TOY BRICK WITH SENSING, ACTUATION AND CONTROL

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ABSTRACT

A toy brick includes a housing, a first coupling element, an operating assembly, and a power source. The first coupling element releasably couples the housing to the housing of at least one other toy brick. The operating assembly is carried by the housing. The operating assembly includes user reprogrammable computing control element, and at least one sensing element capable of sensing an input value, the at least one sensing element operably coupled to the computing control element. The user reprogrammable computing and control element is configured generate an actuator output based at least in part on the sensed input value. The operating assembly also includes at least one actuator operably coupled to the computing control element to receive the actuator output. A power source is coupled to the operating assembly to supply electrical power thereto.
FIG. 1

FIG. 2
FIG. 9

FIG. 10

FIG. 11
FIG. 12

FIG. 13

FIG. 14

RESISTIVE, THERMOCOUPLE OR SEMICONDUCTOR TEMPERATURE TO VOLTAGE TRANSDUCER

AMPLIFIER

COMPUTING CONTROL ELEMENT
POWER DOWN FOR POWER DOWN INTERVAL AND CONSERVE POWER

IS THERE A SIGNAL FROM SENSING ELEMENT

RESET POWER ON TIMER

DO ACTUATION IF CONDITIONS FOR ACTUATION SATISFIED

DECREMENT POWER ON TIMER

HAS POWER ON TIMER EXPIRED

FIG. 16
FIG. 30

SOLAR CELL OR OTHER PHOTO VOLTAIC SOURCE OF ELECTRICITY

ENERGY STORAGE ELEMENT SUCH AS A BATTERY, CAPACITOR AND ASSOCIATED CHARGING CIRCUITRY

SYSTEMS ON BRICK REQUIRING POWER

FIG. 31

ELECTRICAL COIL FOR GENERATING A CURRENT WHEN IN THE PROXIMITY OF A VARYING MAGNETIC FIELD

ENERGY STORAGE ELEMENT SUCH AS A BATTERY, CAPACITOR AND ASSOCIATED CHARGING CIRCUITRY

SYSTEMS ON BRICK REQUIRING POWER
CHECK ACCELERATION IN ALL THREE AXES

IS ACCELERATION >X,Y,Z THRESHOLD

RECORD OR TRANSMIT ACCELERATION OR VELOCITY, OR POSITION DATA UNTIL, ACCN BELOW CERTAIN THRESHOLD OR UNTIL T SECONDS HAVE ELAPSED

TRANSMIT ACCELERATION, OR VELOCITY OR POSITION TO COMPUTING DEVICE

FIG. 33

RECEIVE BROADCAST DATA FROM FIXED OR MOBILE COMPUTING DEVICE

DOES BROADCAST ADDRESS MATCH DEVICE ADDRESS OR ADDRESS BANK?

ACT UPON BROADCAST DATA AND ACTUATE OR DISPLAY AS PRESCRIBED

STOP
GET 3D BRICK TILT DATA OR RECEIVE COLOR TO BE DISPLAYED WIRELESSLY

COMPUTE COLOR TO BE DISPLAYED BASED ON DATA

DISPLAY COLOR ON BRICK BY ADJUSTING RED, GREEN, BLUE, COLOR INTENSITIES AS NEEDED

STOP

START

RECEIVE DATA FROM MANIPULATED TOY BRICK

COMPUTE POSITION AND ORIENTATION OF BRICK

DISPLAY AVATAR OF BRICK ON THE SCREEN

CHECK IF BRICK MOVED IN CLICKING MOTION OR SIGNAL TO CEMENT BRICK IN POSITION IS RECEIVED

CEMENT BRICK AVATAR IN POSITION ON SCREEN

FIG. 34

FIG. 35
TOY BRICK WITH SENSING, ACTUATION AND CONTROL

BACKGROUND OF THE INVENTION

Toy bricks such as LEGO® brand toy bricks have been available for many decades. Toy bricks typically have releasable couplings between bricks, which allow them to be connected to form a larger structure. In their simplest form they build unmanned objects such as castles or houses.

An advancement of toy bricks was the addition of bricks with a rotating joint or axle coupled to a wheel. Such a toy brick can be attached to an animate structure in order to make that structure roll along a surface when pushed.

A further advancement of toy bricks was the addition of “pull back motors.” These motors are mechanical energy storage elements, which store energy in a watch spring or flywheel. Typically these are toy bricks which have the “pull back motor” mechanism contained within the brick. There is a shaft from the mechanism, which when turned in one direction winds up the motor and then when released will turn in the opposite direction. A toy brick car, for example, equipped with such a motor will wind up when pulled back and then go forwards when released. An example of this is the LEGO Pullback Motor.

The next stage of advancement of a toy brick is an electric motor contained within one brick, having a protruding shaft and another toy brick with a battery compartment. These battery and motor bricks can be coupled to each other directly or through wires in order to create a simple mechanism that is electrically actuated. Typically a switch is present on the brick containing the batteries that can turn the motor on or off or reverse its direction. Variations on the actuator can be lights, instead of a motor. An example of this is the LEGO elab.

Toy bricks containing motors and toy bricks containing batteries can be further enhanced by the insertion of a remote control receiver in between them, such that the passage of power can be modified remotely. Typically a handheld remote control transmitter transmits a signal to a receiver brick, which can change the speed or direction of the motor. By way of example, a toy brick vehicle constructed in such a manner can be steered remotely and also have its speed controlled remotely. An example of this is the LEGO Power Functions.

The most complex state of prior art is the programmable robotics kit sold by the LEGO Group under the trademark Mindstorms®. The kit typically includes a handheld programmable computer, to which sensors and actuators can be plugged in, along with toy bricks and specialized components for making a variety of projects. Actuators can be motors, or solenoids, speakers, or lights. Sensors can be switches, microphones, light sensors or ultrasonic rangefinders. By way of example, a program can be downloaded into the handheld computer, so as to control a motor in a manner so as to avoid collisions with objects in the direction of motion. Another example would be to make a noise when motion is detected.

BRIEF SUMMARY OF THE INVENTION

A first example of a toy brick includes a housing, a first coupling element, an operating assembly, and a power source. The first coupling element releasably couples the housing to the housing of at least one other toy brick. The operating assembly includes a user reprogrammable computing control element, and at least one sensing element capable of sensing an input value, the at least one sensing element operably coupled to the computing control element. The user reprogrammable computing and control element is configured to generate an actuator output based at least in part on the sensed input value. The operating assembly also includes at least one actuator operably coupled to the computing control element to receive the actuator output. A power source is coupled to the operating assembly to supply electrical power thereto.

The first example may also include one or more of the following. The computing control element may include a chosen one of a microprocessor or a microcontroller with embedded firmware. The computing control element may include at least one of digital logic chips, FPGA’s, lookup tables in ROM or RAM, fuzzy logic, and analog circuits. The computing control element may be configured for storage of sensing and actuation data for later retrieval. The power source may include rechargeable electrical energy storage element and: an inductive charging device operably connected thereto, a solar collector charging device operably connected thereto, an electrical connector carried by the housing and connected to the rechargeable electrical energy storage element so that the rechargeable electrical energy storage element can be connected to an external electrical energy charging source.

