 904 ), the power to the Retinal stimulation system 1 may again be turned off for a predetermined amount of time (step 905 ) and the process may be repeated until the Retinal stimulation system 1 is again transmitting back telemetry.** ” US8000000B2 at col. 12, ll. 29–63. |
| 5.1 | The visual prosthesis apparatus of claim 1 , |  |
| 5.2 | wherein the forward telemetry comprises the stimulation patterns. | “According to a first aspect, a visual prosthesis apparatus comprising: a camera for capturing a video image; a video processing unit associated with the camera, the video processing unit configured to convert the video image to stimulation patterns; and a retinal stimulation system configured to stop stimulating neural tissue in a subject's eye based on the stimulation patterns when an error is detected in a forward telemetry received from the video processing unit. ” US8000000B2 at col. 2, l. 77–col. 3, l. 6.  “According to a fourth aspect, a visual prosthesis apparatus comprising: a camera for capturing a video image; and a video processing unit associated with the camera and associated with a retinal stimulation system, wherein the video processing unit is configured to convert the video image to stimulation patterns and transmit the stimulation patterns to the retinal stimulation system for stimulation of neural tissue in a subject's eye, and the video processing unit is configured to stop transmitting the stimulation patterns to the retinal stimulation system when the retinal stimulation system does not transmit back telemetry or when the retinal stimulation system detects an error in a forward telemetry received from the video processing unit. ” US8000000B2 at col. 3, ll. 22–34.  “Referring to FIGS. 6 and 7 , the glasses 5 may comprise, for example, a frame 11 holding a camera 12 , an external coil 14 and a mounting system 16 for the external coil 14 . The mounting system 16 may also enclose the RF circuitry. In this configuration, the video camera 12 captures live video. The video signal is sent to an external Video Processing Unit (VPU) 20 (shown in FIGS. 9 , 11 and 12 and discussed below), which processes the video signal and subsequently transforms the processed video signal into electrical stimulation patterns or data. The electrical stimulation data are then sent to the external coil 14 that sends both data and power via radio-frequency (RF) telemetry to the coil 116 of the retinal stimulation system 1 , shown in FIGS. 2 and 3 . The coil 116 receives the RF commands which control the application specific integrated circuit (ASIC) which in turn delivers stimulation to the retina of the subject via a thin film electrode array (TFEA). In one aspect of an embodiment, light amplitude is recorded by the camera 12 . The VPU 20 may use a logarithmic encoding scheme to convert the incoming light amplitudes into the electrical stimulation patterns or data. **These electrical stimulation patterns or data may then be passed on to the Retinal Stimulation System 1 , which results in the retinal cells being stimulated via the electrodes in the electrode array 2 (shown in FIGS. 2 , 3 and 8 ).** In one exemplary embodiment, the electrical stimulation patterns or data being transmitted by the external coil 14 is binary data. The external coil 14 may contain a receiver and transmitter antennae and a radio-frequency (RF) electronics card for communicating with the internal coil 116 . ” US8000000B2 at col. 6, ll. 29–57. |
| 6.1 | A method for limiting power consumption in a visual prosthesis apparatus comprising a retinal stimulation system and a video processing unit, the method comprising: | “According to a fifth aspect, a method for limiting power consumption in a visual prosthesis apparatus comprising a retinal stimulation system and a video processing unit is disclosed, the method comprising: a) transmitting power and data via forward telemetry to the retinal stimulation system; b) determining if the retinal stimulation system is transmitting a back telemetry to the video processing unit; c) stop transmitting the power and the data via forward telemetry to the retinal stimulation system when the retinal stimulation system does not transmit the back telemetry; d) transmitting the power to the retinal stimulation system for a predetermined amount of time; e) determining if the retinal stimulation system is transmitting the back telemetry during the predetermined amount of time; f) stop transmitting power to the retinal stimulation system when the retinal stimulation system does not transmit the back telemetry during the predetermined amount of time; and g) repeating features d) through f) until the retinal stimulation system transmits the back telemetry. ” US8000000B2 at col. 3, ll. 35–53.  “According to a third aspect, a method for limiting power consumption in a visual prosthesis apparatus comprising a retinal stimulation system and a video processing unit is disclosed, the method comprising: determining if the retinal stimulation system is transmitting a back telemetry to the video processing unit; and transmitting power and data to the retinal stimulation system only as long as the retinal stimulation system transmits the back telemetry. ” US8000000B2 at col. 3, ll. 14–21.  “According to a second aspect, method for limiting power consumption in a visual prosthesis apparatus comprising a video capture device and a retinal stimulation system is disclosed, the method comprising: determining if a subject is wearing the video capture device; and transmitting power and data to the retinal stimulation system only as long as the subject is wearing the video capture device. ” US8000000B2 at col. 3, ll. 7–13. |
| 6.2 | determining if the retinal stimulation system is transmitting valid back telemetry data to the video processing unit by sending data without stimulation signals; | “In addition, the VPU 20 may also take action when notified of the LOSS OF SYNC mode 950 . As soon as the Retinal Stimulation System 1 enters the LOSS OF SYNC mode 950 , the Retinal Stimulation System 1 reports this fact to the VPU 20 through back telemetry. When the VPU 20 detects that the Retinal Stimulation System 1 is in LOSS OF SYNC mode 950 , the VPU 20 may start to send 'safe' data frames to the Retinal Stimulation System 1 . **'Safe' data is data in which no stimulation output is programmed and the power to the stimulation drivers is also programmed to be off.** The VPU 20 will not send data frames to the Retinal Stimulation System 1 with stimulation commands until the VPU 20 first receives back telemetry from the Retinal Stimulation System 1 indicating that the Retinal Stimulation System 1 has exited the LOSS OF SYNC mode 950 . After several unsuccessful retries by the VPU 20 to take the implant out of LOSS OF SYNC mode 950 , the VPU 20 will enter a Low Power Mode (described below) in which the implant is only powered for a very short time. In this time, the VPU 20 checks the status of the implant. If the implant continues to report a LOSS OF SYNC mode 950 , the VPU 20 turns power off to the Retinal Stimulation System 1 and tries again later. Since there is no possibility of the implant electronics causing damage when it is not powered, this mode is considered very safe. ” US8000000B2 at col. 11, ll. 32–55.  “The forward telemetry data (transmitted for example at 122.76 kHz) may be modulated onto the exemplary 3 MHz carrier using Amplitude Shift Keying (ASK), while the back telemetry data (transmitted for example at 3.8 kHz) may be modulated using Frequency Shift Keying (FSK) with, for example, 442 kHz and 457 kHz. The theoretical bit error rates can be calculated for both the ASK and FSK scheme assuming a ratio of signal to noise (SNR). The system disclosed in the present disclosure can be reasonably expected to see bit error rates of 10-5 on forward telemetry and 10-3 on back telemetry. These errors may be caught more than 99.998% of the time by both an ASIC hardware telemetry error detection algorithm and the VPU 20 's firmware. For the forward telemetry, this is due to the fact that a 16-bit cyclic redundancy check (CRC) is calculated for every 1024 bits sent to the ASIC within electronics package 4 of the Retinal Stimulation System 1 . The ASIC of the Retinal Stimulation System 1 verifies this CRC and handles corrupt data by entering a non-stimulating 'safe' state and reporting that a telemetry error was detected to the VPU 20 via back telemetry. During the 'safe' mode, the VPU 20 may attempt to return the implant to an operating state. This recovery may be on the order of milliseconds. The back telemetry words are checked for a 16-bit header and a single parity bit. For further protection against corrupt data being misread, the back telemetry is only checked for header and parity if it is recognized as properly encoded Bi-phase Mark Encoded (BPM) data. **If the VPU 20 detects invalid back telemetry data, the VPU 20 immediately changes mode to a 'safe' mode where the Retinal Stimulation System 1 is reset and the VPU 20 only sends non-stimulating data frames.** Back telemetry errors cannot cause the VPU 20 to do anything that would be unsafe. ” US8000000B2 at col. 10, l. 54–col. 11, l. 8.  “In one exemplary embodiment, the VPU 20 is in constant communication with the retinal stimulation system 1 through forward and backward telemetry. In this document, the forward telemetry refers to transmission from VPU 20 to the retinal stimulation system 1 and the backward telemetry refers to transmissions from the Retinal stimulation system 1 to the VPU 20 . **During the initial setup, the VPU 20 may transmit null frames (containing no stimulation information) until the VPU 20 synchronizes with the Retinal stimulation system 1 via the back telemetry.** In one embodiment, an audio alarm may be used to indicate whenever the synchronization has been lost. ” US8000000B2 at col. 10, ll. 35–46. |
