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(54) SYSTEMS AND METHODS FOR DRONE GAMING AND/OR RACING

(71) Applicant: **Pelican Fly LLC**, Baltimore, MD (US)

(72) Inventors: **Muhammad Najeeullah**, Baltimore, MD (US); **John W. Davis**, Baltimore, MD (US)

(73) Assignee: **Pelican Fly LLC**, Baltimore, MD (US)

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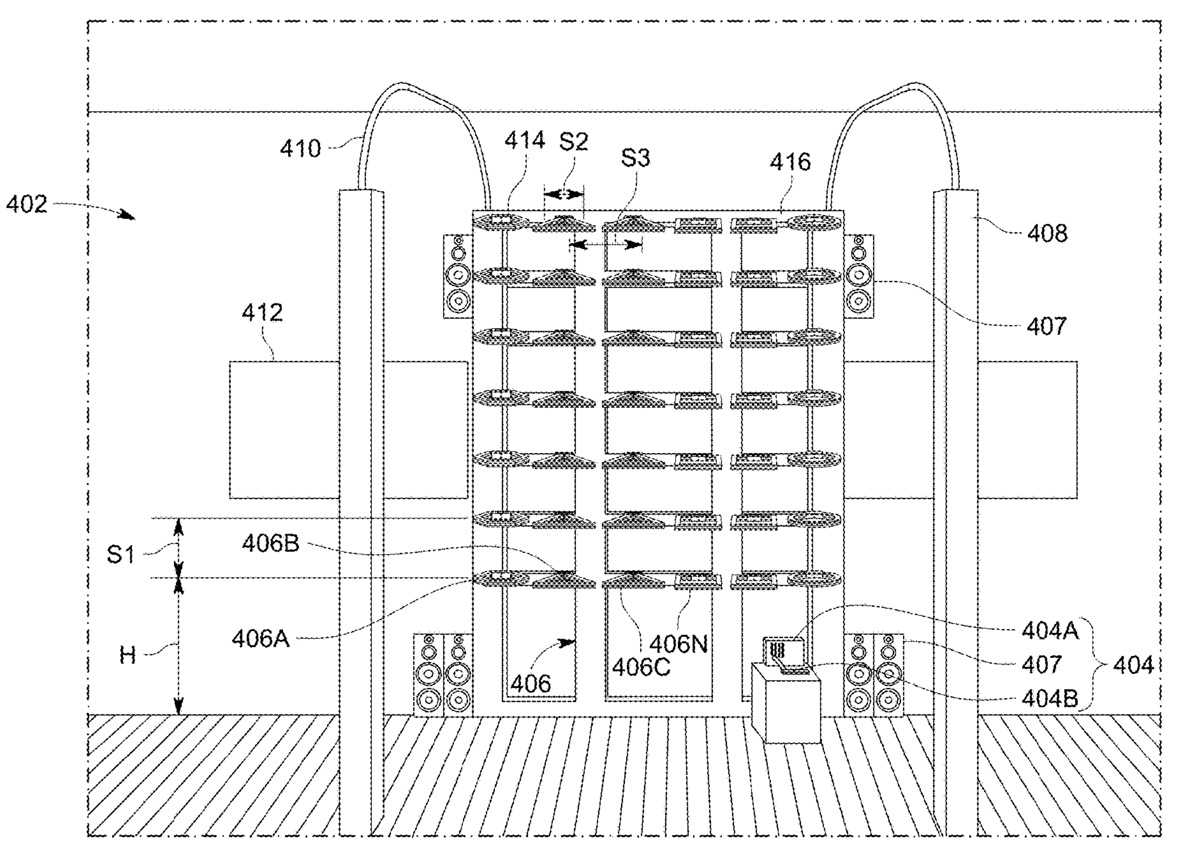
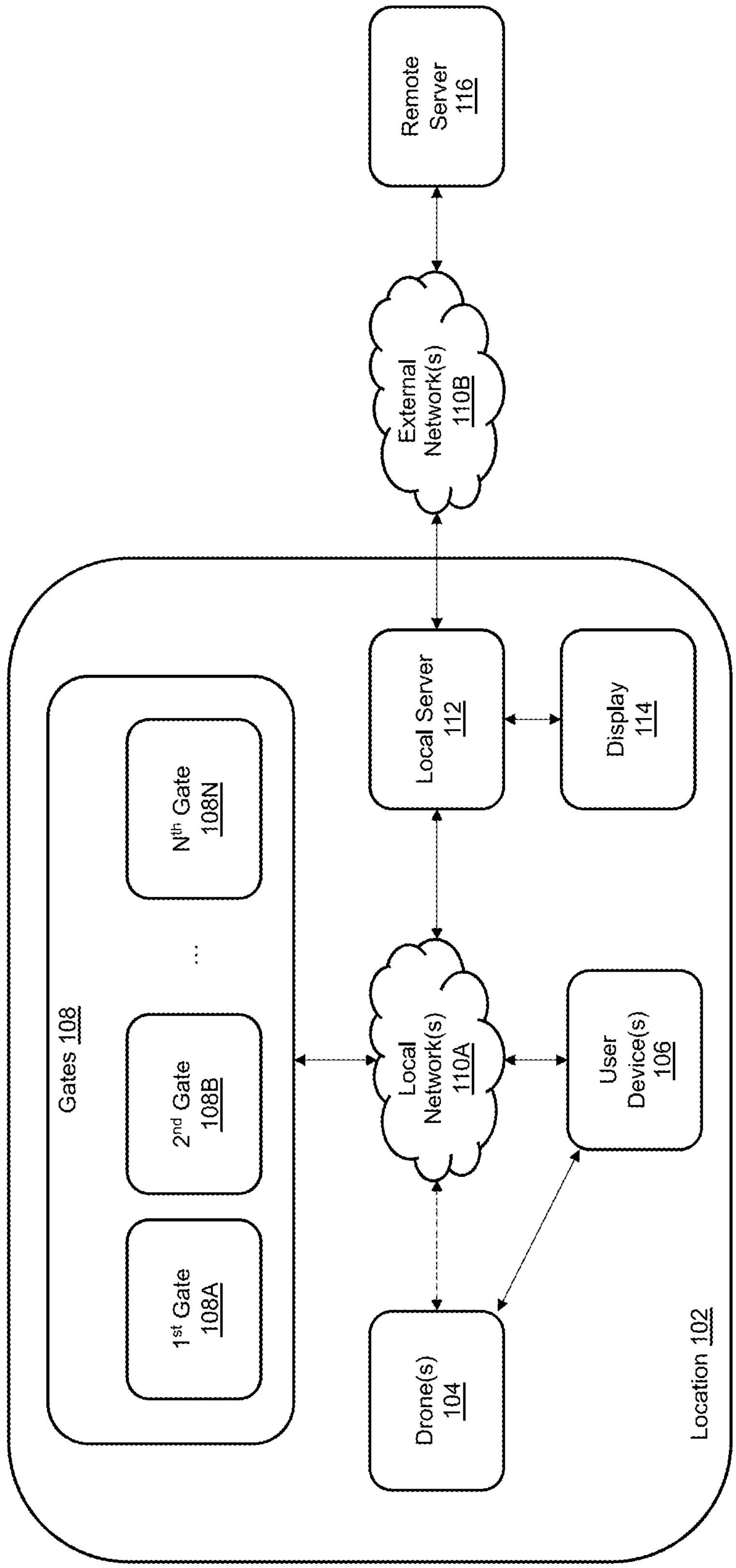
(57) **ABSTRACT**

The present disclosure provides a system for processing sensor data and providing user feedback. The system includes at least two sensors configured to sense sensor data for an object near a gate. A microprocessor is configured to determine at least one parameter for the object based on the sensor data. A control system is configured to output a graphical user interface depicting data related to the object based on the at least one parameter. The system enables real-time tracking and analysis of object movement through the gate, providing instant feedback for various applications such as sports training, performance analysis, and interactive learning experiences.