The first example may also include one or more of the following. The sensing element may include at least one of a radio frequency receiver and a radio frequency transmitter. The sensing element may include at least one of the following: an axis tilt sensor, a gyroscopic motion sensor, a gravity sensor, and an acceleration sensor. The sensing element may include at least one of the following: a digital camera capable of capturing at least one of still images and moving images, a position-triangulating-capable receiver which allows triangulation of position of the toy brick relative to its surroundings, a gripping force sensor, a switch, a magnetic field sensor, and an electrical field sensor, a temperature sensor, a plurality of sensing elements. The sensing element may also include a data sensing element configured to generate data signals for receipt by the computing control element, the sensing element being configured to generate analog signals based upon input to the sensing element, and the computing control element including a microcontroller comprising an analog to digital conversion capability for converting the analog signals from the sensing element into digital signals for receipt by the actuation element, the actuation element being the form of a transmitter. In some examples, the transmitter may be configured to transmit data to an external
computing device. The data gathering sensing element may be configured to transmit gathered data in a wireless manner, and the data gathering sensing element may be configured to transmit the gathered data to the computing control element according to at least one of the following: (1) in real time, or (2) after a delay.

[0012] The first example may also include one or more of the following. The actuator may include a shaft rotatable relative to the housing about a shaft axis. The sensing element may include a shaft angle sensor operably coupled to the shaft. The actuator may include a shaft movable in a linear manner relative to the housing along a shaft axis, and the sensing element may include a shaft position sensor operably coupled to the shaft. The actuator may include one or more the following: at least one motor, at least one sound emission device, at least one light source of variable or fixed intensity and color, a color or monochrome graphical or text display, at least one electrical solenoid, and at least one radio frequency transmitter or transceiver. A plurality of the actuators may be simultaneously present in a single toy brick. At least one of the surfaces of the brick can define a non-rectangular shape. The toy brick may have a unique electronic identifier address; the toy brick may also have a group electronic identifier address so that a plurality of the toy bricks can be simultaneously addressed using the group electronic identifier address.

[0013] A second example of a toy brick includes a housing, a first coupling element, an operating assembly, and a power source. The first coupling element releasably couples the housing to the housing of at least one other toy brick. The operating assembly is carried by the housing and includes a computing control element, and at least one sensing element capable of sensing input values, the sensing element operably coupled to the computing control element. The computing and control element is configured generate an actuator output based at least in part on a currently sensed input value and a previously sensed input value. The operating assembly also includes at least one actuator operably coupled to the computing control element to receive the actuator output. A power source is coupled to the operating assembly to supply electrical power thereto. With the second example, the computing control element may be a reprogrammable computing control element and the actuator output may include a time course of actuator outputs.

[0014] A third example of a toy brick includes a housing, a first coupling element, an operating assembly, and a power source. The first coupling element releasably couples the housing to the housing of at least one other toy brick. The operating assembly is carried by the housing and includes a computing control element and least one sensing element capable of sensing a continuum of input values and operably coupled to the computing control element. The computing and control element is configured generate an actuator output based at least in part on the sensed continuum of input values. The operating assembly also includes at least one actuator operably coupled to the computing control element to receive the actuator output. A power source is coupled to the operating assembly to supply electrical power thereto. With the third example, the computing control element may be a reprogrammable computing control element and the actuator output may include a time course of actuator outputs.

[0015] Other features, aspects and advantages of the present invention can be seen on review the drawings, the detailed description, and the claims which follow.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. 1 shows an example of a toy brick including a solar cell and an actuator shaft.

[0017] FIG. 2 is a block diagram of internal components of a toy brick.

[0018] FIG. 3 is an example of a toy brick including an induction charging device.

[0019] FIG. 4 is an example of a toy brick including a microphone or a light detector.

[0020] FIG. 5 is an example of a toy brick including an RF receiver or a GPS sensor.

[0021] FIG. 6 is an example of a toy brick including a 3-D tilt, or gyroscope, or gravity sensor.

[0022] FIG. 7 is an example of a toy brick including a camera.

[0023] FIG. 8 is an example of a toy brick including one or both of a shaft angle sensor and a shaft extension sensor.

[0024] FIG. 9 is an example of a gripper force toy brick including a gripping force sensor including a strain gauge rosette.

[0025] FIG. 10 illustrates, in a simplified manner, components within the gripper force brick of FIG. 9.

[0026] FIG. 11 is example of a toy brick including electrical switches at an outside surface.

[0027] FIG. 12 is a simplified view showing how the electrical switches of the toy brick of FIG. 11 are connected to the computing control element of the toy block.

[0028] FIG. 13 is an example of a toy brick including a temperature transducer.

[0029] FIG. 14 is a simplified view illustrating how the temperature transducer of FIG. 13 is coupled to the computing control element of the toy brick through an amplifier.

[0030] FIG. 15 is a block diagram of an example of a microcontroller for use with a toy brick.

[0031] FIG. 16 is a flow diagram illustrating power management signal detection and actuation.

[0032] FIG. 17 is an example of a toy brick including a light source.

[0033] FIG. 18 is an example of a toy brick including a speaker.

[0034] FIG. 19 is an example of a toy brick including a flat display.

[0035] FIG. 20 is an example of a toy brick including at least one of an organic LED and an organic LCD.

[0036] FIG. 21 is an example of a toy brick including a projected image from a projected image display.

[0037] FIG. 22 is an example of a toy brick including an image from a fiber optic display.

[0038] FIG. 23 is an example of a toy airplane built with toy bricks, which can emit sound or turn a propeller when moved as detected by a motion sensor.

[0039] FIG. 24 is an example of a toy car with a toy brick including a motion sensor, a recorder, and a speaker for emission of car sounds.

[0040] FIG. 25 is an example of a toy train built with toy bricks, including a camera brick as in FIG. 7 for display of an image from the camera on a mobile or fixed computing device.

[0041] FIGS. 26-28 illustrate examples of toy bricks shaped as flying insects or aircraft and displaying images reminiscent of different insects or aircraft.

[0042] FIG. 29 illustrates a mobile computing device used to update the image on the flying insect or aircraft toy bricks of FIGS. 26-28.
FIG. 30 is a simplified block diagram illustrating an example of a toy brick solar panel recharging system.

FIG. 31 is a simplified block diagram illustrating an example of a toy brick inductively coupled recharging system including an inductive charging device.

FIG. 32 is a flow diagram illustrating an example of a crash test recording algorithm.

FIG. 33 is a flow diagram illustrating an example of an addressable device communication algorithm.

FIG. 34 is a flow diagram illustrating a color change brick algorithm.

FIG. 35 is an algorithm for manipulation of toy brick avatars.

DETAILED DESCRIPTION OF THE INVENTION

The following description will typically be with reference to specific structural embodiments and methods. It is to be understood that there is no intention to limit the invention to the specifically disclosed embodiments and methods but that the invention may be practiced using other features, elements, methods and embodiments. Preferred embodiments are described to illustrate the present invention, not to limit its scope, which is defined by the claims. Those of ordinary skill in the art will recognize a variety of equivalent variations on the description that follows. Like elements in various embodiments are commonly referred to with like reference numerals.