| 6.3 | and transmitting power and data to the retinal stimulation system only as long as the retinal stimulation system transmits the valid back telemetry data. | “In one exemplary embodiment, the Low Power Mode may be implemented to save power for VPU 20 . The Low Power Mode may be entered, for example, anytime the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . Upon entry to the Low Power Mode, the VPU 20 turns off power to the Retinal stimulation system 1 . After that, and periodically, the VPU 20 turns power back on to the Retinal stimulation system 1 for an amount of time just long enough for the presence of the Retinal stimulation system 1 to be recognized via its back telemetry. If the Retinal stimulation system 1 is not immediately recognized, the controller again shuts off power to the Retinal stimulation system 1 . In this way, the controller 'polls' for the passive Retinal stimulation system 1 and a significant reduction in power used is seen when the Retinal stimulation system 1 is too far away from its controller device. FIG. 13 b depicts an exemplary block diagram 900 of the steps taken when the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . If the VPU 20 receives back telemetry from the Retinal stimulation system 1 (output "YES" of step 901 ), the Retinal stimulation system 1 may be provided with power and data (step 906 ). If the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 (output "NO" of step 901 ), the power to the Retinal stimulation system 1 may be turned off. After some amount of time, power to the Retinal stimulation system 1 may be turned on again for enough time to determine if the Retinal stimulation system 1 is again transmitting back telemetry (step 903 ). If the Retinal stimulation system 1 is again transmitting back telemetry (step 904 ), the Retinal stimulation system 1 is provided with power and data (step 906 ). **If the Retinal stimulation system 1 is not transmitting back telemetry (step 904 ), the power to the Retinal stimulation system 1 may again be turned off for a predetermined amount of time (step 905 ) and the process may be repeated until the Retinal stimulation system 1 is again transmitting back telemetry.** ” US8000000B2 at col. 12, ll. 29–63.  “In one exemplary embodiment, the Low Power Mode may be implemented to save power for VPU 20 . The Low Power Mode may be entered, for example, anytime the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . Upon entry to the Low Power Mode, the VPU 20 turns off power to the Retinal stimulation system 1 . After that, and periodically, the VPU 20 turns power back on to the Retinal stimulation system 1 for an amount of time just long enough for the presence of the Retinal stimulation system 1 to be recognized via its back telemetry. If the Retinal stimulation system 1 is not immediately recognized, the controller again shuts off power to the Retinal stimulation system 1 . In this way, the controller 'polls' for the passive Retinal stimulation system 1 and a significant reduction in power used is seen when the Retinal stimulation system 1 is too far away from its controller device. FIG. 13 b depicts an exemplary block diagram 900 of the steps taken when the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . If the VPU 20 receives back telemetry from the Retinal stimulation system 1 (output "YES" of step 901 ), the Retinal stimulation system 1 may be provided with power and data (step 906 ). If the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 (output "NO" of step 901 ), the power to the Retinal stimulation system 1 may be turned off. After some amount of time, power to the Retinal stimulation system 1 may be turned on again for enough time to determine if the Retinal stimulation system 1 is again transmitting back telemetry (step 903 ). **If the Retinal stimulation system 1 is again transmitting back telemetry (step 904 ), the Retinal stimulation system 1 is provided with power and data (step 906 ).** If the Retinal stimulation system 1 is not transmitting back telemetry (step 904 ), the power to the Retinal stimulation system 1 may again be turned off for a predetermined amount of time (step 905 ) and the process may be repeated until the Retinal stimulation system 1 is again transmitting back telemetry. ” US8000000B2 at col. 12, ll. 29–63.  “According to a third aspect, a method for limiting power consumption in a visual prosthesis apparatus comprising a retinal stimulation system and a video processing unit is disclosed, the method comprising: determining if the retinal stimulation system is transmitting a back telemetry to the video processing unit; and transmitting power and data to the retinal stimulation system only as long as the retinal stimulation system transmits the back telemetry. ” US8000000B2 at col. 3, ll. 14–21. |
| 7.1 | A method of claim 6 , further comprising: |  |
| 7.2 | periodically transmitting power to the retinal stimulation system until the retinal stimulation system transmits the back telemetry. | “In one exemplary embodiment, the Low Power Mode may be implemented to save power for VPU 20 . The Low Power Mode may be entered, for example, anytime the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . Upon entry to the Low Power Mode, the VPU 20 turns off power to the Retinal stimulation system 1 . After that, and periodically, the VPU 20 turns power back on to the Retinal stimulation system 1 for an amount of time just long enough for the presence of the Retinal stimulation system 1 to be recognized via its back telemetry. If the Retinal stimulation system 1 is not immediately recognized, the controller again shuts off power to the Retinal stimulation system 1 . In this way, the controller 'polls' for the passive Retinal stimulation system 1 and a significant reduction in power used is seen when the Retinal stimulation system 1 is too far away from its controller device. FIG. 13 b depicts an exemplary block diagram 900 of the steps taken when the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . If the VPU 20 receives back telemetry from the Retinal stimulation system 1 (output "YES" of step 901 ), the Retinal stimulation system 1 may be provided with power and data (step 906 ). If the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 (output "NO" of step 901 ), the power to the Retinal stimulation system 1 may be turned off. After some amount of time, power to the Retinal stimulation system 1 may be turned on again for enough time to determine if the Retinal stimulation system 1 is again transmitting back telemetry (step 903 ). If the Retinal stimulation system 1 is again transmitting back telemetry (step 904 ), the Retinal stimulation system 1 is provided with power and data (step 906 ). **If the Retinal stimulation system 1 is not transmitting back telemetry (step 904 ), the power to the Retinal stimulation system 1 may again be turned off for a predetermined amount of time (step 905 ) and the process may be repeated until the Retinal stimulation system 1 is again transmitting back telemetry.** ” US8000000B2 at col. 12, ll. 29–63.  “In one exemplary embodiment, the Low Power Mode may be implemented to save power for VPU 20 . The Low Power Mode may be entered, for example, anytime the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . Upon entry to the Low Power Mode, the VPU 20 turns off power to the Retinal stimulation system 1 . After that, and periodically, the VPU 20 turns power back on to the Retinal stimulation system 1 for an amount of time just long enough for the presence of the Retinal stimulation system 1 to be recognized via its back telemetry. If the Retinal stimulation system 1 is not immediately recognized, the controller again shuts off power to the Retinal stimulation system 1 . In this way, the controller 'polls' for the passive Retinal stimulation system 1 and a significant reduction in power used is seen when the Retinal stimulation system 1 is too far away from its controller device. FIG. 13 b depicts an exemplary block diagram 900 of the steps taken when the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . If the VPU 20 receives back telemetry from the Retinal stimulation system 1 (output "YES" of step 901 ), the Retinal stimulation system 1 may be provided with power and data (step 906 ). If the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 (output "NO" of step 901 ), the power to the Retinal stimulation system 1 may be turned off. After some amount of time, power to the Retinal stimulation system 1 may be turned on again for enough time to determine if the Retinal stimulation system 1 is again transmitting back telemetry (step 903 ). **If the Retinal stimulation system 1 is again transmitting back telemetry (step 904 ), the Retinal stimulation system 1 is provided with power and data (step 906 ).** If the Retinal stimulation system 1 is not transmitting back telemetry (step 904 ), the power to the Retinal stimulation system 1 may again be turned off for a predetermined amount of time (step 905 ) and the process may be repeated until the Retinal stimulation system 1 is again transmitting back telemetry. ” US8000000B2 at col. 12, ll. 29–63.  “In one exemplary embodiment, the Low Power Mode may be implemented to save power for VPU 20 . The Low Power Mode may be entered, for example, anytime the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . Upon entry to the Low Power Mode, the VPU 20 turns off power to the Retinal stimulation system 1 . After that, and periodically, the VPU 20 turns power back on to the Retinal stimulation system 1 for an amount of time just long enough for the presence of the Retinal stimulation system 1 to be recognized via its back telemetry. If the Retinal stimulation system 1 is not immediately recognized, the controller again shuts off power to the Retinal stimulation system 1 . In this way, the controller 'polls' for the passive Retinal stimulation system 1 and a significant reduction in power used is seen when the Retinal stimulation system 1 is too far away from its controller device. FIG. 13 b depicts an exemplary block diagram 900 of the steps taken when the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . If the VPU 20 receives back telemetry from the Retinal stimulation system 1 (output "YES" of step 901 ), the Retinal stimulation system 1 may be provided with power and data (step 906 ). If the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 (output "NO" of step 901 ), the power to the Retinal stimulation system 1 may be turned off. **After some amount of time, power to the Retinal stimulation system 1 may be turned on again for enough time to determine if the Retinal stimulation system 1 is again transmitting back telemetry (step 903 ).** If the Retinal stimulation system 1 is again transmitting back telemetry (step 904 ), the Retinal stimulation system 1 is provided with power and data (step 906 ). If the Retinal stimulation system 1 is not transmitting back telemetry (step 904 ), the power to the Retinal stimulation system 1 may again be turned off for a predetermined amount of time (step 905 ) and the process may be repeated until the Retinal stimulation system 1 is again transmitting back telemetry. ” US8000000B2 at col. 12, ll. 29–63. |
| 8.1 | A visual prosthesis apparatus comprising: | “**FIG. 1 shows a visual prosthesis apparatus.** The visual apparatus comprises, in combination, an implantable retinal stimulation system 1 and a video capture/transmission apparatus or visor embodied in visor/Glasses 5 . An exemplary retinal stimulation system 1 is shown in more detail in FIGS. 2 and 3 and an exemplary visor 5 is shown in more detail in FIGS. 6 and 7 . ” US8000000B2 at col. 4, ll. 48–54.  “FIG. 1 shows a visual prosthesis apparatus according to the present disclosure. ” US8000000B2 at col. 3, ll. 57–58.  “The visual prosthesis apparatus of FIG. 1 may operate in two modes: i) stand-alone mode and ii) communication mode. ” US8000000B2 at col. 8, ll. 29–31. |
| 8.2 | a camera for capturing a video image; | “According to a first aspect, a visual prosthesis apparatus comprising: a camera for capturing a video image; a video processing unit associated with the camera, the video processing unit configured to convert the video image to stimulation patterns; and a retinal stimulation system configured to stop stimulating neural tissue in a subject's eye based on the stimulation patterns when an error is detected in a forward telemetry received from the video processing unit. ” US8000000B2 at col. 2, l. 77–col. 3, l. 6.  “According to a fourth aspect, a visual prosthesis apparatus comprising: a camera for capturing a video image; and a video processing unit associated with the camera and associated with a retinal stimulation system, wherein the video processing unit is configured to convert the video image to stimulation patterns and transmit the stimulation patterns to the retinal stimulation system for stimulation of neural tissue in a subject's eye, and the video processing unit is configured to stop transmitting the stimulation patterns to the retinal stimulation system when the retinal stimulation system does not transmit back telemetry or when the retinal stimulation system detects an error in a forward telemetry received from the video processing unit. ” US8000000B2 at col. 3, ll. 22–34.  “Referring to FIGS. 6 and 7 , the glasses 5 may comprise, for example, a frame 11 holding a camera 12 , an external coil 14 and a mounting system 16 for the external coil 14 . The mounting system 16 may also enclose the RF circuitry. In this configuration, the video camera 12 captures live video. The video signal is sent to an external Video Processing Unit (VPU) 20 (shown in FIGS. 9 , 11 and 12 and discussed below), which processes the video signal and subsequently transforms the processed video signal into electrical stimulation patterns or data. The electrical stimulation data are then sent to the external coil 14 that sends both data and power via radio-frequency (RF) telemetry to the coil 116 of the retinal stimulation system 1 , shown in FIGS. 2 and 3 . The coil 116 receives the RF commands which control the application specific integrated circuit (ASIC) which in turn delivers stimulation to the retina of the subject via a thin film electrode array (TFEA). **In one aspect of an embodiment, light amplitude is recorded by the camera 12 .** The VPU 20 may use a logarithmic encoding scheme to convert the incoming light amplitudes into the electrical stimulation patterns or data. These electrical stimulation patterns or data may then be passed on to the Retinal Stimulation System 1 , which results in the retinal cells being stimulated via the electrodes in the electrode array 2 (shown in FIGS. 2 , 3 and 8 ). In one exemplary embodiment, the electrical stimulation patterns or data being transmitted by the external coil 14 is binary data. The external coil 14 may contain a receiver and transmitter antennae and a radio-frequency (RF) electronics card for communicating with the internal coil 116 . ” US8000000B2 at col. 6, ll. 29–57. |
| 8.3 | and a video processing unit associated with the camera and associated with a retinal stimulation system, | “According to a first aspect, a visual prosthesis apparatus comprising: a camera for capturing a video image; a video processing unit associated with the camera, the video processing unit configured to convert the video image to stimulation patterns; and a retinal stimulation system configured to stop stimulating neural tissue in a subject's eye based on the stimulation patterns when an error is detected in a forward telemetry received from the video processing unit. ” US8000000B2 at col. 2, l. 77–col. 3, l. 6.  “According to a fourth aspect, a visual prosthesis apparatus comprising: a camera for capturing a video image; and a video processing unit associated with the camera and associated with a retinal stimulation system, wherein the video processing unit is configured to convert the video image to stimulation patterns and transmit the stimulation patterns to the retinal stimulation system for stimulation of neural tissue in a subject's eye, and the video processing unit is configured to stop transmitting the stimulation patterns to the retinal stimulation system when the retinal stimulation system does not transmit back telemetry or when the retinal stimulation system detects an error in a forward telemetry received from the video processing unit. ” US8000000B2 at col. 3, ll. 22–34.  “**Referring to FIGS. 6 and 7 , the glasses 5 may comprise, for example, a frame 11 holding a camera 12 , an external coil 14 and a mounting system 16 for the external coil 14 .** The mounting system 16 may also enclose the RF circuitry. In this configuration, the video camera 12 captures live video. The video signal is sent to an external Video Processing Unit (VPU) 20 (shown in FIGS. 9 , 11 and 12 and discussed below), which processes the video signal and subsequently transforms the processed video signal into electrical stimulation patterns or data. The electrical stimulation data are then sent to the external coil 14 that sends both data and power via radio-frequency (RF) telemetry to the coil 116 of the retinal stimulation system 1 , shown in FIGS. 2 and 3 . The coil 116 receives the RF commands which control the application specific integrated circuit (ASIC) which in turn delivers stimulation to the retina of the subject via a thin film electrode array (TFEA). In one aspect of an embodiment, light amplitude is recorded by the camera 12 . The VPU 20 may use a logarithmic encoding scheme to convert the incoming light amplitudes into the electrical stimulation patterns or data. These electrical stimulation patterns or data may then be passed on to the Retinal Stimulation System 1 , which results in the retinal cells being stimulated via the electrodes in the electrode array 2 (shown in FIGS. 2 , 3 and 8 ). In one exemplary embodiment, the electrical stimulation patterns or data being transmitted by the external coil 14 is binary data. The external coil 14 may contain a receiver and transmitter antennae and a radio-frequency (RF) electronics card for communicating with the internal coil 116 . ” US8000000B2 at col. 6, ll. 29–57. |