400A




Remote Server 116
External Network(s) 110B
Gates 108
1st Gate 108A
2nd Gate 108B
...
Nth Gate 108N
Local Network(s) 110A
Local Server 112
Display 114
User Device(s) 106
Drone(s) 104
Location 102

100

FIG. 1

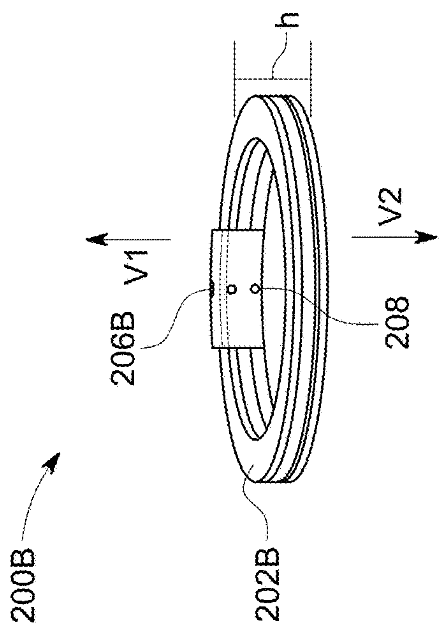

200B
202B
206B
208
V1
V2
h
210
212
V3
d2
214

FIG. 2B

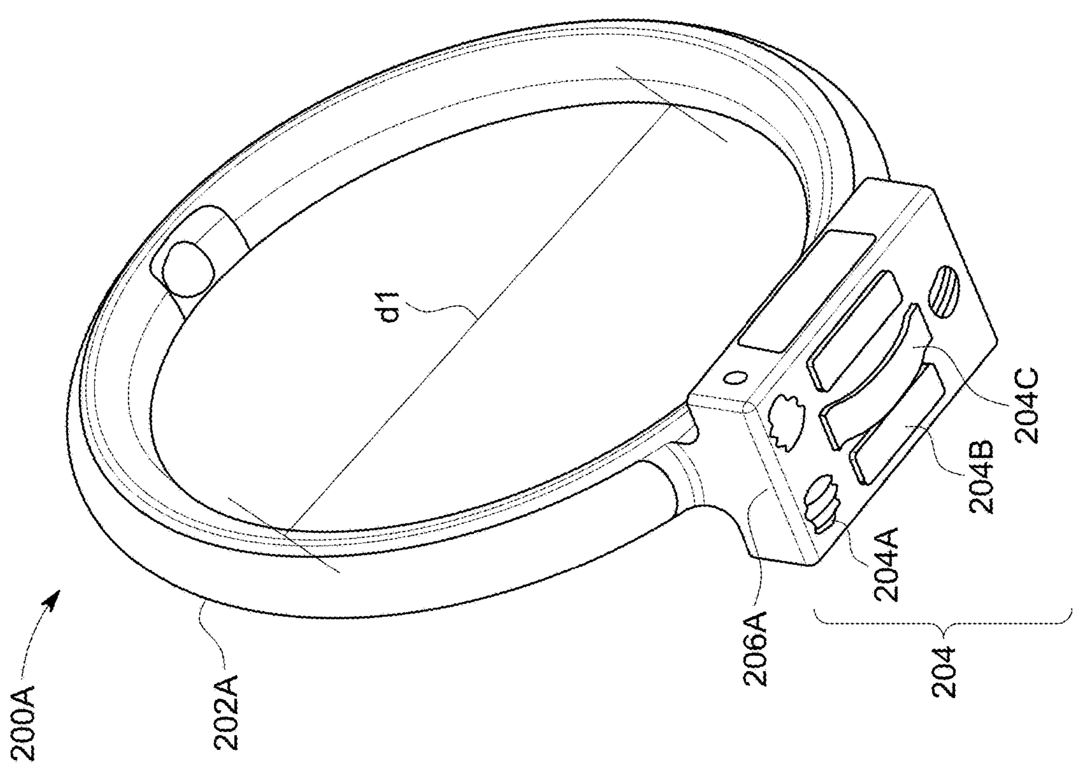

200A
202A
d1
206A
204
204A
204B
204C

FIG. 2A

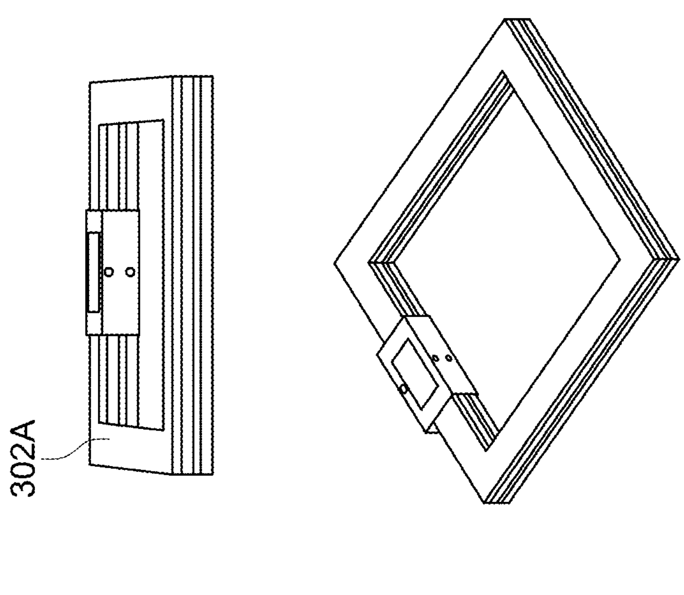