The prior art discussed above consists of inanimate bricks suitable for small children, or more complex powered and wired or coupled brick elements, which must be assembled intelligently in order to perform a function. The bricks which require intelligent coupling in order to perform a function are suitable for much older children. Examples of the toy brick described herein allow some animation functions to be experienced by younger children, without requiring them to understand electrical concepts.

In addition, the prior art discussed above typically requires wiring between blocks to provide power to and control functions between the blocks. Such wires or connection between blocks disrupt from the object to be created by the blocks. Examples of the toy brick will also allow some functions to be achieved without the use of wires. While the toy brick building system disclosed in U.S. Patent No. 7,708,615 does not require wires, it discloses the use of function blocks, sensor bricks and logic bricks which require intelligent assembly and thus may not be suitable for younger children.

An intent of the various examples of the toy brick is to provide the end user with a rich experience from a toy brick, without burdening the user with needing to gain knowledge of how that experience is delivered. Typically a user would perform an action in order to initiate the experience, sensors and a controller within the toy brick would detect the interaction of the user with the brick, the toy brick will then automatically perform an action, in response to the stimulus.

As shown in FIG. 1, a first example of a toy brick is a single toy brick 10 including a housing 12 typically of size 3 inches or less on each side, the housing carrying coupling elements 14 used to releasably couple housing 12 of one toy brick 10 to the housing of another toy brick. The coupling element typically include pegs or other extending elements acting as first coupling elements which mate with corresponding openings, not shown, formed on housing 12 of other toy bricks 10. For ease of illustration only one set of peg-type coupling elements 14 are shown. Coupling elements 14 are typically conventional and may be compatible with coupling elements used with LEGO® brand toy bricks. The toy brick 10 example of FIG. 1 also includes a solar cell 16 mounted to one side of housing 12 and a shaft 18 extending from another side of housing 12. Solar cell 16 forms part of the power source for a toy brick 10 while shaft 18 is a type of actuator. These features will be discussed in more detail below. A toy brick 10 will also include sensing and control functions integrated within the toy brick.

Such a toy brick 10 would perform a function in response to a stimulus. The function to be performed is dependent on the sensors present, the programming of the controller, and the actuators present on toy brick 10, which are discussed in detail below.

FIG. 2 is a block diagram 20 of the main functional components of an example of toy brick 10. In this example, the charging device 22, which typically is in the form of solar cell 16 or an inductive charging device 24 shown in FIG. 3, is mounted to or is an integral part of housing 12. Solar cell 16 can be used to create electricity from light. Inductive charging device 24 uses electromagnetic induction to create electrical current to charge energy storage element 26. An external charging station, not shown, creates an alternate magnetic field and is positioned near the coils of inductive charging device 24 to send electromagnetic energy to inductive charging device 24 thereby inducing an electrical current within the coils of inductive charging device 24. Charging device 22 is connected to a rechargeable electrical energy storage element 26 by a line 28. Energy storage element 26 is typically in the form of a battery. However, energy storage element 26 can also be of other types, such as a capacitive energy storage element. Charging device 22 and energy storage element 26 constitute a power source 29. Energy storage element 26 is connected by power lines 36 to at least one sensing element 30, a computing control element 32, and usually to at least one actuator 34. Sensing element 30 communicates with computing control element 32 through a line 38 while computing control element 32 is coupled to actuator 34 by a line 39. In some cases any power required by actuator 34 may be provided through, for example, computing control element 32.

The provision of a rechargeable power source 29 within the toy brick 10 will allow the toy brick 10 to be incorporated into structures without the need for wires. Further, recharging capability will allow any model or other structure built with the toy brick 10 to exist without requiring disassembly for replacing or recharging the batteries. The ability to transfer electrical power without electrical contact will also allow the brick to be hermetically sealed, so as to be child friendly.

A function of some examples of the toy brick is to detect an input via the sensing element 30, then determine via computation or other logic as described below if the input conditions satisfy the predetermined requirements to actuate one or more actuators 34, and if so actuate one or more actuators 34, typically in sequence or simultaneously as per a predetermined pattern.

Sensing elements 30 can be one or more of the following: (1) a microphone 40 for reception of a sound encoded trigger, such as, but not limited to a clapping sound or voice recognition as shown in FIG. 4; (2) an infrared or visible light detector 42 for receiving a light encoded trigger as shown in FIG. 4, such as but not limited to a signal from an infrared remote, or the passage of a flashlight beam across a light sensor; (3) an RF transceiver 44 for detecting a radio
frequency encoded trigger as shown in FIG. 5, such as but not limited to a Bluetooth signal from an iPad; (4) a 3 dimensional tilt sensor, or gyroscopic sensor, or gravity sensor 46, as shown in FIG. 6 for detecting a motion triggered event such as but not limited to, a shaking of the toy brick 10 or orientation of the toy brick, or a time course of certain motions of the toy brick; (5) a camera 48 for capturing still or moving images, as shown in FIG. 7; (6) a position triangulation sensor 50 such as but not limited to a global positioning sensor as shown in FIG. 5; (7) a shaft angle sensor 52, as shown in FIGS. 8, and (8) a shaft extension sensor 54 also shown in FIG. 8.

[0059] A gripping force sensor 56, typically in the form of a strain gauge rosette as shown in FIG. 9, can be used to sense forces exerted on toy brick 10. FIG. 10 illustrates, in a simplified manner, components within a toy brick 10, sometimes referred to as a gripper force brick 10, including an amplifier 58 coupled to computing control element 32. For example, two push button electrical switches 60. Although switches 60 are shown both on one side of toy brick 10, a greater or lesser number can be used and can be on more than one side. FIG. 12 illustrates, in a simplified form, switches 60 coupled to computing control element 32 within toy brick 10.

[0060] In some examples, not illustrated, toy brick 10 may be constructed so that it takes more force to decouple a component, such as a power source 29, actuator 34 or sensing element 30, from housing 12 than it does to decouple the housing 12 of one toy brick 10 from the housing 12 of another toy brick 10.

[0061] FIG. 13 shows a temperature transducer type of toy brick 10 which includes a temperature transducer 62 typically secured along the inside surface of one of the walls of the toy brick. Temperature transducer 62 may be of different types including resistive, thermocouple, and semiconductor temperature transducers. FIG. 14 shows temperature transducer 62 coupled to computing control element 32 through an amplifier 64. Computing control element 32 can be implemented by, but is not limited to, a microprocessor, or analog or digital circuit, or fuzzy logic controller. FIG. 15 is a schematic diagram illustrating one example of a computing control element 32 in the form of a microprocessor. The programming of computing control element 32 can be preset at the factory, or may be programmable or reprogrammable in the field.

[0062] Computing control element 32, in the example of FIG. 15, is a single chip microcontroller. A microcontroller is a microprocessor with several different peripherals such as memory, communication devices, input and output devices built into a piece of silicon die.

[0063] Peripherals can include but are not limited to: USB (Universal Serial Bus), USART (universal synchronous/asynchronous receiver/transmitter), I2C (1 squared-C) computer bus, ADC (Analog to Digital Converter), DAC (Digital to Analog Converter), Timers, Pulse Width Modulators, Flash Memory, RAM Memory, EEPROM (Electrically Erasable Programmable Read Only Memory), Bluetooth interface, Ethernet interface, liquid crystal display interface. An example of such microcontrollers would be the Texas Instruments TMS320LF28XX family or MSP430 family of microcontrollers.