| 8.4 | wherein the video processing unit is configured to convert the video image to stimulation patterns and transmit the stimulation patterns to the retinal stimulation system for stimulation of neural tissue in a subject's eye, | “According to a fourth aspect, a visual prosthesis apparatus comprising: a camera for capturing a video image; and a video processing unit associated with the camera and associated with a retinal stimulation system, wherein the video processing unit is configured to convert the video image to stimulation patterns and transmit the stimulation patterns to the retinal stimulation system for stimulation of neural tissue in a subject's eye, and the video processing unit is configured to stop transmitting the stimulation patterns to the retinal stimulation system when the retinal stimulation system does not transmit back telemetry or when the retinal stimulation system detects an error in a forward telemetry received from the video processing unit. ” US8000000B2 at col. 3, ll. 22–34.  “According to a first aspect, a visual prosthesis apparatus comprising: a camera for capturing a video image; a video processing unit associated with the camera, the video processing unit configured to convert the video image to stimulation patterns; and a retinal stimulation system configured to stop stimulating neural tissue in a subject's eye based on the stimulation patterns when an error is detected in a forward telemetry received from the video processing unit. ” US8000000B2 at col. 2, l. 77–col. 3, l. 6.  “Referring to FIGS. 1 , 2 and 10 , in the stand-alone mode, the video camera 12 , on the glasses 5 , captures a video image that is sent to the VPU 20 . **The VPU 20 processes the image from the camera 12 and transforms it into electrical stimulation patterns that are transmitted to the external coil 14 .** The external coil 14 sends the electrical stimulation patterns and power via radio-frequency (RF) telemetry to the implanted retinal stimulation system 1 ( FIGS. 2 and 3 ). The internal coil 116 of the retinal stimulation system 1 receives the RF commands from the external coil 14 and transmits them to the electronics package 4 that in turn delivers stimulation to the retina via the electrode array 2 . Additionally, the retinal stimulation system 1 may communicate safety and operational status back to the VPU 20 by transmitting RF telemetry from the internal coil 116 to the external coil 14 . The visual prosthesis apparatus of FIG. 1 may be configured to electrically activate the retinal stimulation system 1 only when it is powered by the VPU 20 through the external coil 14 . The stand-alone mode may be used for clinical testing and/or at-home use by the subject. ” US8000000B2 at col. 8, ll. 33–51. |
| 8.5 | and the video processing unit is configured to stop transmitting the stimulation patterns to the retinal stimulation system when the retinal stimulation system detects an error in a forward telemetry received from the video processing unit, and does not transmit valid, non-error, back telemetry data. | “In addition, the VPU 20 may also take action when notified of the LOSS OF SYNC mode 950 . As soon as the Retinal Stimulation System 1 enters the LOSS OF SYNC mode 950 , the Retinal Stimulation System 1 reports this fact to the VPU 20 through back telemetry. When the VPU 20 detects that the Retinal Stimulation System 1 is in LOSS OF SYNC mode 950 , the VPU 20 may start to send 'safe' data frames to the Retinal Stimulation System 1 . **'Safe' data is data in which no stimulation output is programmed and the power to the stimulation drivers is also programmed to be off.** The VPU 20 will not send data frames to the Retinal Stimulation System 1 with stimulation commands until the VPU 20 first receives back telemetry from the Retinal Stimulation System 1 indicating that the Retinal Stimulation System 1 has exited the LOSS OF SYNC mode 950 . After several unsuccessful retries by the VPU 20 to take the implant out of LOSS OF SYNC mode 950 , the VPU 20 will enter a Low Power Mode (described below) in which the implant is only powered for a very short time. In this time, the VPU 20 checks the status of the implant. If the implant continues to report a LOSS OF SYNC mode 950 , the VPU 20 turns power off to the Retinal Stimulation System 1 and tries again later. Since there is no possibility of the implant electronics causing damage when it is not powered, this mode is considered very safe. ” US8000000B2 at col. 11, ll. 32–55.  “The forward telemetry data (transmitted for example at 122.76 kHz) may be modulated onto the exemplary 3 MHz carrier using Amplitude Shift Keying (ASK), while the back telemetry data (transmitted for example at 3.8 kHz) may be modulated using Frequency Shift Keying (FSK) with, for example, 442 kHz and 457 kHz. The theoretical bit error rates can be calculated for both the ASK and FSK scheme assuming a ratio of signal to noise (SNR). The system disclosed in the present disclosure can be reasonably expected to see bit error rates of 10-5 on forward telemetry and 10-3 on back telemetry. These errors may be caught more than 99.998% of the time by both an ASIC hardware telemetry error detection algorithm and the VPU 20 's firmware. For the forward telemetry, this is due to the fact that a 16-bit cyclic redundancy check (CRC) is calculated for every 1024 bits sent to the ASIC within electronics package 4 of the Retinal Stimulation System 1 . The ASIC of the Retinal Stimulation System 1 verifies this CRC and handles corrupt data by entering a non-stimulating 'safe' state and reporting that a telemetry error was detected to the VPU 20 via back telemetry. During the 'safe' mode, the VPU 20 may attempt to return the implant to an operating state. This recovery may be on the order of milliseconds. The back telemetry words are checked for a 16-bit header and a single parity bit. For further protection against corrupt data being misread, the back telemetry is only checked for header and parity if it is recognized as properly encoded Bi-phase Mark Encoded (BPM) data. **If the VPU 20 detects invalid back telemetry data, the VPU 20 immediately changes mode to a 'safe' mode where the Retinal Stimulation System 1 is reset and the VPU 20 only sends non-stimulating data frames.** Back telemetry errors cannot cause the VPU 20 to do anything that would be unsafe. ” US8000000B2 at col. 10, l. 54–col. 11, l. 8.  “According to a fourth aspect, a visual prosthesis apparatus comprising: a camera for capturing a video image; and a video processing unit associated with the camera and associated with a retinal stimulation system, wherein the video processing unit is configured to convert the video image to stimulation patterns and transmit the stimulation patterns to the retinal stimulation system for stimulation of neural tissue in a subject's eye, and the video processing unit is configured to stop transmitting the stimulation patterns to the retinal stimulation system when the retinal stimulation system does not transmit back telemetry or when the retinal stimulation system detects an error in a forward telemetry received from the video processing unit. ” US8000000B2 at col. 3, ll. 22–34. |
| 9.1 | The visual prosthesis apparatus of claim 8 , |  |
| 9.2 | wherein the retinal stimulation system is configured to notify the video processing unit of the error. | “In order to supply power and data to the Retinal stimulation system 1 , the VPU 20 may drive the external coil 14 , for example, with a 3 MHz signal. **To protect the subject, the retinal stimulation system 1 may comprise a failure detection circuit to detect direct current leakage and to notify the VPU 20 through back telemetry so that the visual prosthesis apparatus can be shut down.** ” US8000000B2 at col. 10, ll. 47–53.  “In addition, the VPU 20 may also take action when notified of the LOSS OF SYNC mode 950 . **As soon as the Retinal Stimulation System 1 enters the LOSS OF SYNC mode 950 , the Retinal Stimulation System 1 reports this fact to the VPU 20 through back telemetry.** When the VPU 20 detects that the Retinal Stimulation System 1 is in LOSS OF SYNC mode 950 , the VPU 20 may start to send 'safe' data frames to the Retinal Stimulation System 1 . 'Safe' data is data in which no stimulation output is programmed and the power to the stimulation drivers is also programmed to be off. The VPU 20 will not send data frames to the Retinal Stimulation System 1 with stimulation commands until the VPU 20 first receives back telemetry from the Retinal Stimulation System 1 indicating that the Retinal Stimulation System 1 has exited the LOSS OF SYNC mode 950 . After several unsuccessful retries by the VPU 20 to take the implant out of LOSS OF SYNC mode 950 , the VPU 20 will enter a Low Power Mode (described below) in which the implant is only powered for a very short time. In this time, the VPU 20 checks the status of the implant. If the implant continues to report a LOSS OF SYNC mode 950 , the VPU 20 turns power off to the Retinal Stimulation System 1 and tries again later. Since there is no possibility of the implant electronics causing damage when it is not powered, this mode is considered very safe. ” US8000000B2 at col. 11, ll. 32–55.  “One typical application of neural tissue stimulation is in the rehabilitation of the blind. **Some forms of blindness involve selective loss of the light sensitive transducers of the retina.** Other retinal neurons remain viable, however, and may be activated in the manner described above by placement of a prosthetic electrode device on the inner (toward the vitreous) retinal surface (epiretinal). This placement must be mechanically stable, minimize the distance between the device electrodes and the visual neurons, and avoid undue compression of the visual neurons. ” US8000000B2 at col. 2, ll. 25–34. |
| 10.1 | The visual prosthesis apparatus of claim 9 , |  |
| 10.2 | wherein the retinal stimulation system is configured to stop stimulating neural tissue in the subject's eye until the error is resolved. | “The eye moves constantly. **The eye moves to scan a scene and also has a jitter motion to prevent image stabilization.** Even though such motion is useless in the blind, it often continues long after a person has lost their sight. Thus, in one embodiment of the present disclosure, the entire retinal stimulation system 1 of the prosthesis is attached to and supported by the sclera of a subject. By placing the device under the rectus muscles with the electronics package in an area of fatty tissue between the rectus muscles, eye motion does not cause any flexing which might fatigue, and eventually damage, the device. ” US8000000B2 at col. 5, ll. 50–60.  “In order to supply power and data to the Retinal stimulation system 1 , the VPU 20 may drive the external coil 14 , for example, with a 3 MHz signal. **To protect the subject, the retinal stimulation system 1 may comprise a failure detection circuit to detect direct current leakage and to notify the VPU 20 through back telemetry so that the visual prosthesis apparatus can be shut down.** ” US8000000B2 at col. 10, ll. 47–53.  “One typical application of neural tissue stimulation is in the rehabilitation of the blind. **Some forms of blindness involve selective loss of the light sensitive transducers of the retina.** Other retinal neurons remain viable, however, and may be activated in the manner described above by placement of a prosthetic electrode device on the inner (toward the vitreous) retinal surface (epiretinal). This placement must be mechanically stable, minimize the distance between the device electrodes and the visual neurons, and avoid undue compression of the visual neurons. ” US8000000B2 at col. 2, ll. 25–34. |