FIG. 3A

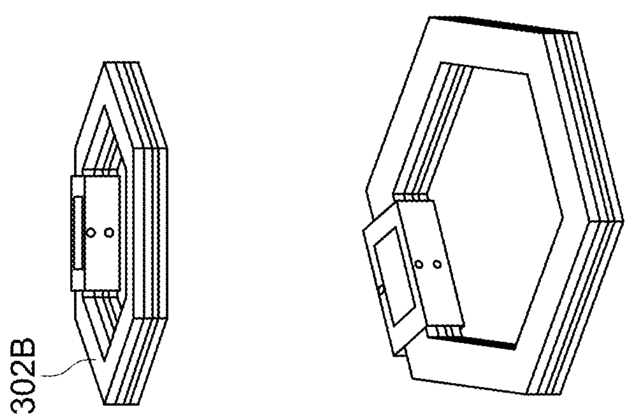


FIG. 3B

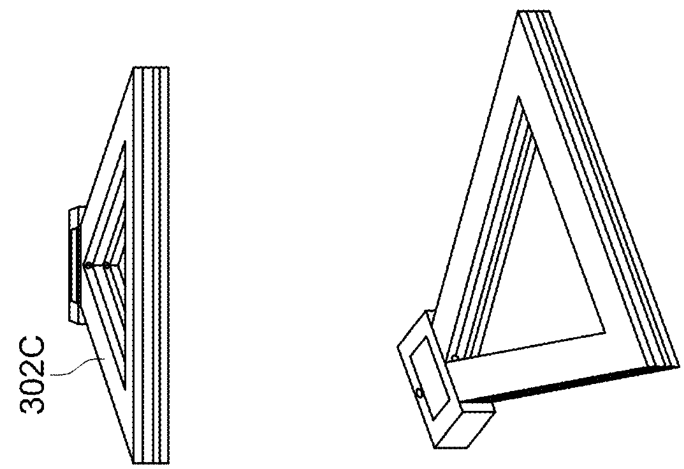


FIG. 3C

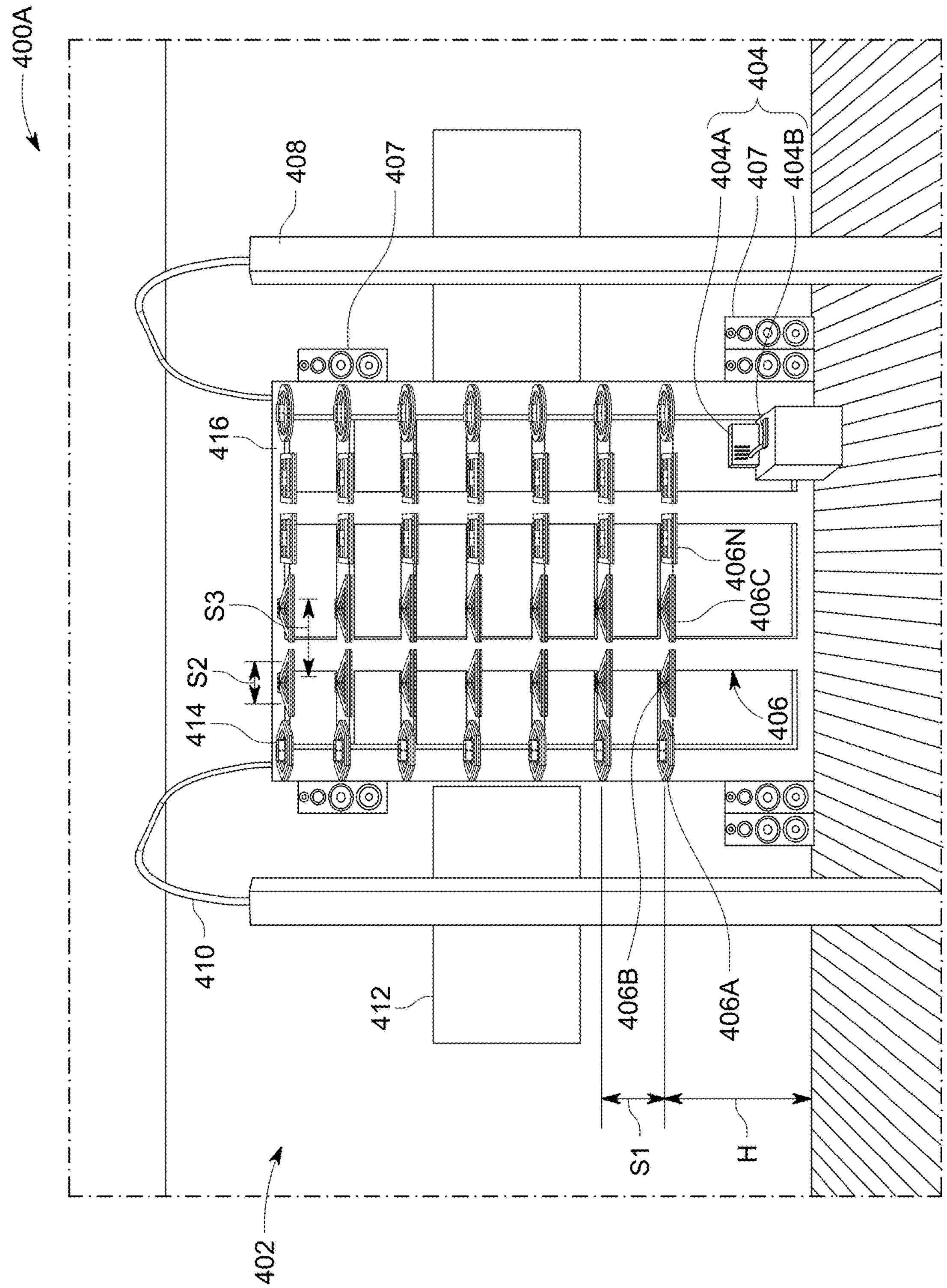

400A
408
407
404
404A
407
404B
416
406N
406C
S3
S2
414
406
410
412
406B
406A
S1
H
402

FIG. 4A

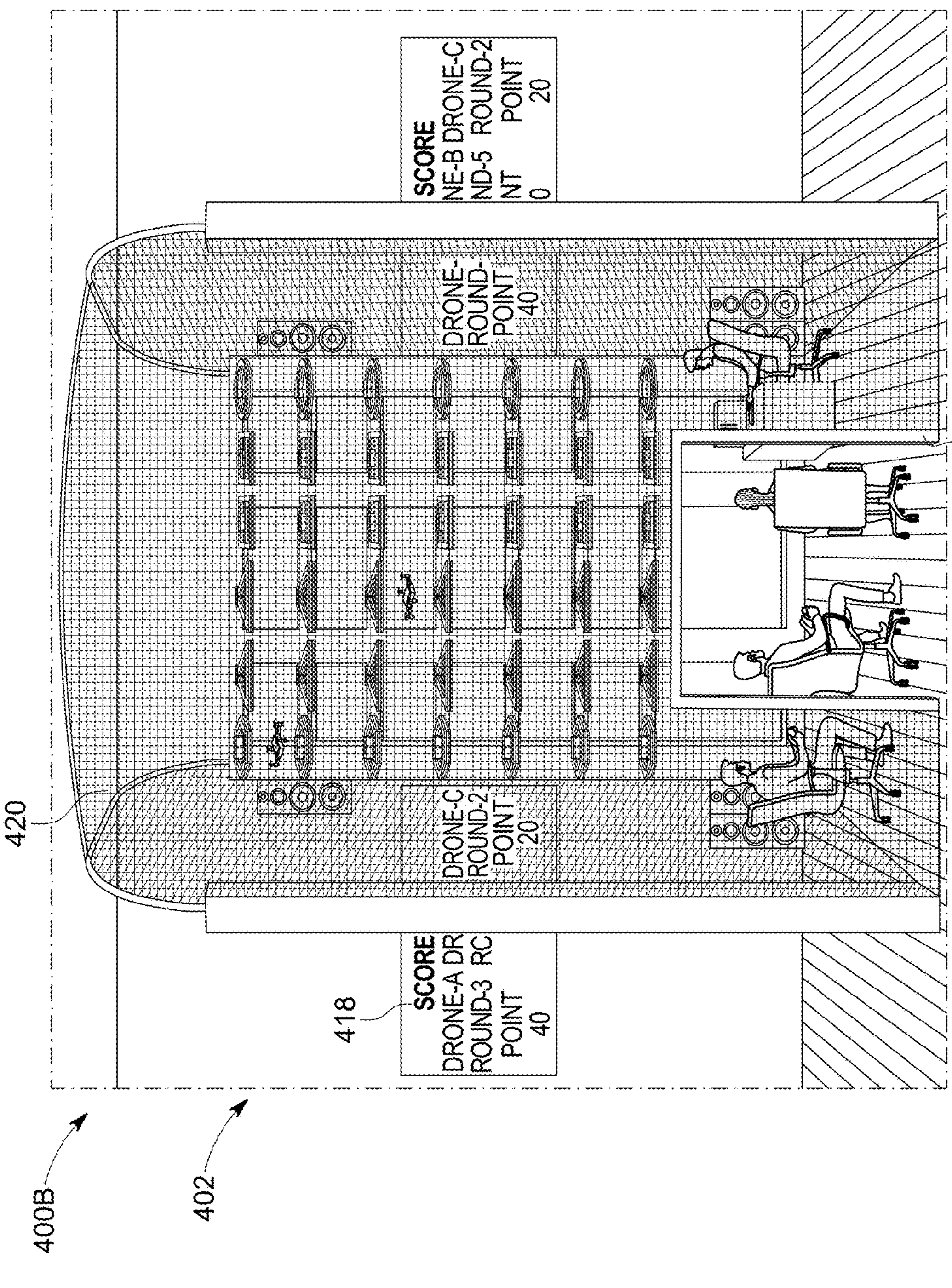

420
SCORE
NE-B DRONE-C
ND-5 ROUND-2
NT POINT
0 20
DRONE-
ROUND-
POINT
40
DRONE-C
ROUND-2
POINT
20
422
418
SCORE
DRONE-A DR
ROUND-3 RC
POINT
40
400B
402