[0064] Typically a microcontroller is designed to perform a specific task, and only requires a subset of all possible peripherals to be present in order to perform that task. Usually the input and output of the peripheral devices are externally accessible via metal pins. The internal data and memory access bus structure is not typically connected to the externally accessible pins of the chip.

[0065] The microcontroller receives signals as electrical voltages or currents, presented to one or more of its externally accessible pins. These signals are typically sampled on a one time basis, continuously, or at a regular time intervals by circuitry within the microcontroller, such as an analog to digital converter. The time course and amplitude of such a signal may be kept in the internal memory and analyzed by algorithms. By way of example, a speech recognition algorithm may analyze digitized speech from a microphone, or a motion detection algorithm may analyze signals from accelerometers or tilt switches.

[0066] The algorithms which analyze the digitized electrical signals, can be written in a language such as Basic, C or Assembly. The Algorithms may implement logical functions such as: "IF INPUT signal is GREATER THAN A VALUE THEN turn ON an OUTPUT". The signals may in addition be transformed by transforms such as but not limited to the Fourier transform, or form feedback based algorithms in the S or Z domain such as Kalman Filters. Other algorithms such as neural network based fuzzy logic are also implementable. Indeed almost any algorithm that can be run on a personal computer can be implemented on a microcontroller based design.

[0067] Signals received may also be from a communication device, such as a Bluetooth link to an external device such as an iPad® or other tablet computer. Such signals may contain a full message of actions to perform, requiring the microcontroller to perform those actions rather than attempt to make a decision as to if actuation is warranted.

[0068] Computing control element 32, in the form of microcontroller 32, receives electrical signals, performs analysis of said signals and then performs an action. Signals for actuation are sent as electrical signals from the pins of microcontroller 32. By way of example, actuation such as making a noise may require microcontroller 32 to create a time course of electrical signal amplitudes, which may be accomplished by means of a DAC (Digital to Analog Converter) which varies the amplitude of the voltage on a pin of microcontroller 32. In another embodiment actuation of a display, for example, may require microcontroller 32 to send out RGB (Red/Green/Blue) intensities to various display pixels in order to create an image.

[0069] Microcontroller 32 may in addition manage battery charging and also conservation of power by powering down peripherals, and even entering a low power mode (sleep mode) and only exit from the low power mode (wake up) at either certain intervals to check if signals are present, or may wake up due to a signal being presented to one or more peripherals which are capable of waking the microcontroller from a sleep state.

[0070] Computing control element 32 analyzes the signals from the one or more sensing elements 30, as described below by way of example in FIG. 16, and makes a determination as to if actuation is warranted, and then sends signals to one or more actuators 34 as prescribed by the logic or programming of the computing control element 32. The computing control element 32 will also typically have memory that is readable and writable, and may be nonvolatile. The programming of computing control element 32 may, in some examples, be altered in the field by erasing and rewriting the program memory via wireless download, for example. Data form signals monitored may also be stored in the memory for later
retrieval. For example, a toy brick 10 that is involved in a crash test may have its motion during the crash stored inside the memory of the computing control element 32 of the toy brick for later retrieval and display, or a video or picture may be stored on the toy brick for later retrieval and display.

[0071] An example of a process for power management, signal detection and actuation is shown in FIG. 16. Initially, after start step 65, computing control element 32 is in a powered down mode as indicated at step 66. At step 68, if there is no signal from a sensing element 30, the program returns to step 66. If there is a signal from a sensing element 30, the program resets power on the timer at step 70 to a fixed predetermined number, such as 60 seconds. After step 70, there is an inquiry at step 72 whether or not there is a signal. If there is a signal, such as from an accelerometer, an appropriate actuation, such as emission of a sound, is conducted if conditions for the actuation are satisfied at step 74, followed by return to step 70. If there is no signal, control passes to step 76 and the power on the timer is reduced. Control then passes to step 78 where the inquiry of whether power on the timer has expired is made. If yes, control is returned to step 66. If no, control is returned to step 72.

[0072] Actuators which generate the output of a toy brick 10 can be, but are not limited to, one or more light sources 80, as shown in FIG. 17 and sound emission devices, such as speaker 82, as shown in FIG. 18. In addition, output can be generated by graphical displays including flat displays 84 as shown in FIG. 19, organic LED or organic LCD wraparound displays 86 as shown in FIG. 20, projected image displays 88 and the associated projected image 90 as shown in FIG. 21, and fiber-optic displays 92 and the associate projected image 94. In addition, output can be generated by a variety of other devices such as motors, radio transmitters, radio transceivers and solenoids. Actuators 34 can also include various types of transmitters. Actuation can be simple on/off or more complex actions such as but not limited to transmission of a radio signal, or even a time course of actions.

EXAMPLES OF VARIOUS EMBODIMENTS

[0073] By way of example, in one embodiment a single toy brick 10, similar to that shown in FIG. 1, may, when left undisturbed simply go to a “sleep” state, as when power on the timer has expired at step 78 in FIG. 16, while charging its battery or other energy storage element via ambient light, from a solar cell 16 on one of its surfaces. Then when brick 10 is lifted, it may, for example, emit the sound of an airplane taking off, when dived make the sound of an airplane diving, and when shaken emit the sound of guns. Such a brick 10 would be suited to the building of a toy brick fighter aircraft as shown in FIG. 23. The toy brick fighter aircraft as shown in FIG. 23 is constructed with a single toy brick 10 including the components illustrated in FIG. 2. The other toy bricks used in the construction of the toy brick fighter aircraft are conventional toy bricks without the components of FIG. 2. However, as discussed below, additional toy bricks 10 could be used in the construction of the toy airplane.

[0074] In yet another embodiment a single brick with integral solar power battery and Bluetooth receiver, again see FIG. 1, may spin a small motor with a shaft protruding from one side, when a Bluetooth signal is received from, for example, a tablet computer, such as an iPad®, or a smartphone, such as an iPhone®. Such a brick may be used in a windmill, for example. Another use of such a brick may be to build several small toy brick airplanes 96, as shown in FIG. 23, which can be remotely made to turn their propellers 98 when a Bluetooth signal is sent from a mobile or fixed computing or communication device.

[0075] In yet another embodiment, shown used as a component of a racecar 100 in FIG. 24, a brick 10 may incorporate several features, such as speaker 82 of the brick 10 of FIGS. 18, and 3-D movement sensor 46 of the brick 10 of FIG. 6, and make a engine revving sound when moved back and forth and the sound of a car “peeling tires” when pushed fast in one direction.

[0076] In yet another embodiment a clear brick 10, similar to that of FIG. 17, with a self contained power source may have red, green, and blue light sources 80 within it and have its color set by remote from an iPad® per the computer algorithm described below with reference to FIG. 34, or in another embodiment change color when held at different orientations by means of actuation being controlled by a tilt or gravity sensor.