| 11.1 | The visual prosthesis apparatus of claim 9 , |  |
| 11.2 | wherein the video processing unit is configured to limit power transmitted to the retinal stimulation system. | “According to a third aspect, a method for limiting power consumption in a visual prosthesis apparatus comprising a retinal stimulation system and a video processing unit is disclosed, the method comprising: determining if the retinal stimulation system is transmitting a back telemetry to the video processing unit; and transmitting power and data to the retinal stimulation system only as long as the retinal stimulation system transmits the back telemetry. ” US8000000B2 at col. 3, ll. 14–21.  “According to a fifth aspect, a method for limiting power consumption in a visual prosthesis apparatus comprising a retinal stimulation system and a video processing unit is disclosed, the method comprising: a) transmitting power and data via forward telemetry to the retinal stimulation system; b) determining if the retinal stimulation system is transmitting a back telemetry to the video processing unit; c) stop transmitting the power and the data via forward telemetry to the retinal stimulation system when the retinal stimulation system does not transmit the back telemetry; d) transmitting the power to the retinal stimulation system for a predetermined amount of time; e) determining if the retinal stimulation system is transmitting the back telemetry during the predetermined amount of time; f) stop transmitting power to the retinal stimulation system when the retinal stimulation system does not transmit the back telemetry during the predetermined amount of time; and g) repeating features d) through f) until the retinal stimulation system transmits the back telemetry. ” US8000000B2 at col. 3, ll. 35–53.  “In one exemplary embodiment, the Low Power Mode may be implemented to save power for VPU 20 . The Low Power Mode may be entered, for example, anytime the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . Upon entry to the Low Power Mode, the VPU 20 turns off power to the Retinal stimulation system 1 . After that, and periodically, the VPU 20 turns power back on to the Retinal stimulation system 1 for an amount of time just long enough for the presence of the Retinal stimulation system 1 to be recognized via its back telemetry. If the Retinal stimulation system 1 is not immediately recognized, the controller again shuts off power to the Retinal stimulation system 1 . In this way, the controller 'polls' for the passive Retinal stimulation system 1 and a significant reduction in power used is seen when the Retinal stimulation system 1 is too far away from its controller device. FIG. 13 b depicts an exemplary block diagram 900 of the steps taken when the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . If the VPU 20 receives back telemetry from the Retinal stimulation system 1 (output "YES" of step 901 ), the Retinal stimulation system 1 may be provided with power and data (step 906 ). If the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 (output "NO" of step 901 ), the power to the Retinal stimulation system 1 may be turned off. After some amount of time, power to the Retinal stimulation system 1 may be turned on again for enough time to determine if the Retinal stimulation system 1 is again transmitting back telemetry (step 903 ). If the Retinal stimulation system 1 is again transmitting back telemetry (step 904 ), the Retinal stimulation system 1 is provided with power and data (step 906 ). **If the Retinal stimulation system 1 is not transmitting back telemetry (step 904 ), the power to the Retinal stimulation system 1 may again be turned off for a predetermined amount of time (step 905 ) and the process may be repeated until the Retinal stimulation system 1 is again transmitting back telemetry.** ” US8000000B2 at col. 12, ll. 29–63. |
| 12.1 | A method for limiting power consumption in a visual prosthesis apparatus comprising a retinal stimulation system and a video processing unit, the method comprising: | “According to a fifth aspect, a method for limiting power consumption in a visual prosthesis apparatus comprising a retinal stimulation system and a video processing unit is disclosed, the method comprising: a) transmitting power and data via forward telemetry to the retinal stimulation system; b) determining if the retinal stimulation system is transmitting a back telemetry to the video processing unit; c) stop transmitting the power and the data via forward telemetry to the retinal stimulation system when the retinal stimulation system does not transmit the back telemetry; d) transmitting the power to the retinal stimulation system for a predetermined amount of time; e) determining if the retinal stimulation system is transmitting the back telemetry during the predetermined amount of time; f) stop transmitting power to the retinal stimulation system when the retinal stimulation system does not transmit the back telemetry during the predetermined amount of time; and g) repeating features d) through f) until the retinal stimulation system transmits the back telemetry. ” US8000000B2 at col. 3, ll. 35–53.  “According to a third aspect, a method for limiting power consumption in a visual prosthesis apparatus comprising a retinal stimulation system and a video processing unit is disclosed, the method comprising: determining if the retinal stimulation system is transmitting a back telemetry to the video processing unit; and transmitting power and data to the retinal stimulation system only as long as the retinal stimulation system transmits the back telemetry. ” US8000000B2 at col. 3, ll. 14–21.  “According to a second aspect, method for limiting power consumption in a visual prosthesis apparatus comprising a video capture device and a retinal stimulation system is disclosed, the method comprising: determining if a subject is wearing the video capture device; and transmitting power and data to the retinal stimulation system only as long as the subject is wearing the video capture device. ” US8000000B2 at col. 3, ll. 7–13. |
| 12.2 | a) transmitting power and data via forward telemetry to the retinal stimulation system; | “In one exemplary embodiment, the Low Power Mode may be implemented to save power for VPU 20 . The Low Power Mode may be entered, for example, anytime the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . Upon entry to the Low Power Mode, the VPU 20 turns off power to the Retinal stimulation system 1 . After that, and periodically, the VPU 20 turns power back on to the Retinal stimulation system 1 for an amount of time just long enough for the presence of the Retinal stimulation system 1 to be recognized via its back telemetry. If the Retinal stimulation system 1 is not immediately recognized, the controller again shuts off power to the Retinal stimulation system 1 . In this way, the controller 'polls' for the passive Retinal stimulation system 1 and a significant reduction in power used is seen when the Retinal stimulation system 1 is too far away from its controller device. FIG. 13 b depicts an exemplary block diagram 900 of the steps taken when the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . If the VPU 20 receives back telemetry from the Retinal stimulation system 1 (output "YES" of step 901 ), the Retinal stimulation system 1 may be provided with power and data (step 906 ). If the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 (output "NO" of step 901 ), the power to the Retinal stimulation system 1 may be turned off. After some amount of time, power to the Retinal stimulation system 1 may be turned on again for enough time to determine if the Retinal stimulation system 1 is again transmitting back telemetry (step 903 ). **If the Retinal stimulation system 1 is again transmitting back telemetry (step 904 ), the Retinal stimulation system 1 is provided with power and data (step 906 ).** If the Retinal stimulation system 1 is not transmitting back telemetry (step 904 ), the power to the Retinal stimulation system 1 may again be turned off for a predetermined amount of time (step 905 ) and the process may be repeated until the Retinal stimulation system 1 is again transmitting back telemetry. ” US8000000B2 at col. 12, ll. 29–63.  “According to a fifth aspect, a method for limiting power consumption in a visual prosthesis apparatus comprising a retinal stimulation system and a video processing unit is disclosed, the method comprising: a) transmitting power and data via forward telemetry to the retinal stimulation system; b) determining if the retinal stimulation system is transmitting a back telemetry to the video processing unit; c) stop transmitting the power and the data via forward telemetry to the retinal stimulation system when the retinal stimulation system does not transmit the back telemetry; d) transmitting the power to the retinal stimulation system for a predetermined amount of time; e) determining if the retinal stimulation system is transmitting the back telemetry during the predetermined amount of time; f) stop transmitting power to the retinal stimulation system when the retinal stimulation system does not transmit the back telemetry during the predetermined amount of time; and g) repeating features d) through f) until the retinal stimulation system transmits the back telemetry. ” US8000000B2 at col. 3, ll. 35–53.  “In one exemplary embodiment, the Low Power Mode may be implemented to save power for VPU 20 . The Low Power Mode may be entered, for example, anytime the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . Upon entry to the Low Power Mode, the VPU 20 turns off power to the Retinal stimulation system 1 . After that, and periodically, the VPU 20 turns power back on to the Retinal stimulation system 1 for an amount of time just long enough for the presence of the Retinal stimulation system 1 to be recognized via its back telemetry. If the Retinal stimulation system 1 is not immediately recognized, the controller again shuts off power to the Retinal stimulation system 1 . In this way, the controller 'polls' for the passive Retinal stimulation system 1 and a significant reduction in power used is seen when the Retinal stimulation system 1 is too far away from its controller device. FIG. 13 b depicts an exemplary block diagram 900 of the steps taken when the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . **If the VPU 20 receives back telemetry from the Retinal stimulation system 1 (output "YES" of step 901 ), the Retinal stimulation system 1 may be provided with power and data (step 906 ).** If the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 (output "NO" of step 901 ), the power to the Retinal stimulation system 1 may be turned off. After some amount of time, power to the Retinal stimulation system 1 may be turned on again for enough time to determine if the Retinal stimulation system 1 is again transmitting back telemetry (step 903 ). If the Retinal stimulation system 1 is again transmitting back telemetry (step 904 ), the Retinal stimulation system 1 is provided with power and data (step 906 ). If the Retinal stimulation system 1 is not transmitting back telemetry (step 904 ), the power to the Retinal stimulation system 1 may again be turned off for a predetermined amount of time (step 905 ) and the process may be repeated until the Retinal stimulation system 1 is again transmitting back telemetry. ” US8000000B2 at col. 12, ll. 29–63. |
| 12.3 | b) determining if the retinal stimulation system is transmitting an error signal in the back telemetry to the video processing unit; | “The forward telemetry data (transmitted for example at 122.76 kHz) may be modulated onto the exemplary 3 MHz carrier using Amplitude Shift Keying (ASK), while the back telemetry data (transmitted for example at 3.8 kHz) may be modulated using Frequency Shift Keying (FSK) with, for example, 442 kHz and 457 kHz. The theoretical bit error rates can be calculated for both the ASK and FSK scheme assuming a ratio of signal to noise (SNR). The system disclosed in the present disclosure can be reasonably expected to see bit error rates of 10-5 on forward telemetry and 10-3 on back telemetry. These errors may be caught more than 99.998% of the time by both an ASIC hardware telemetry error detection algorithm and the VPU 20 's firmware. For the forward telemetry, this is due to the fact that a 16-bit cyclic redundancy check (CRC) is calculated for every 1024 bits sent to the ASIC within electronics package 4 of the Retinal Stimulation System 1 . **The ASIC of the Retinal Stimulation System 1 verifies this CRC and handles corrupt data by entering a non-stimulating 'safe' state and reporting that a telemetry error was detected to the VPU 20 via back telemetry.** During the 'safe' mode, the VPU 20 may attempt to return the implant to an operating state. This recovery may be on the order of milliseconds. The back telemetry words are checked for a 16-bit header and a single parity bit. For further protection against corrupt data being misread, the back telemetry is only checked for header and parity if it is recognized as properly encoded Bi-phase Mark Encoded (BPM) data. If the VPU 20 detects invalid back telemetry data, the VPU 20 immediately changes mode to a 'safe' mode where the Retinal Stimulation System 1 is reset and the VPU 20 only sends non-stimulating data frames. Back telemetry errors cannot cause the VPU 20 to do anything that would be unsafe. ” US8000000B2 at col. 10, l. 54–col. 11, l. 8.  “In one exemplary embodiment, the VPU 20 is in constant communication with the retinal stimulation system 1 through forward and backward telemetry. In this document, the forward telemetry refers to transmission from VPU 20 to the retinal stimulation system 1 and the backward telemetry refers to transmissions from the Retinal stimulation system 1 to the VPU 20 . During the initial setup, the VPU 20 may transmit null frames (containing no stimulation information) until the VPU 20 synchronizes with the Retinal stimulation system 1 via the back telemetry. **In one embodiment, an audio alarm may be used to indicate whenever the synchronization has been lost.** ” US8000000B2 at col. 10, ll. 35–46.  “In order to supply power and data to the Retinal stimulation system 1 , the VPU 20 may drive the external coil 14 , for example, with a 3 MHz signal. **To protect the subject, the retinal stimulation system 1 may comprise a failure detection circuit to detect direct current leakage and to notify the VPU 20 through back telemetry so that the visual prosthesis apparatus can be shut down.** ” US8000000B2 at col. 10, ll. 47–53. |
| 12.4 | c) stop transmitting the power and the data via forward telemetry to the retinal stimulation system when the retinal stimulation system does not transmit valid, non-error, back telemetry data; | “In one exemplary embodiment, the Low Power Mode may be implemented to save power for VPU 20 . The Low Power Mode may be entered, for example, anytime the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . Upon entry to the Low Power Mode, the VPU 20 turns off power to the Retinal stimulation system 1 . After that, and periodically, the VPU 20 turns power back on to the Retinal stimulation system 1 for an amount of time just long enough for the presence of the Retinal stimulation system 1 to be recognized via its back telemetry. If the Retinal stimulation system 1 is not immediately recognized, the controller again shuts off power to the Retinal stimulation system 1 . In this way, the controller 'polls' for the passive Retinal stimulation system 1 and a significant reduction in power used is seen when the Retinal stimulation system 1 is too far away from its controller device. FIG. 13 b depicts an exemplary block diagram 900 of the steps taken when the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . If the VPU 20 receives back telemetry from the Retinal stimulation system 1 (output "YES" of step 901 ), the Retinal stimulation system 1 may be provided with power and data (step 906 ). If the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 (output "NO" of step 901 ), the power to the Retinal stimulation system 1 may be turned off. After some amount of time, power to the Retinal stimulation system 1 may be turned on again for enough time to determine if the Retinal stimulation system 1 is again transmitting back telemetry (step 903 ). If the Retinal stimulation system 1 is again transmitting back telemetry (step 904 ), the Retinal stimulation system 1 is provided with power and data (step 906 ). **If the Retinal stimulation system 1 is not transmitting back telemetry (step 904 ), the power to the Retinal stimulation system 1 may again be turned off for a predetermined amount of time (step 905 ) and the process may be repeated until the Retinal stimulation system 1 is again transmitting back telemetry.** ” US8000000B2 at col. 12, ll. 29–63.  “In addition, the VPU 20 may also take action when notified of the LOSS OF SYNC mode 950 . As soon as the Retinal Stimulation System 1 enters the LOSS OF SYNC mode 950 , the Retinal Stimulation System 1 reports this fact to the VPU 20 through back telemetry. When the VPU 20 detects that the Retinal Stimulation System 1 is in LOSS OF SYNC mode 950 , the VPU 20 may start to send 'safe' data frames to the Retinal Stimulation System 1 . **'Safe' data is data in which no stimulation output is programmed and the power to the stimulation drivers is also programmed to be off.** The VPU 20 will not send data frames to the Retinal Stimulation System 1 with stimulation commands until the VPU 20 first receives back telemetry from the Retinal Stimulation System 1 indicating that the Retinal Stimulation System 1 has exited the LOSS OF SYNC mode 950 . After several unsuccessful retries by the VPU 20 to take the implant out of LOSS OF SYNC mode 950 , the VPU 20 will enter a Low Power Mode (described below) in which the implant is only powered for a very short time. In this time, the VPU 20 checks the status of the implant. If the implant continues to report a LOSS OF SYNC mode 950 , the VPU 20 turns power off to the Retinal Stimulation System 1 and tries again later. Since there is no possibility of the implant electronics causing damage when it is not powered, this mode is considered very safe. ” US8000000B2 at col. 11, ll. 32–55.  “In one exemplary embodiment, the Low Power Mode may be implemented to save power for VPU 20 . The Low Power Mode may be entered, for example, anytime the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . Upon entry to the Low Power Mode, the VPU 20 turns off power to the Retinal stimulation system 1 . After that, and periodically, the VPU 20 turns power back on to the Retinal stimulation system 1 for an amount of time just long enough for the presence of the Retinal stimulation system 1 to be recognized via its back telemetry. If the Retinal stimulation system 1 is not immediately recognized, the controller again shuts off power to the Retinal stimulation system 1 . In this way, the controller 'polls' for the passive Retinal stimulation system 1 and a significant reduction in power used is seen when the Retinal stimulation system 1 is too far away from its controller device. FIG. 13 b depicts an exemplary block diagram 900 of the steps taken when the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . If the VPU 20 receives back telemetry from the Retinal stimulation system 1 (output "YES" of step 901 ), the Retinal stimulation system 1 may be provided with power and data (step 906 ). If the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 (output "NO" of step 901 ), the power to the Retinal stimulation system 1 may be turned off. After some amount of time, power to the Retinal stimulation system 1 may be turned on again for enough time to determine if the Retinal stimulation system 1 is again transmitting back telemetry (step 903 ). **If the Retinal stimulation system 1 is again transmitting back telemetry (step 904 ), the Retinal stimulation system 1 is provided with power and data (step 906 ).** If the Retinal stimulation system 1 is not transmitting back telemetry (step 904 ), the power to the Retinal stimulation system 1 may again be turned off for a predetermined amount of time (step 905 ) and the process may be repeated until the Retinal stimulation system 1 is again transmitting back telemetry. ” US8000000B2 at col. 12, ll. 29–63. |
| 12.5 | d) transmitting the power to the retinal stimulation system for a predetermined amount of time; | “According to a fifth aspect, a method for limiting power consumption in a visual prosthesis apparatus comprising a retinal stimulation system and a video processing unit is disclosed, the method comprising: a) transmitting power and data via forward telemetry to the retinal stimulation system; b) determining if the retinal stimulation system is transmitting a back telemetry to the video processing unit; c) stop transmitting the power and the data via forward telemetry to the retinal stimulation system when the retinal stimulation system does not transmit the back telemetry; d) transmitting the power to the retinal stimulation system for a predetermined amount of time; e) determining if the retinal stimulation system is transmitting the back telemetry during the predetermined amount of time; f) stop transmitting power to the retinal stimulation system when the retinal stimulation system does not transmit the back telemetry during the predetermined amount of time; and g) repeating features d) through f) until the retinal stimulation system transmits the back telemetry. ” US8000000B2 at col. 3, ll. 35–53.  “According to a third aspect, a method for limiting power consumption in a visual prosthesis apparatus comprising a retinal stimulation system and a video processing unit is disclosed, the method comprising: determining if the retinal stimulation system is transmitting a back telemetry to the video processing unit; and transmitting power and data to the retinal stimulation system only as long as the retinal stimulation system transmits the back telemetry. ” US8000000B2 at col. 3, ll. 14–21.  “In one exemplary embodiment, the Low Power Mode may be implemented to save power for VPU 20 . The Low Power Mode may be entered, for example, anytime the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . Upon entry to the Low Power Mode, the VPU 20 turns off power to the Retinal stimulation system 1 . After that, and periodically, the VPU 20 turns power back on to the Retinal stimulation system 1 for an amount of time just long enough for the presence of the Retinal stimulation system 1 to be recognized via its back telemetry. If the Retinal stimulation system 1 is not immediately recognized, the controller again shuts off power to the Retinal stimulation system 1 . In this way, the controller 'polls' for the passive Retinal stimulation system 1 and a significant reduction in power used is seen when the Retinal stimulation system 1 is too far away from its controller device. FIG. 13 b depicts an exemplary block diagram 900 of the steps taken when the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . If the VPU 20 receives back telemetry from the Retinal stimulation system 1 (output "YES" of step 901 ), the Retinal stimulation system 1 may be provided with power and data (step 906 ). If the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 (output "NO" of step 901 ), the power to the Retinal stimulation system 1 may be turned off. After some amount of time, power to the Retinal stimulation system 1 may be turned on again for enough time to determine if the Retinal stimulation system 1 is again transmitting back telemetry (step 903 ). **If the Retinal stimulation system 1 is again transmitting back telemetry (step 904 ), the Retinal stimulation system 1 is provided with power and data (step 906 ).** If the Retinal stimulation system 1 is not transmitting back telemetry (step 904 ), the power to the Retinal stimulation system 1 may again be turned off for a predetermined amount of time (step 905 ) and the process may be repeated until the Retinal stimulation system 1 is again transmitting back telemetry. ” US8000000B2 at col. 12, ll. 29–63. |
| 12.6 | e) determining if the retinal stimulation system is transmitting an error signal in the back telemetry during the predetermined amount of time; | “The forward telemetry data (transmitted for example at 122.76 kHz) may be modulated onto the exemplary 3 MHz carrier using Amplitude Shift Keying (ASK), while the back telemetry data (transmitted for example at 3.8 kHz) may be modulated using Frequency Shift Keying (FSK) with, for example, 442 kHz and 457 kHz. The theoretical bit error rates can be calculated for both the ASK and FSK scheme assuming a ratio of signal to noise (SNR). The system disclosed in the present disclosure can be reasonably expected to see bit error rates of 10-5 on forward telemetry and 10-3 on back telemetry. These errors may be caught more than 99.998% of the time by both an ASIC hardware telemetry error detection algorithm and the VPU 20 's firmware. For the forward telemetry, this is due to the fact that a 16-bit cyclic redundancy check (CRC) is calculated for every 1024 bits sent to the ASIC within electronics package 4 of the Retinal Stimulation System 1 . **The ASIC of the Retinal Stimulation System 1 verifies this CRC and handles corrupt data by entering a non-stimulating 'safe' state and reporting that a telemetry error was detected to the VPU 20 via back telemetry.** During the 'safe' mode, the VPU 20 may attempt to return the implant to an operating state. This recovery may be on the order of milliseconds. The back telemetry words are checked for a 16-bit header and a single parity bit. For further protection against corrupt data being misread, the back telemetry is only checked for header and parity if it is recognized as properly encoded Bi-phase Mark Encoded (BPM) data. If the VPU 20 detects invalid back telemetry data, the VPU 20 immediately changes mode to a 'safe' mode where the Retinal Stimulation System 1 is reset and the VPU 20 only sends non-stimulating data frames. Back telemetry errors cannot cause the VPU 20 to do anything that would be unsafe. ” US8000000B2 at col. 10, l. 54–col. 11, l. 8.  “In one exemplary embodiment, the VPU 20 is in constant communication with the retinal stimulation system 1 through forward and backward telemetry. In this document, the forward telemetry refers to transmission from VPU 20 to the retinal stimulation system 1 and the backward telemetry refers to transmissions from the Retinal stimulation system 1 to the VPU 20 . During the initial setup, the VPU 20 may transmit null frames (containing no stimulation information) until the VPU 20 synchronizes with the Retinal stimulation system 1 via the back telemetry. **In one embodiment, an audio alarm may be used to indicate whenever the synchronization has been lost.** ” US8000000B2 at col. 10, ll. 35–46.  “According to a first aspect, a visual prosthesis apparatus comprising: a camera for capturing a video image; a video processing unit associated with the camera, the video processing unit configured to convert the video image to stimulation patterns; and a retinal stimulation system configured to stop stimulating neural tissue in a subject's eye based on the stimulation patterns when an error is detected in a forward telemetry received from the video processing unit. ” US8000000B2 at col. 2, l. 77–col. 3, l. 6. |