FIG. 4B

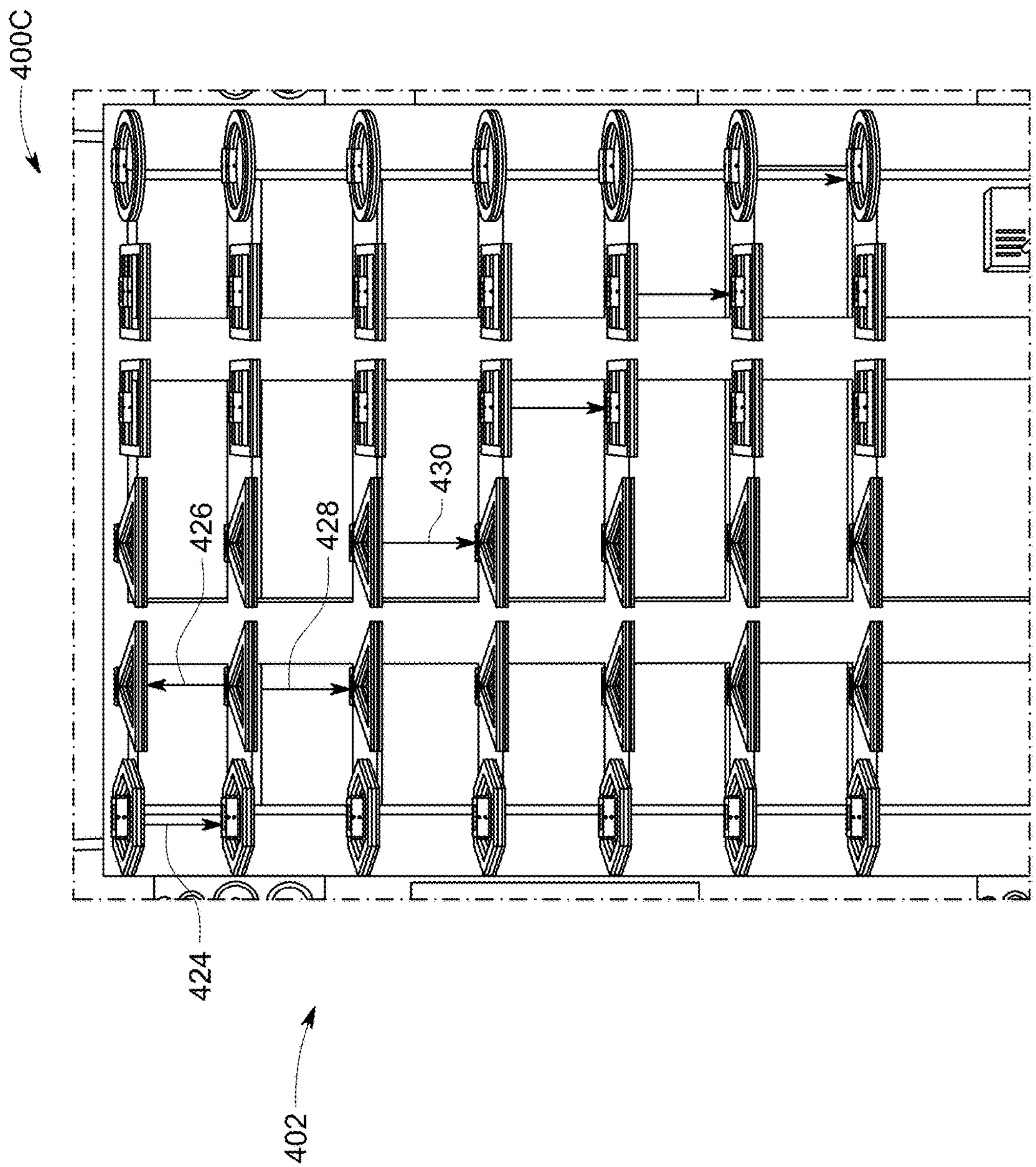


FIG. 4C

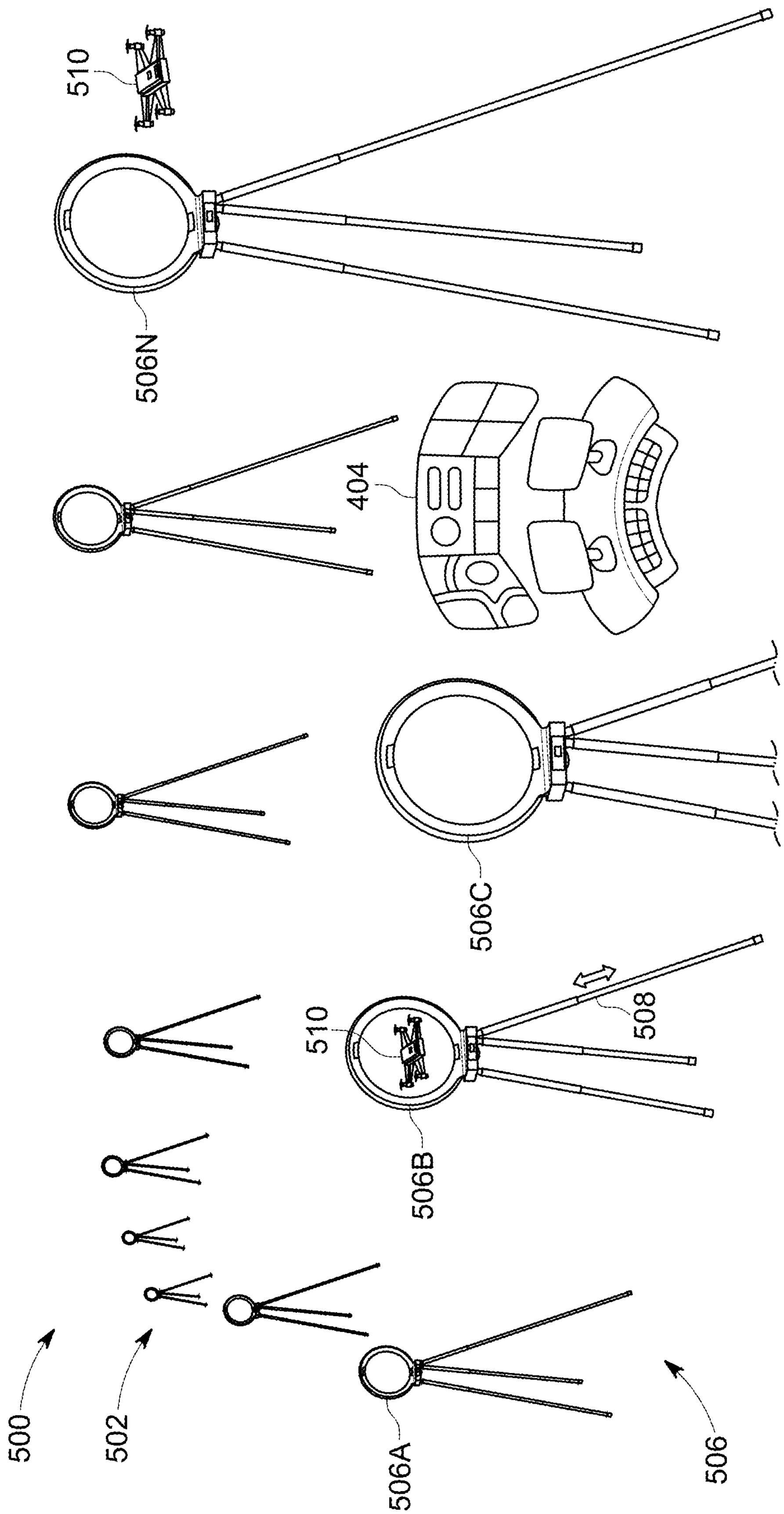
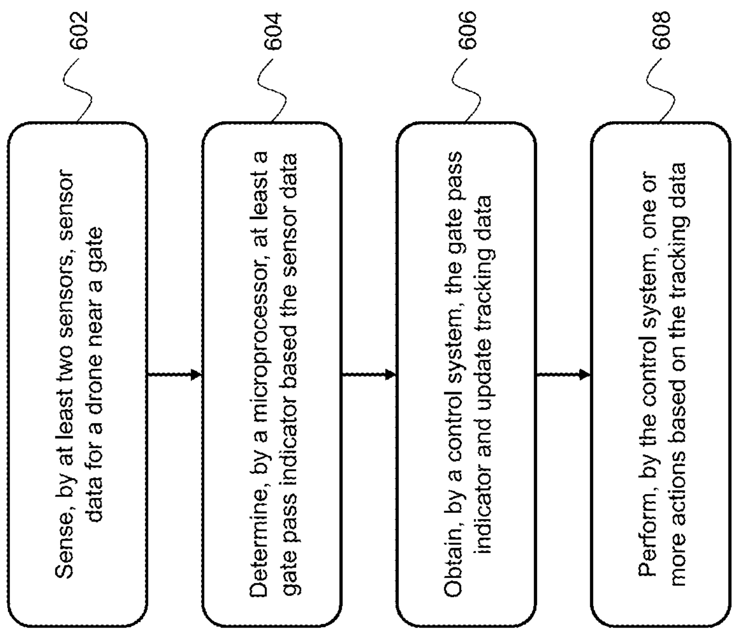


FIG. 5


602
Sense, by at least two sensors, sensor data for a drone near a gate
604
Determine, by a microprocessor, at least a gate pass indicator based the sensor data
606
Obtain, by a control system, the gate pass indicator and update tracking data
608
Perform, by the control system, one or more actions based on the tracking data

600

FIG. 6

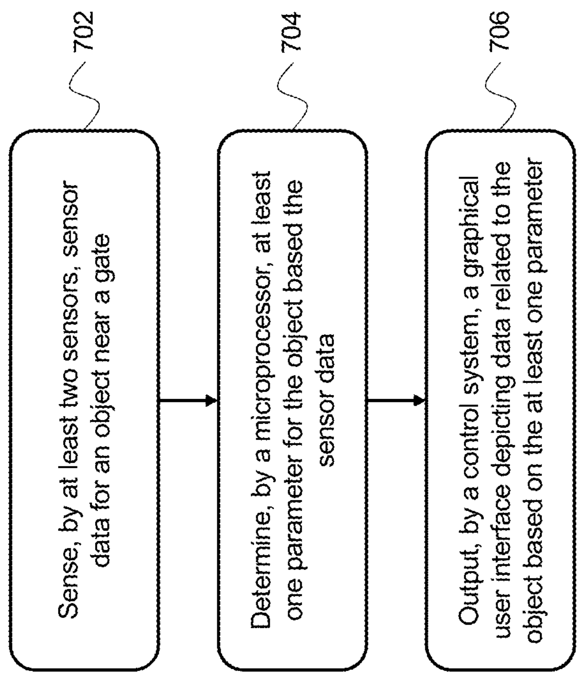
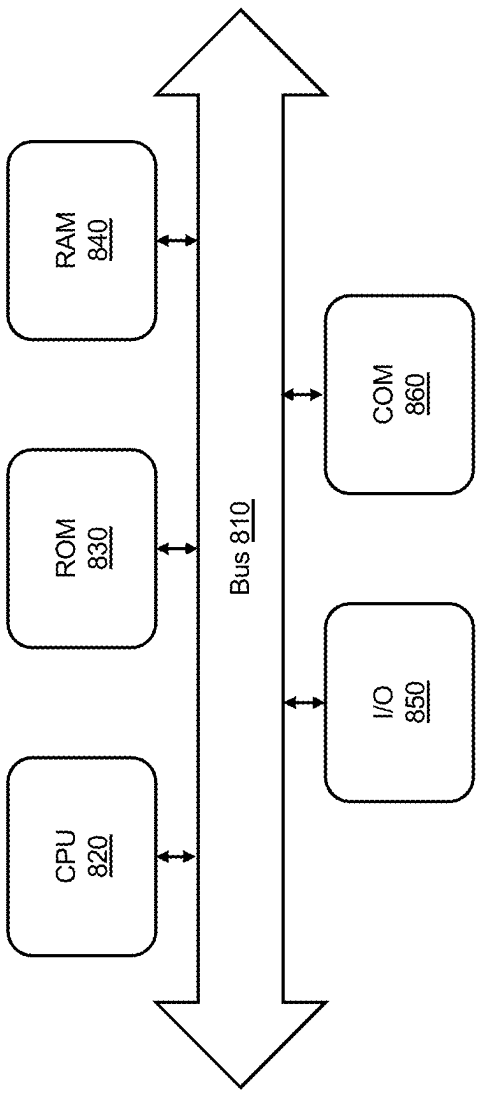

702
Sense, by at least two sensors, sensor data for an object near a gate
704
Determine, by a microprocessor, at least one parameter for the object based the sensor data
706
Output, by a control system, a graphical user interface depicting data related to the object based on the at least one parameter

FIG. 7

700



800 **FIG. 8**

SYSTEMS AND METHODS FOR DRONE GAMING AND/OR RACING

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application claims the benefit of U.S. Provisional Application No. 63/552,079, filed Feb. 9, 2024.

[0002] The contents of each of the above referenced applications are hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0003] Various aspects of the present disclosure relate generally to systems and methods for smart gates and, more particularly, to systems and methods for drone gaming/racing using sensing gates and/or and machine learning to enhance game/race experience.

BACKGROUND

[0004] Generally, the present disclosure pertains to the field of drone technology, a rapidly evolving area that has seen a surge in applications ranging from aerial photography and surveillance to package delivery and environmental monitoring. Within this broad field, at the intersection of drone technology and interactive gaming or racing is an emerging area that leverages the capabilities of drones to create engaging and immersive gaming or racing experiences.

[0005] The present disclosure is directed to overcoming one or more of these above-referenced challenges.

SUMMARY OF THE DISCLOSURE

[0006] According to certain aspects of the disclosure, systems, methods, and computer readable memory are disclosed for drone gaming/racing.