[0077] In yet another embodiment as shown in FIG. 25 a toy brick 10 with a camera 48 similar to that shown in FIG. 7, may transmit a video signal via Bluetooth or Wi-Fi to a mobile or fixed device including a display screen. Such a brick when incorporated into a model such as, but not limited to, a toy brick train 102, will enable a view 104 as seen from the toy to be experienced by the user on, for example, a tablet computer screen.

[0078] In yet another embodiment, not illustrated, a toy brick 10 with a camera 48 and integral face or object recognition algorithm may greet a child with a sound such as “Hello John” when approached. The face to be recognized and the sound to be emitted by the brick may be user downloadable into the toy brick 10 via radio link. The face may even be learned by the video captured by the camera itself. Alternately when the face is recognized the toy brick may transmit a signal to a fixed or mobile computing device.

[0079] In yet another embodiment, a sequence of sensing and a sequence of actuation may be programmed, typically by an adult, into the toy brick 10, with perhaps the aid of a user interface running on a fixed or mobile computing device, with radio link or other connection to the toy brick. Once programmed, a child may interact with the brick in a much simpler manner.

[0080] In yet another embodiment several different shaped bricks may be manipulated by a child or other user. The bricks will transmit their shape and position to a fixed or mobile computing device which will show the manipulation of the bricks, with correct shape and size in a virtual build environment on a display screen. Transmission of position may be done by GPS signal, or by a more localized triangulation method, such as through the use of a base-plate, on which the toy bricks 10 are supported, with triangulation capability. The following are three examples of methods of position triangulation.

[0081] Measurement of time delay of signals from a signal source of known position: One or more signal sources of known position may send a pulse ("ping") or encoded message via sound, light or radio wave, at a certain time. The message may contain the time that this signal was sent. The message will be received at a later time by the object that is to be triangulated, in this case typically a toy brick 10. By receiving messages from 3 or more such sources of known positions, and by computing the distance to those sources by measuring the delay between the time that the signal was sent and the time that the signal was received, it is possible to
triangulate by standard trigonometric methods the position of the object to be triangulated. A simplified embodiment of a toy brick base-plate can be constructed to be capable of triangulating an object, such as toy brick 10, placed upon it. Such a triangulating base-plate may contain four or more signal emitters at the corners, in the plane of the base-plate and also above the plane of the base-plate. These emitters will emit encoded signals, preferably simultaneously. Then by measurement of the time delay between reception of the signals, it would be possible to locate the three-dimensional position of a toy brick in the vicinity of the base-plate.

Measurement of the position of known landmarks, by image analysis: The object to be triangulated may contain a camera and may compute its position by measurement of angles to various landmarks present in the image. By way of example, a toy brick 10 may contain a camera 48 and analyze the position of, for example, specific colored or marked bricks or flashing lights, placed in and above the plane of a base plate.

Measurement of the position of an object by analysis of its position relative to a known landscape: An object may be photographed in two or more, preferably orthogonal, views against a known landscape and its position computed. By way of example, a toy brick base-plate assembly may be constructed to contain two or more cameras capable of photographing the object in plan and elevation, against the base-plate and/or an orthogonal vertical wall with features present upon the base-plate/wall, such as uniquely marked bricks or flashing lights, whose positions are known.

The bricks may be cemented into position in the virtual environment by a gesture of the brick (such as not limited to a clicking motion) or by pushing a button on the brick as described in the computer algorithm described below with reference to FIG. 35. What is referred to as a clicking motion may be carried out by hovering over a correct position followed by a sharp downward thrust reminiscent of a mouse click. Such manipulation will allow the same brick to be used repeatedly to create a structure in the virtual environment, while no physical structure is created. Further, the manipulated brick may have its avatar on the virtual screen changed so as to be a different shape than the physically manipulated brick; in this case the physically manipulated brick may be of arbitrary shape.

In yet another embodiment, a toy brick with an accelerometer may be placed in a brick constructed car, such as that shown in FIG. 24, and the acceleration, velocity and position of the car, transmitted and plotted on a mobile or fixed computing device. This will allow standard physics experiments such as acceleration down an inclined plane to be generated with ease. In addition, g forces during a crash test can be plotted and examined. It should be noted that the data may be stored on the brick itself for later retrieval, rather than transmitted in real time.

In yet another embodiment bricks may be grouped by electronic addressing scheme, as described below with reference to FIG. 33, such that they may respond individually or as a group to a stimulus. By way of example, four identical toy bricks capable of changing color when shaken, two may be programmed to become red and two may be programmed to turn green. In yet another example of addressing and grouping, bricks with the actuator being a motor may be grouped by electronic addressing scheme. Such bricks may be incorporated in two grouped squadrons of toy brick airplanes, and one or the other squadron selectively commanded to spin their propellers upon command from a fixed or mobile computing device via wireless command. It can be seen by a person skilled in the art that electronic addressing will allow an entire landscape of toy bricks 10 to be commanded via radio or other signal individually, grouped or in a time sequenced manner.

In another embodiment, such as shown in FIG. 19, one or more LCD or other type of color or monochrome displays may be embedded within the brick and multiple images from multiple displays, or multiple images from a single display may be transmitted to one or more surfaces of the toy brick via optical elements such as but not limited to prisms, lenses, as shown in FIG. 21, or by means of light guides such as optical fibers 101 as shown in FIG. 22. By way of example, a toy brick 10 may be shaped as a flying insect as shown in FIGS. 26-28 may be set to display, for example, the image of a bee 105 as in FIG. 26, or display the image of a locust 106 as in FIG. 27, or an altogether different image 107 as in FIG. 28. The toy brick 10 may be opaque with only some areas having a display, or fiber optic. Toy 10 may have its image updated via integral wireless connection to a fixed or mobile computing device 109 as shown in FIG. 29. The display device can also be of a thin film wrap around type, such as an organic LCD or organic LED displays 86 as shown in FIG. 20. Such a display device can form the “skin” of the toy brick rather than a traditional flat screen device.

FIG. 30 is a block diagram illustrating an example of a toy brick solar panel recharging system 108. System 108 includes a solar cell 16, or other photovoltaic source of electricity, which provides energy to energy storage element 26, typically in the form of a battery or capacitor plus associated charging circuitry. Energy storage element 26 is then used to provide power to various systems 110, such as sensing element 30, computing control element 32 and actuators 34 of FIG. 2.

FIG. 31 is a simplified block diagram illustrating an example of a toy brick inductively coupled recharging system 112 including an inductive charging device 24, typically in the form of an electrical coil, which supplies electrical energy to energy storage element 26, typically in the form of a battery or capacitor plus associated charging circuitry. As with the example of FIG. 28, energy storage element 26 is then used to provide power to various systems 110.

FIG. 32 is a flow diagram illustrating an example of a crash test recording algorithm 114. After start at step 116, acceleration in all three axes is checked at step 118. If acceleration is not greater than a threshold along any of the X, Y or Z axes as determined at step 120, control is returned to step 118. Otherwise, control is transferred to step 122. At step 122 one or more of acceleration, velocity and position data is recorded and/or transmitted until acceleration is below a threshold value or until a threshold time period has elapsed. Thereafter control is passed to step 124 at which one or more of acceleration, velocity and position data is transmitted to computing control element 32. After that the algorithm terminates at step 126.