| 12.7 | f) stop transmitting power to the retinal stimulation system when the retinal stimulation system transmits an error signal in the back telemetry during the predetermined amount of time; | “In addition, the VPU 20 may also take action when notified of the LOSS OF SYNC mode 950 . As soon as the Retinal Stimulation System 1 enters the LOSS OF SYNC mode 950 , the Retinal Stimulation System 1 reports this fact to the VPU 20 through back telemetry. When the VPU 20 detects that the Retinal Stimulation System 1 is in LOSS OF SYNC mode 950 , the VPU 20 may start to send 'safe' data frames to the Retinal Stimulation System 1 . **'Safe' data is data in which no stimulation output is programmed and the power to the stimulation drivers is also programmed to be off.** The VPU 20 will not send data frames to the Retinal Stimulation System 1 with stimulation commands until the VPU 20 first receives back telemetry from the Retinal Stimulation System 1 indicating that the Retinal Stimulation System 1 has exited the LOSS OF SYNC mode 950 . After several unsuccessful retries by the VPU 20 to take the implant out of LOSS OF SYNC mode 950 , the VPU 20 will enter a Low Power Mode (described below) in which the implant is only powered for a very short time. In this time, the VPU 20 checks the status of the implant. If the implant continues to report a LOSS OF SYNC mode 950 , the VPU 20 turns power off to the Retinal Stimulation System 1 and tries again later. Since there is no possibility of the implant electronics causing damage when it is not powered, this mode is considered very safe. ” US8000000B2 at col. 11, ll. 32–55.  “In one exemplary embodiment, the Low Power Mode may be implemented to save power for VPU 20 . The Low Power Mode may be entered, for example, anytime the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . Upon entry to the Low Power Mode, the VPU 20 turns off power to the Retinal stimulation system 1 . After that, and periodically, the VPU 20 turns power back on to the Retinal stimulation system 1 for an amount of time just long enough for the presence of the Retinal stimulation system 1 to be recognized via its back telemetry. If the Retinal stimulation system 1 is not immediately recognized, the controller again shuts off power to the Retinal stimulation system 1 . In this way, the controller 'polls' for the passive Retinal stimulation system 1 and a significant reduction in power used is seen when the Retinal stimulation system 1 is too far away from its controller device. FIG. 13 b depicts an exemplary block diagram 900 of the steps taken when the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . If the VPU 20 receives back telemetry from the Retinal stimulation system 1 (output "YES" of step 901 ), the Retinal stimulation system 1 may be provided with power and data (step 906 ). If the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 (output "NO" of step 901 ), the power to the Retinal stimulation system 1 may be turned off. After some amount of time, power to the Retinal stimulation system 1 may be turned on again for enough time to determine if the Retinal stimulation system 1 is again transmitting back telemetry (step 903 ). If the Retinal stimulation system 1 is again transmitting back telemetry (step 904 ), the Retinal stimulation system 1 is provided with power and data (step 906 ). **If the Retinal stimulation system 1 is not transmitting back telemetry (step 904 ), the power to the Retinal stimulation system 1 may again be turned off for a predetermined amount of time (step 905 ) and the process may be repeated until the Retinal stimulation system 1 is again transmitting back telemetry.** ” US8000000B2 at col. 12, ll. 29–63.  “The forward telemetry data (transmitted for example at 122.76 kHz) may be modulated onto the exemplary 3 MHz carrier using Amplitude Shift Keying (ASK), while the back telemetry data (transmitted for example at 3.8 kHz) may be modulated using Frequency Shift Keying (FSK) with, for example, 442 kHz and 457 kHz. The theoretical bit error rates can be calculated for both the ASK and FSK scheme assuming a ratio of signal to noise (SNR). The system disclosed in the present disclosure can be reasonably expected to see bit error rates of 10-5 on forward telemetry and 10-3 on back telemetry. These errors may be caught more than 99.998% of the time by both an ASIC hardware telemetry error detection algorithm and the VPU 20 's firmware. For the forward telemetry, this is due to the fact that a 16-bit cyclic redundancy check (CRC) is calculated for every 1024 bits sent to the ASIC within electronics package 4 of the Retinal Stimulation System 1 . The ASIC of the Retinal Stimulation System 1 verifies this CRC and handles corrupt data by entering a non-stimulating 'safe' state and reporting that a telemetry error was detected to the VPU 20 via back telemetry. During the 'safe' mode, the VPU 20 may attempt to return the implant to an operating state. This recovery may be on the order of milliseconds. The back telemetry words are checked for a 16-bit header and a single parity bit. For further protection against corrupt data being misread, the back telemetry is only checked for header and parity if it is recognized as properly encoded Bi-phase Mark Encoded (BPM) data. **If the VPU 20 detects invalid back telemetry data, the VPU 20 immediately changes mode to a 'safe' mode where the Retinal Stimulation System 1 is reset and the VPU 20 only sends non-stimulating data frames.** Back telemetry errors cannot cause the VPU 20 to do anything that would be unsafe. ” US8000000B2 at col. 10, l. 54–col. 11, l. 8. |
| 12.8 | and g) repeating features d) through f) until the retinal stimulation system transmits the back telemetry without an error signal. | “The forward telemetry data (transmitted for example at 122.76 kHz) may be modulated onto the exemplary 3 MHz carrier using Amplitude Shift Keying (ASK), while the back telemetry data (transmitted for example at 3.8 kHz) may be modulated using Frequency Shift Keying (FSK) with, for example, 442 kHz and 457 kHz. The theoretical bit error rates can be calculated for both the ASK and FSK scheme assuming a ratio of signal to noise (SNR). The system disclosed in the present disclosure can be reasonably expected to see bit error rates of 10-5 on forward telemetry and 10-3 on back telemetry. These errors may be caught more than 99.998% of the time by both an ASIC hardware telemetry error detection algorithm and the VPU 20 's firmware. For the forward telemetry, this is due to the fact that a 16-bit cyclic redundancy check (CRC) is calculated for every 1024 bits sent to the ASIC within electronics package 4 of the Retinal Stimulation System 1 . The ASIC of the Retinal Stimulation System 1 verifies this CRC and handles corrupt data by entering a non-stimulating 'safe' state and reporting that a telemetry error was detected to the VPU 20 via back telemetry. During the 'safe' mode, the VPU 20 may attempt to return the implant to an operating state. This recovery may be on the order of milliseconds. The back telemetry words are checked for a 16-bit header and a single parity bit. For further protection against corrupt data being misread, the back telemetry is only checked for header and parity if it is recognized as properly encoded Bi-phase Mark Encoded (BPM) data. **If the VPU 20 detects invalid back telemetry data, the VPU 20 immediately changes mode to a 'safe' mode where the Retinal Stimulation System 1 is reset and the VPU 20 only sends non-stimulating data frames.** Back telemetry errors cannot cause the VPU 20 to do anything that would be unsafe. ” US8000000B2 at col. 10, l. 54–col. 11, l. 8.  “The forward telemetry data (transmitted for example at 122.76 kHz) may be modulated onto the exemplary 3 MHz carrier using Amplitude Shift Keying (ASK), while the back telemetry data (transmitted for example at 3.8 kHz) may be modulated using Frequency Shift Keying (FSK) with, for example, 442 kHz and 457 kHz. The theoretical bit error rates can be calculated for both the ASK and FSK scheme assuming a ratio of signal to noise (SNR). 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For further protection against corrupt data being misread, the back telemetry is only checked for header and parity if it is recognized as properly encoded Bi-phase Mark Encoded (BPM) data. If the VPU 20 detects invalid back telemetry data, the VPU 20 immediately changes mode to a 'safe' mode where the Retinal Stimulation System 1 is reset and the VPU 20 only sends non-stimulating data frames. Back telemetry errors cannot cause the VPU 20 to do anything that would be unsafe. ” US8000000B2 at col. 10, l. 54–col. 11, l. 8.  “In one exemplary embodiment, the Low Power Mode may be implemented to save power for VPU 20 . The Low Power Mode may be entered, for example, anytime the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . Upon entry to the Low Power Mode, the VPU 20 turns off power to the Retinal stimulation system 1 . After that, and periodically, the VPU 20 turns power back on to the Retinal stimulation system 1 for an amount of time just long enough for the presence of the Retinal stimulation system 1 to be recognized via its back telemetry. If the Retinal stimulation system 1 is not immediately recognized, the controller again shuts off power to the Retinal stimulation system 1 . In this way, the controller 'polls' for the passive Retinal stimulation system 1 and a significant reduction in power used is seen when the Retinal stimulation system 1 is too far away from its controller device. FIG. 13 b depicts an exemplary block diagram 900 of the steps taken when the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 . If the VPU 20 receives back telemetry from the Retinal stimulation system 1 (output "YES" of step 901 ), the Retinal stimulation system 1 may be provided with power and data (step 906 ). If the VPU 20 does not receive back telemetry from the Retinal stimulation system 1 (output "NO" of step 901 ), the power to the Retinal stimulation system 1 may be turned off. After some amount of time, power to the Retinal stimulation system 1 may be turned on again for enough time to determine if the Retinal stimulation system 1 is again transmitting back telemetry (step 903 ). If the Retinal stimulation system 1 is again transmitting back telemetry (step 904 ), the Retinal stimulation system 1 is provided with power and data (step 906 ). **If the Retinal stimulation system 1 is not transmitting back telemetry (step 904 ), the power to the Retinal stimulation system 1 may again be turned off for a predetermined amount of time (step 905 ) and the process may be repeated until the Retinal stimulation system 1 is again transmitting back telemetry.** ” US8000000B2 at col. 12, ll. 29–63. |