[0007] In some cases, a drone gaming/racing system may include: a plurality of gates, wherein each of the plurality of gates include: at least two sensors configured to capture sensor data, and a microprocessor configured to process the sensor data to determine at least gate pass indicator(s); a control system communicatively coupled to the plurality of gates, wherein the control system is configured to: receive the sensor data and the gate pass indicator(s); update, based on the sensor data and the gate pass indicator(s), tracking data for a plurality of drones while the plurality of drones navigate the plurality of gates; and perform at least one action based on the tracking data.

[0008] In some cases, a drone racing system may include: a plurality of drones, wherein each of the plurality of drones include an RFID tag; a racecourse, wherein the race course includes a plurality of gates in a sequential order, and each gate incudes a sensor module for capturing sensor data and a microprocessor for processing the sensor data; and a control system configured to: receive and manage the sensor data for tracking the plurality of drones, and referee a race of the plurality of drones through the sequential order of the plurality of gates.

[0009] In some cases, a drone gaming system may include: a plurality of hoops, wherein each of the plurality of hoops include a set of sensors, the set of sensors include one or combinations of: an RFID sensor, camera, and accelerometer, and the set of sensors are configured to sense drones passing through the hoops; and a control system configured to: manage data from the plurality of hoops, and referee gameplay based on the data from the plurality of hoops.

[0010] In some cases, a gaming system may include: a plurality of gates, each gate including at least two sensors configured to capture sensor data for an object and a microprocessor configured to process the sensor data to determine at least one parameter for the object; and a control system communicatively coupled to the plurality of gates, the control system configured to: receive the sensor data and the at least one parameter for the object, and generate and output a graphical user interface based on the at least one parameter.

[0011] Additional objects and advantages of the disclosed technology will be set forth in part in the description that follows, and in part will be apparent from the description, or may be learned by practice of the disclosed technology.

[0012] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the disclosed technology, as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate various exemplary aspects and together with the description, serve to explain the principles of the disclosed technology.

[0014] FIG. **1** depicts an example environment for drone gaming/racing.

[0015] FIG. **2**A depicts a diagram showing a first sensing gate.

[0016] FIG. **2**B depicts a diagram showing a second sensing gate.

[0017] FIGS. **3**A, **3**B, and **3**C depict diagrams showing a different geometries of a second type of a sensing gate.

[0018] FIGS. **4**A-**4**C depict diagrams of a first drone gaming/racing infrastructure.

[0019] FIG. **5** depicts a diagrams of a second drone gaming/racing infrastructure.

[0020] FIG. **6** depicts a flowchart of an exemplary method for drone racing using sensing gates.

[0021] FIG. **7** illustrates a flowchart for processing sensor data and providing user feedback, according to aspects of the present disclosure.

[0022] FIG. **8** depicts an example system that may execute techniques presented herein.

DETAILED DESCRIPTION

[0023] Various aspects of the present disclosure relate generally to drone racing/gaming using sensing gates and/or machine learning models to change game/race dynamics in real-time.

[0024] In some cases, drone-based gaming/racing systems of the present disclosure may use sensor technology. Sensors may play a pivotal role in tracking the movement and position of drones, thereby enabling the implementation of game rules, and scoring mechanisms. Various types of sensors, such as Radio Frequency Identification (RFID) sensors and cameras, may be used in the systems or methods. RFID sensors may detect the presence of drones by reading RFID tags attached to them, while cameras can visually track the movement of drones.

[0025] In some cases, the drone-based gaming/racing systems of the present disclosure may use microprocessors to process data locally at sensing gates. These devices may be responsible for processing the data captured by the sensors and generating appropriate responses, such as allocating points, triggering lighting effects, and playing sound effects. The microprocessors may be programmed with predefined outputs that correspond to different game/race scenarios.

[0026] In some cases, the drone-based gaming/racing systems of the present disclosure may use a control system. The control system may be communicatively coupled (e.g., wirelessly or wired connection) to sensor-equipped components of the system, such as the sensing gates or other sensor systems, for data communication and (in some cases) power supply. The control system may manage the data from the sensors and perform various functions, such as tracking and/or referee functions during game or race play.

[0027] In some cases, the drone-based gaming/racing systems of the present disclosure may use machine learning models to adjust and/or enhance game or race dynamics. The machine learning models may process real-time data captured by the sensors (or features extracted by, e.g., the control system) to adjust the interactive elements of the game or race play based on skill level(s) of the current user(s) or other dynamics. This may add a dynamic and adaptive element to the gaming or racing experience, making it more engaging and challenging for the players.

[0028] Thus, methods and systems of the present disclosure may be improvements to computer technology and/or drone-based racing or gaming.

1. Environment for Smart Gates and Drones

[0029] FIG. **1** depicts an example environment for drone gaming/racing. The environment **100** may include drones **104**, user devices **106**, gates **108**, local network(s) **110**A, and a local server **112**. In some cases, the environment may include display(s) **114**. Generally, the various devices may be located at a location **102**. In some cases, the environment **100** may include external network(s) **110**B and a remote server **116**.

[0030] The drones **104** may, respectively, be controlled by a user device of the user devices **106**. For instance, in some cases, the user devices may be controllers for first person view (FPV) control of drones **104**. In some cases, the user devices may be personal computing devices, such as mobile devices, mobile phones, computers, laptops, and the like, that send instructions using radio frequency, WIFI, 4G/5G, and the like.

[0031] The gates **108** may be arranged indoors or outdoors in fixed or dynamic arrangements. The gates **108** may include a plurality of gates, such as a first gate **108**A, a second gate **108**B, and so on up to an Nth gate **108**N. The gates **108** may be arranged in a sequence, as discussed herein.

[0032] Each gate **108** may have at least a structure, a communication module, at least two sensors, and a microprocessor, as discussed herein. In some cases, some, or all of the gates **108** may have indicator light(s). The structure may be hoops, platforms, poles, and the like. While hoops are depicted in figures herein, certain features of the disclosure may be applicable to platforms, poles, and the like.

[0033] The communication module may be wired (e.g., ethernet) or wireless (e.g., WIFI or Bluetooth). In some cases, the gates **108** may be powered by an onboard battery, connected to an electrical grid (e.g., outlet), and/or powered over ethernet. The communication module may be connected (via wires or wireless) to the local server **112**, so as to connect the microprocessor to the local server **112**.

[0034] The at least two sensors may sense sensor data that indicates (or not) that a drone passed through a defined volume associated with the gate **108**. The defined volume associated with a gate may be defined in accordance with its structure. For instance, in the case of a hoop, the defined volume may be a volume of space circumscribed by the structure of the hoop. For instance, the at least two sensors may be configured to capture data related to the passage of drones through hoops of the gates **108**. In the case of a platform, the volume may be a volume of space adjacent the platform, such as above, to the side, or below the platform. In the case of a pole, the volume may be a volume of space adjacent the pole, such as above, to the side, or below the pole. The at least two sensors may include at least two or combinations of: an RFID sensor, an accelerometer, a vibration sensor, and a camera.

[0035] The RFID sensor may sense nearby RFID tags (passive or active) attached to drones **104**. In some cases, the RFID sensor may determine drone identifiers (IDs). In some cases, the RFID sensor may determine that a drone was within a certain distance of the gate **108**. In some cases, the RFID sensor may determine a distance the RFID tag is away from the RFID sensor and/or at a certain vector from the gate **108** (e.g., a relative distance and/or location of the drone from the gate **108**).