FIG. 33 is a flow diagram illustrating an example of an addressable device communication algorithm 128. After start step 130, broadcast data is received from a fixed or mobile computing device at step 132. Thereafter, at step 134, an inquiry is made whether or not the broadcast address matches a device address or an address in an address bank. If no, control returns to step 132. If yes, control passes to step 136. At that step the broadcast data is acted upon to, in this
example, actuate a device or display an image as prescribed. By way of example, assume use of binary 8 Bit addressing with a possibility of 256 uniquely addressable light emitting toy bricks 10, such as that shown in FIG. 17. The toy bricks 10 may be assigned arbitrarily to banks, such that bricks 1, 56 and 233 will be in bank “A” and bricks 2, 45 and 123 are in bank “B”. A signal may be sent to all bricks in bank “A” to turn on and display red, and all bricks in bank “B” to turn on and emit green light. Therefore, control passes to step 138.

[0092] FIG. 34 is a flow diagram illustrating a color change brick algorithm 140. After start step 142, either three-dimensional brick tilt data is obtained from a 3 dimensional tilt sensor 46 or information on the color to be displayed is received from a mobile or fixed computing device via an RF transceiver 44 at step 144. Next, at step 146, the color to be displayed based on the data received from the sensor is computed. At step 148 the color is displayed on the toy brick 10 by adjusting red, green and blue intensities as needed. Therefore, control is passed to the step step 150.

[0093] The final algorithm to be discussed is the algorithm for avatar manipulation 152 shown in the flow diagram of FIG. 35. This algorithm is run on the fixed or mobile computing device, not illustrated, receiving data from the brick being manipulated. After start step 154 data is received from a manipulated toy brick at step 156, by way of example, from sensors such as orientation sensor 46 and position sensor 50, and communicated via transceiver 44. Next, at step 158, the position and orientation of toy brick 10 is computed. Next, the avatar of the toy brick 10 is displayed on a display screen, such as found on a smart phone, a fixed computer or a tablet computer, at step 160. Following that, at step 162 the program checks to see if toy brick 10 has moved in a clicking motion, signifying the toy brick is to be cemented in that position, or some other signal signifying that the toy brick is to be cemented in position is received. If no, control is returned to step 156. If yes, control passes to step 164 at which the brick avatar is cemented in position on the screen, followed by return of control to step 156.

[0094] In some examples, computing control element 32 is a user reprogrammable computer control element in contrast with a computer control element that cannot be reprogrammed during normal use, but typically only in a manufacturing-type environment. Such reprogramming can take place in the manners discussed above with regard to the communication algorithm of FIG. 33, the color change algorithm of FIG. 34, and the avatar manipulation algorithm of FIG. 35. That is, the reprogramming of computer control element 32 can be accomplished by either specifically reprogramming the software or as a function of how the toy brick 10 is used.

[0095] In some examples, toy brick 10 can generate an output based upon a currently sensed input value and a previously sensed input value. This is opposed to a decision based on a current input only, such as single push of a button. This aspect is based in part on things that happened prior to an event, e.g., two buttons pushed one second apart. In digital computing terms current and previous means more than one clock apart, which in the current generation of computers running at say 4 GHz is 1/(4x10^9)~0.25 nanoseconds. A computer’s ability to define NOW and BEFORE is defined by its clock speed, since it can only sense things once per clock cycle. However it is possible to have an analog computer do a continuous time integral, for example, the time integral of acceleration yields velocity, and you could have a trigger that triggers when the velocity, as computed by a continuous integral of acceleration, exceeds a certain velocity. In another example, toy brick 10 may be provided an input in the form of a signal received by RF transceiver 44 telling toy brick to await further instruction in the form of an oral command received by microphone 40.

[0096] In some examples, toy brick 10 can generate an output(s) or time course of output(s) based on a time course input(s), wherein the current output(s) or time course of output(s), is determined by mathematical computations based on previous input(s) as well as the current input(s). An example of this is a force or acceleration sensor(s) the signals from which can be integrated to find velocity and integrated again to compute position. Integration is the area under the curve, which is a function of the past history of the signal amplitude over time. In other examples, the mathematical function described can be altered in the field via wired or wireless download of new algorithms. An example of this is a brick which can emit green light when shaken, or can be, for example, reprogrammed via Bluetooth connection to emit red light when shaken. In a further example, each input has more than two possible states (with on and off being two states). Instead, each input may have a continuum of gradually changing values, such as would exist with the input from an accelerometer, the brick may be programmed to continuously change through all the colors of the rainbow as it is tilted in various orientations.

[0097] In other examples, toy brick 10 can perform one way or two way communication with an external device wirelessly. The messaging between the devices being more complicated than the detection and/or generation of an instantaneous presence or absence of signal, and is a decoding of the time course of such a signal, said time course carrying an embedded message. An example of this type of toy brick is one which responds to the complex on/off time course of pulsations of light carrying a message from, for example, an infrared remote control.

[0098] It can be seen to a person skilled in the art that such a self contained brick with power, sensing, actuation and control elements within it, sacrifices little of the complex functions possible with the multi-brick prior art. Instead it allows a simple user experience for a small child, and removes the burden of programming the function to the factors, i.e., a parent, a teacher, or an older child. The intelligent toy brick provides a much different, much more accessible user experience than the multi-brick intelligent systems described in prior art.

[0099] The above descriptions may have used terms such as above, below, top, bottom, over, under, et cetera. These terms may be used in the description and claims to aid understanding of the invention and not used in a limiting sense.

[0100] While the present invention is disclosed by reference to the preferred embodiments and examples detailed above, it is to be understood that these examples are intended in an illustrative rather than in a limiting sense. It is contemplated that modifications and combinations will occur to those skilled in the art, which modifications and combinations will be within the spirit of the invention and the scope of the following claims. For example, other methods of getting energy, like vibration energy harvesting via piezoelectric element or thermal energy harvesting via Peltier devices, may be used.

[0101] The following clauses describe aspects of various examples of toy bricks.
A toy brick comprising:
- a housing;
- a first coupling element for releasably coupling the housing to the housing of at least one other toy brick;
- an operating assembly carried by the housing, the operating assembly comprising:
  - a user reprogrammable computing control element; at least one sensing element capable of sensing an input value, said at least one sensing element operably coupled to the computing control element;
  - the user reprogrammable computing and control element configured generate an actuator output based at least in part on the sensed input value; and
  - at least one actuator operably coupled to the computing control element to receive said actuator output; and
- a power source coupled to the operating assembly to supply electrical power thereto.

A toy brick comprising:
- a housing;
- a first coupling element for releasably coupling the housing to the housing of at least one other toy brick;
- an operating assembly carried by the housing, the operating assembly comprising:
  - a computing control element;
  - at least one sensing element capable of sensing input values, said at least one sensing element operably coupled to the computing control element;
  - the computing and control element configured generate an actuator output based at least in part on a currently sensed input value and a previously sensed input value; and
  - at least one actuator operably coupled to the computing control element to receive said actuator output; and
- a power source coupled to the operating assembly to supply electrical power thereto.