[0036] The accelerometer and/or the vibration sensor may detect a physical strike of the drone with the structure of gate **108**. In some cases, the accelerometer may detect a strike by detecting an acceleration above an acceleration threshold. In some cases, the vibration sensor may detect a strike by detecting a vibration above a vibration threshold. The acceleration threshold and the vibration threshold may be preset to avoid detecting noise or wind, and the like.

[0037] The camera may capture a set of images (e.g., at a given frame rate) of a given field of field. In some case, the camera may be positioned to capture a first region associated with its own gate. In some cases, the camera may be positioned to capture to capture a second region associated with a different gate. In some cases, the camera may be positioned to capture the first region and/or the second region. In some cases, the camera (or the micro-processor) may identify a presence of drone (e.g., this object is a drone); identify a relative location (over time) of the drone within the location **102** in its field of view; and/or identify a drone ID (e.g., based on color, labels, and the like). In this manner, the camera may be used to visually confirm that a drone successful passed its own gate or a different gate. In some cases, the camera may be a color camera, a black and white camera, and the like. In some cases, the camera (or microprocessor) may have machine vision functionality to perform associated functions.

[0038] Thus, the sensor data may include one or combinations: a drone ID, relative location of a drone, strike data, or raw data. The at least two sensors may provide sensor data to the microprocessor. The microprocessor may process the sensor data to determine one or combinations of: a drone ID, a successful (or not) gate traversal indicator, camera or video data, strike indicator, relative distance of the drone, and the like.

[0039] In some cases, the microprocessor may control the indicator light(s) based on the sensor data and/or instructions form the local server **112**. For instance, the microprocessor may cause the indicator light(s) to change based on a drone passing successfully through the region associated with the gate; change based on a drone not passing successfully through the region associated with the gate; change based on a drone striking the gate; change based on game play (e.g., to re-configure a sequence arrangement or target action); and/or change based on race progress (e.g., lead drone, lap number, and the like).

[0040] The local network(s) **110**A may route data between various devices at the location **102**. For instance, while the user devices **106** may directly communicate with drones **104**, the user devices **106** may also (or instead) use the local network(s) **110**A. Moreover, the local network(s) **110**A may route data (e.g., sensor data and/or determinations of the micro-processor) from gates **108** to local server **112**. In some cases, the drones **104** may transmit data (e.g., GPS data, camera feed, and the like) to the local server **112**.

[0041] The local server **112** (alternatively referred to herein as "control system **404**") may track game/race progress based on data collected from the various devices. In some cases, the local server **112** perform referee functions or machine learning functions while tracking the game/race progress.

[0042] The referee functions may (1) determine point deductions (or time additions) or infractions based on programmatic rules (e.g., drone was out of bounds, drone struck a gate, a first drone got to near a second drone or a gate, and the like); (2) determine point additions (or time deductions) based on programmatic rules (e.g., drone had the fastest lap, drone performed a specific maneuver, and the like); (3) track game/lap times and order of game/race participants; and (4) determine a winner based on the foregoing and the like data, based on programmatic rules.

[0043] The machine learning functions may receive as inputs (e.g., in feature vectors) sensor data (and/or feature thereof) and output inferences of user(s) skill level(s). The machine learning functions may include a machine learning model trained on a training set. The training set may include example sets of data of different types of skill levels (e.g., professional, adult, child, and the like). The machine learning model may be a neural network, a classification model, a regression model, and the like. The machine learning functions may determine adjustments to game/race play dynamics based on the inferred skill level(s) of the user(s). In some case, the machine learning functions may determine the skill level(s) before game/race play has begun and adjust a game/race before the start (e.g., based on historical data associated with the users). In some cases, the machine learning functions may determine the skill level(s) (e.g., based on current data and/or a combination of historical data and current data) during game/race play and make the adjustments during game/race play. In some cases, the machine learning functions may select a lowest skill level associated with the active users, select an average skill level of the active users (e.g., a numerical average or median), select the highest skill level of the active users, and so.

[0044] To adjust the game/race play based on (a selected) skill level, the system (e.g., the local server **112**) may dynamically re-arrange an order of gates (e.g., by changing indicator lights) or causing physical re-arrangement of fates (e.g., motorized control of gates or instructions to users to re-arrange the gates). In some cases, the adjustment may be: (1) a target maneuver for a drone, (2) a target time for a lap, (3) a target point total, and the like.

[0045] The local server **112** may process the data and determine where drones are in a game play/race progress, points for progress or actions taken by drones, deduct points for strikes of gates, and the like based on programmatic rules for different types of games/races. In some cases, the local server **112** may send instructions to microprocessors, via communications modules, to change indicator light(s). In some cases, the local server **112** may generate and update visuals to be displayed on the display(s) **114**. For instance, the display(s) **114** may display a current leader board, points, strikes, and the like for each drone/hoop.

[0046] In some cases, the local server **112** may use the external network(s) **110**B to provide data to the remote server **116**. The external network(s) **110**B may be any communication standard that connections distance devices, such as cellular, fiber networks, satellite, and the like. In some cases, the remote server **116** may receive and store in-progress game/race data (e.g., for online streaming). In some cases, the remote server **116** may receive and store game/race results (e.g., for social media and the like). In some cases, the remote server **116** may provide in-progress game/race data and/or game/race results to the user devices **106**.

2. First Type of Sensing Gate

[0047] FIG. **2**A depicts a diagram showing a first sensing gate **200**A. The features of FIG. **2**A may be applied to any of FIGS. **1**, **2**B, **3**, **4**A-**4**C, **5**, and **6**. The first sensing gate **200**A may include a first structure **202**A, and an attachment structure **204**. The first structure **202**A may be a circular hoop. The hoop may be a generally tubular shape bent into a circular configuration from the attachment structure **204** (e.g., the base **206**A). The hoop may have a diameter d**1**. The diameter d**1** may be sized so that drones may be able to pass through the hoop. For instance, the diameter d**1** may be sized to be 1.5, 2, 2.5 and the like times the size a drone. The tubular shape may be constructed of metal or plastic. The dimensions/material of the tubular shape may be sufficient to withstand impacts from drones.

[0048] The attachment structure **204** may include a base **206**A and one or combinations of leg attachment(s) **204**A, adhesive attachment(s) **204**B, and/or strap attachment(s) **204**C. The attachment structure **204** may be used to position and secure the first sensing gate **200**A at a relative location of the location **102**.

[0049] The leg attachment(s) **204**A may have a screw or press fit adapter to receive respective legs (see, e.g., legs **508** of FIG. **5**). In some cases, the leg attachment(s) **204**A may include one, two, three, or more leg attachments. See FIG. **5** for an example of a tripod arrangement. The legs may be adjustable in length so as to vary heights or orientations of the first sensing gate **200**A. In some cases, the legs may be replaced with screws or pegs that may be used to attach the first sensing gate **200**A to a position.

[0050] The adhesive attachment(s) **204**B may single use or re-usable adhesive to securely attach the first sensing gate **200**A to a surface.

[0051] The strap attachment(s) **204**C may be a fabric, leather, or plastic material that is secured to the base **206**A. In some cases, the strap attachment(s) **204**C may be detachable (e.g., to wrap around an object, such as a pole or handle). In some cases, the strap attachment(s) **204**C may be fixed to the base **206**A.

[0052] In some cases, the sensor modules in the gates **108** may include an RFID sensor and a camera. The RFID sensor may be configured to detect an RFID tag attached to a drone passing through (or near) the gate. This could allow the system to identify which drone has passed through (or near) the gate and at what time. The camera, on the other hand, may be positioned to capture images of drones passing through its own gate and/or other gates **108**. This could allow the system to visually track the movement of the drones and determine their relative positions in the gaming/racing area.