A toy brick comprising:
- a housing;
- a first coupling element for releasably coupling the housing to the housing of at least one other toy brick;
- an operating assembly carried by the housing, the operating assembly comprising:
  - a computing control element;
  - at least one sensing element capable of sensing a continuum of input values, said at least one sensing element operably coupled to the computing control element;
  - the computing and control element configured generate an actuator output based at least in part on said sensed continuum of input values; and
  - at least one actuator operably coupled to the computing control element to receive said actuator output; and
- a power source coupled to the operating assembly to supply electrical power thereto.

A toy brick according to any of the preceding clauses, wherein the computing control element is a user reprogrammable computing control element.

A toy brick according to clause 3, wherein the computing control element is a user reprogrammable computing control element.

A toy brick according to clause 1 or clause 2, wherein the actuator output comprises a time course of actuator outputs.

A toy brick according to any of the preceding clauses, wherein the source power comprises:
- a rechargeable electrical energy storage element;
- and
- an inductive charging device operably connected to the rechargeable electrical energy storage element.

A toy brick according to any of the preceding clauses 1-10, wherein the power source comprises:
- a rechargeable electrical energy storage element;
- and
- a solar collector charging device operably connected to the rechargeable electrical energy storage element.

A toy brick according to any of the preceding clauses 1-10, wherein the power source comprises:
- a rechargeable electrical energy storage element;
- and
- an electrical connector carried by the housing and connected to the rechargeable electrical energy storage element so that the rechargeable electrical energy storage element can be connected to an external electrical energy charging source.

A toy brick according to any of the preceding clauses, wherein the power source comprises:
- an electrical energy storage element in the form of a removable and replaceable battery; and wherein the housing comprises:
  - a battery access element permitting user access to the removable and replaceable battery.

A toy brick according to any of the preceding clauses, wherein the sensing element comprises at least one of a radio frequency receiver and a radio frequency transceiver.

A toy brick according to any of the preceding clauses, wherein the sensing element comprises a sound receiver.

A toy brick according to any of the preceding clauses, wherein the sensing element comprises a light sensor capable of sensing at least one of visible light and invisible light.

A toy brick according to any of the preceding clauses, wherein the sensing element comprises at least one of the following: an axis tilt sensor, a gyroscopic motion sensor, a gravity sensor, and an acceleration sensor.

A toy brick according to any of the preceding clauses, wherein the sensing element comprises a digital camera capable of capturing at least one of still images and moving images.

A toy brick according to any of the preceding clauses, wherein the sensing element comprises a position-
triangulating-capable receiver which allows triangulation of position of the toy brick relative to its surroundings.

[0153] 21. The toy brick according to any of the preceding clauses, wherein the sensing element comprises a gripping force sensor.

[0154] 22. The toy brick according to any of the preceding clauses, wherein the sensing element comprises a switch.

[0155] 23. The toy brick according to any of the preceding clauses, wherein the sensing element comprises a magnetic field sensor.

[0156] 24. The toy brick according to any of the preceding clauses, wherein the sensing element comprises an electrical field sensor.

[0157] 25. The toy brick according to any of the preceding clauses, wherein the sensing element comprises a temperature sensor.

[0158] 26. The toy brick according to any of the preceding clauses, wherein the sensing element comprises a plurality of sensing elements.

[0159] 27. The toy brick according to any of the preceding clauses, wherein the sensing element comprises a data sensing element configured to generate data signals for receipt by the computing control element.

[0160] 28. The toy brick according to clause 27, wherein:

[0161] the sensing element is configured to generate analog signals based upon input to the sensing element; and

[0162] the computing control element comprises a microcontroller comprising an analog to digital conversion capability for converting the analog signals from the sensing element into digital signals for receipt by the actuation element, the actuation element being the form of a transmitter.

[0163] 29. The toy brick according to clause 28, wherein the transmitter is configured to transmit data to an external computing device.

[0164] 30. The toy brick according to clause 28, wherein the data gathering sensing element is configured to transmit gathered data in a wireless manner.

[0165] 31. The toy brick according to clause 28, wherein:

[0166] the data gathering sensing element is configured to transmit the gathered data to the computing control element according to at least one of the following: (1) in real time, or (2) after a delay.

[0167] 32. The toy brick according to any of the preceding clauses, wherein the actuator comprises a shaft rotatable relative to the housing about a shaft axis.

[0168] 33. The toy brick according to clause 32, wherein the sensing element comprises a shaft angle sensor operably coupled to the shaft.

[0169] 34. The toy brick according to any of the preceding clauses, wherein the actuator comprises a shaft movable in a linear manner relative to the housing along a shaft axis.

[0170] 35. The toy brick according to clause 34, wherein the sensing element comprises a shaft linear position sensor operably coupled to the shaft.

[0171] 36. The toy brick according to any of the preceding clauses, wherein the actuator comprises at least one motor.

[0172] 37. The toy brick according to any of the preceding clauses, wherein the actuator comprises at least one sound emission device.

[0173] 38. The toy brick according to any of the preceding clauses, wherein the actuator comprises at least one light source of variable or fixed intensity and color.

[0174] 39. The toy brick according to any of the preceding clauses, wherein the actuator comprises a color or monochrome graphical or text display.

[0175] 40. The toy brick according to any of the preceding clauses, wherein the actuator comprises at least one electrical solenoid.

[0176] 41. The toy brick according to any of the preceding clauses, wherein the actuator comprises at least one radio frequency transmitter or transceiver.

[0177] 42. The toy brick according to any of the preceding clauses, wherein a plurality of actuators are simultaneously present in a single toy brick.

[0178] 43. The toy brick according to any of the preceding clauses, wherein the brick has a rectangular parallelepiped shape.

[0179] 44. The toy brick according to any of the preceding clauses, wherein the brick comprises:

[0180] first and second surfaces, the first and second surfaces being parallel, spaced apart and opposite one another;

[0181] third and fourth surfaces joined to and oriented at right angles to the first and second surfaces, the third and fourth surfaces being parallel, spaced apart and opposite one another; fifth and sixth surfaces, the fifth and sixth surfaces joined to the first, second, third and fourth surfaces, the fifth and sixth surfaces being spaced apart and opposite one another; and the first, second, fifth and sixth surfaces defining a non-rectangular shape.

[0182] 45. The toy brick according to clause 44 wherein the non-rectangular shape is a trapezoid.

[0183] 46. The toy brick according to any of the preceding clauses, wherein the toy brick has a unique electronic identifier address.

[0184] 47. The toy brick according to clause 46, wherein the toy brick also has a group electronic identifier address so that a plurality of said toy bricks can be simultaneously addressed using the group electronic identifier address.

[0185] 48. The toy brick according to any of the preceding clauses, wherein the housing is hermetically sealed housing.

[0186] Any and all patents, patent applications and printed publications referred to above are incorporated by reference.

What is claimed is:

1. A toy brick comprising:
a housing;
a first coupling element for releasably coupling the housing to the housing of at least one other toy brick;
an operating assembly carried by the housing, the operating assembly comprising:
a user reprogrammable computing control element;
at least one sensing element capable of sensing an input value, said at least one sensing element operably coupled to the computing control element;
the user reprogrammable computing and control element configured to receive the input value and to output a control signal based on the input value; and
the user reprogrammable computing and control element operably coupled to the power source to receive the input signal and to provide the power to operate the computing control element.

2. A toy brick comprising:
a housing;
a first coupling element for releasably coupling the housing to the housing of at least one other toy brick;
an operating assembly carried by the housing, the operating assembly comprising:
a computing control element;
at least one sensing element capable of sensing input values, said at least one sensing element operably coupled to the computing control element;
the computing and control element configured generate an actuator output based at least in part on a currently sensed input value and a previously sensed input value; and
at least one actuator operably coupled to the computing control element to receive said actuator output; and
a power source coupled to the operating assembly to supply electrical power thereto.

3. A toy brick comprising:
a housing;
a first coupling element for releasably coupling the housing to the housing of at least one other toy brick;
an operating assembly carried by the housing, the operating assembly comprising:
a computing control element;
at least one sensing element capable of sensing a continuum of input values, said at least one sensing element operably coupled to the computing control element;
the computing and control element configured generate an actuator output based at least in part on said sensed continuum of input values; and
at least one actuator operably coupled to the computing control element to receive said actuator output; and
a power source coupled to the operating assembly to supply electrical power thereto.

4. The toy brick according to claim 1, wherein the computing control element comprises a chosen one of a microprocessor or a microcontroller with embedded firmware.

5. The toy brick according to claim 1, wherein the computing control element comprises at least one of digital logic chips, FPGA’s, lookup tables in ROM or RAM, fuzzy logic, and analog circuits.

6. The toy brick according to claim 1, wherein the computing control element is configured for storage of sensing and actuation data for later retrieval.

7. The toy brick according to claim 2, wherein the computing control element is a reprogrammable computing control element.

8. The toy brick according to claim 3, wherein the computing control element is a reprogrammable computing control element.

9. The toy brick according to claim 2, wherein the actuator output comprises a time course of actuator outputs.

10. The toy brick according to claim 3, wherein the actuator output comprises a time course of actuator outputs.

11. The toy brick according to claim 1, wherein the power source comprises:
a rechargeable electrical energy storage element; and
an inductive charging device operably connected to the rechargeable electrical energy storage element.

12. The toy brick according to claim 1, wherein the power source comprises:
a rechargeable electrical energy storage element; and
a solar collector charging device operably connected to the rechargeable electrical energy storage element.

13. The toy brick according to claim 1, wherein the power source comprises:
a rechargeable electrical energy storage element; and
an electrical connector carried by the housing and connected to the rechargeable electrical energy storage element so that the rechargeable electrical energy storage element can be connected to an external electrical energy charging source.

14. The toy brick according to claim 1, wherein the power source comprises:
an electrical energy storage element in the form of a removable and replaceable battery; and
wherein the housing comprises:
a battery access element permitting user access to the removable and replaceable battery.

15. The toy brick according to claim 1, wherein the sensing element comprises at least one of a radio frequency receiver and a radio frequency transceiver.

16. The toy brick according to claim 1, wherein the sensing element comprises a sound receiver.

17. The toy brick according to claim 1, wherein the sensing element comprises a light sensor capable of sensing at least one of visible light and invisible light.

18. The toy brick according to claim 1, wherein the sensing element comprises at least one of the following: an axis tilt sensor, a gyrosopic motion sensor, a gravity sensor, and an acceleration sensor.

19. The toy brick according to claim 1, wherein the sensing element comprises a digital camera capable of capturing at least one of still images and moving images.

20. The toy brick according to claim 1, wherein the sensing element comprises a position-triangulating-capable receiver which allows triangulation of position of the toy brick relative to its surroundings.

21. The toy brick according to claim 1, wherein the sensing element comprises a gripping force sensor.

22. The toy brick according to claim 1, wherein the sensing element comprises a switch.

23. The toy brick according to claim 1, wherein the sensing element comprises a magnetic field sensor.

24. The toy brick according to claim 1, wherein the sensing element comprises an electrical field sensor.

25. The toy brick according to claim 1, wherein the sensing element comprises a temperature sensor.

26. The toy brick according to claim 1, wherein the sensing element comprises a plurality of sensing elements.

27. The toy brick according to claim 1, wherein the sensing element comprises a data sensing element configured to generate data signals for receipt by the computing control element.

28. The toy brick according to claim 27, wherein:
the sensing element is configured to generate analog signals based upon input to the sensing element; and
the computing control element comprises a microcontroller comprising an analog to digital conversion capability for converting the analog signals from the sensing element into digital signals for receipt by the actuation element, the actuation element being the form of a transmitter.

29. The toy brick according to claim 28, wherein the transmitter is configured to transmit data to an external computing device.

30. The toy brick according to claim 28, wherein the data gathering sensing element is configured to transmit gathered data in a wireless manner.
31. The toy brick according to claim 28, wherein:
the data gathering sensing element is configured to trans-
mitt the gathered data to the computing control element
according to at least one of the following: (1) in real
time, or (2) after a delay.
32. The toy brick according to claim 1, wherein the actuator
comprises a shaft rotatable relative to the housing about a
shaft axis.
33. The toy brick according to claim 32, wherein the sensing
element comprises a shaft angle sensor operably coupled
to the shaft.
34. The toy brick according to claim 1, wherein the actuator
comprises a shaft movable in a linear manner relative to the
housing along a shaft axis.
35. The toy brick according to claim 34, wherein the sensing
element comprises a shaft linear position sensor operably
coupled to the shaft.
36. The toy brick according to claim 1, wherein the actuator
comprises at least one motor.
37. The toy brick according to claim 1, wherein the actuator
comprises at least one sound emission device.
38. The toy brick according to claim 1, wherein the actuator
comprises at least one light source of variable or fixed inten-
sity and color.
39. The toy brick according to claim 1, wherein the actuator
comprises a color or monochrome graphical or text display.
40. The toy brick according to claim 1, wherein the actuator
comprises at least one electrical solenoid.
41. The toy brick according to claim 1, wherein the actuator
comprises at least one radio frequency transmitter or trans-
ceiver.
42. The toy brick according to claim 1, wherein a plurality
of actuators are simultaneously present in a single toy brick.
43. The toy brick according to claim 1, wherein the brick
has a rectangular parallelepiped shape.
44. The toy brick according to claim 1, wherein the brick
comprises:
first and second surfaces, the first and second surfaces
being parallel, spaced apart and opposite one another;
third and fourth surfaces joined to and oriented at right
angles to the first and second surfaces, the third and
fourth surfaces being parallel, spaced apart and opposite
one another;
fifth and sixth surfaces, the fifth and sixth surfaces joined to
the first, second, third and fourth surfaces, the fifth and
sixth surfaces being spaced apart and opposite one
another; and
the first, second, fifth and sixth surfaces defining a non-
rectangular shape.
45. The toy brick according to claim 44, wherein the non-
rectangular shape is a trapezoid.
46. The toy brick according to claim 1, wherein the toy
brick has a unique electronic identifier address.
47. The toy brick according to claim 46, wherein the toy
brick also has a group electronic identifier address so that a
plurality of said toy bricks can be simultaneously addressed
using the group electronic identifier address.
48. The toy brick according to claim 1, wherein the housing
is a hermetically sealed housing.

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