[0053] The microprocessor in the gates **108** may be configured to process the captured data in real-time during gameplay, allowing for immediate feedback and/or interaction. This could involve analyzing the real-time data to determine the skill level of the user or users and adjusting the gameplay accordingly. For example, the machine learning model may determine user skill levels and the system may increase the difficulty of the gameplay for more skilled users or decrease the difficulty for less skilled users.

3. Second Type of Sensing Gate

[0054] FIG. **2**B depicts a diagram showing a second sensing gate **200**B. The features of FIG. **2**B may be applied to any of FIGS. **1**, **2**A, **3**, **4**A-**4**C, **5**, and **6**. The second sensing gate **200**B may have a second structure **202**B, and a second base **206**B. The second structure **202**B may be a circular hoop. The hoop may be a generally cylinder shape with height h and inner diameter d**2**. The second base **206**B may be like base **206**A. The diameter d**2** may be the same or different from the diameter d**1**. The hoop may be constructed of metal or plastic. The dimensions/material of the hoop may be sufficient to withstand impacts from drones.

[0055] The second sensing gate **200**B may depict relative locations of a sensing module **208**, a communication module **210**, a microprocessor **212**, and lighting indicators **214**. The sensing module **208**, the communication module **210**, and the microprocessor **212** may be positioned inside the second base **206**B. For instance, the sensing module **208** may include the at least two sensors, as discussed herein. In some cases, the sensing module **208** may face an interior direction of hoop along vector V**3**. In some cases, the sensing module **208** may face one or both of a front (e.g., along vector V**1**) or back (e.g., along vector V**3**) of hoop. In some cases, certain sensors (e.g., camera) may face along a first vector (e.g., V**1**), while other sensors may face a different vector (e.g., V**3**). In this manner, different volumes may be sensed by the sensing module **208**.

[0056] The communication module **210** may include an ethernet port and (optionally) a power port. In the case where wireless communications and a battery are used, the ports may be removed, and the communication module **210** may be encased inside the second base **206**B.

[0057] In some cases, the microprocessor **212** may be positioned inside the second base **206**B with air vents. The air vents may avoid overheating or provide audio outputs (e.g., from a speaker).

[0058] In some cases, the lighting indicators **214** may be arranged on an exterior facing surface of the hoop and/or an interior facing surface of the hoop. In some case, the hoop may have one light (e.g., that protrudes from the hoop). In some cases, the lighting indicators **214** may be built into the surface of the hoop. In some case, the lighting indicators **214** may be an LED stripe.

4. Geometries of Sensing Gates

[0059] FIGS. **3**A, **3**B, and **3**C depict diagrams, including diagram **300**A, diagram **300**B, and diagram **300**C, showing a different geometries of sensing gates, including a third sensing gate **302**A, a fourth sensing gate **302**B, and a fifth sensing gate **302**C. The features of FIGS. **3**A, **3**B, and **3**C may be applied to any of FIGS. **1**, **2**A, **2**B, **4**A-**4**C, **5**, and **6**. The diagram **300**A depicts the third sensing gate **302**A; the diagram **300**B depicts the fourth sensing gate **302**B; and the diagram **300**C depicts the fifth sensing gate **302**C. The third sensing gate **302**A, the fourth sensing gate **302**B, and the fifth sensing gate **302**C may be constructed similar to the first sensing gate **200**A and/or the second sensing gate **200**B, but have different geometries.

[0060] The third sensing gate **302**A may be a generally square or rectangular shape. This shape may allow for a different gameplay experience and/or challenge compared to other shapes. For instance, a square or rectangular shape may require more precision in drone navigation compared to a circular shape.

[0061] The fourth sensing gate **302**B may be a generally hexagonal shape. This shape may provide a balance between the complexity of navigation and the size of the opening for the drone to pass through. The hexagonal shape may also provide a visually appealing design for the gaming/racing system.

[0062] The fifth sensing gate **302**C may be a generally triangular shape. This shape may provide a challenging gameplay experience as the drone may be required to navigate through the narrower opening compared to other shapes. The triangular shape may also provide a distinct visual element in the gaming/racing system.

[0063] In general, the sensing gates that are hoops may be any polygon with an opening with an area/volume circumscribed by the polygon such that a drone may fly through the area/volume of the opening. This flexibility in the shape of the sensing gates may allow for a variety of gameplay experiences and challenges, enhancing the versatility and appeal of the drone gaming/racing system.

5. Indoor/Fixed Drone Gaming/Racing Infrastructure

[0064] FIGS. **4**A-**4**C depict diagrams of a first drone gaming/racing infrastructure **402**. The features of FIGS. **4**A-**4**C may be applied to any of FIGS. **1**, **2**A, **2**B, **3**, **5**, and **6**.

[0065] FIG. **4**A depicts a diagram **400**A of the first drone gaming/racing infrastructure **402** without drones, users, or a net. The first drone gaming/racing infrastructure **402** may include at least a control system **404**, a first gate arrangement **406**, and a structure.

[0066] The structure may support the first gate arrangement **406** for gaming/racing, while the control system **404** may receive data from at least a plurality of gates of the first gate arrangement **406**, such as gate **406**A, gate **406**B, gate **406**C and so on up to gate **406**N. The plurality of gates, such as the gate **406**A, the gate **406**B, the gate **406**C, and so on, may be one or combinations of sensing gates described herein, such as the first sensing gate **200**A, the second sensing gate **200**B, the third sensing gate **302**A, fourth sensing gate **302**B, or fifth sensing gate **302**C.

[0067] The control system **404** may instruct the plurality of gates to change colors and such, in accordance with the gaming/racing programmatic rules. The control system **404** may instruct speaker(s) **407** and/or display(s) **412** to output sound and/or images, as discussed herein. The control system **404** may include a server **404**A (such as local server **112**) that manages data input and instructions to various devices in accordance with gaming/racing programmatic rules. In some cases, the control system **404** may be connected to a personal device **404**B (e.g., a laptop or computer), so that users may interact with the server **404**A and interact, e.g., with a user interface. For instance, the personal device **404**B may be used by a referee or operator of the gaming/racing infrastructure **402**.

[0068] In some cases, the structure may include a frame **414**. The frame **414** may be designed to support the plurality of gates of the first gate arrangement **406**. In some cases, the frame **414** may be made from metal or plastic. In some cases, the frame **414** may be arranged to provide placement of the gates of the first gate arrangement **406**. In some cases, the first gate arrangement **406** may position and orientate (in fixed or adjustable configurations) the gates on the frame **414**. In some cases, the first gate arrangement **406** may be a grid with spacing S**1** (e.g., five feet and the like) between rows of gates, with each gate spaced apart (from respective centers of gates) from each other by a space S**3** (e.g., 1.5 times S**2**), and each gate having an opening of area S**2** (e.g., such that drones may pass through the gates). In some cases, a bottom of the first gate arrangement **406** may be a minimum height H (e.g., 8 feet and the like) above a floor space. While the first gate arrangement **406** is depicted as the grid herein, the first gate arrangement **406** may be configured in various other designs, such as loops, circuits, and the like (e.g., with fixed or varying distances between gates, with fixed or varying orientations between sequential gates). In some cases, the gates may be arranged in a plane (e.g., all gates are aligned on one end in the same plane), while in other arrangements the gates may be offset from each other at varying distances (e.g., on protrusions or depressions that support the respective gates) from the plane.

[0069] In some cases, the structure may include one or more supports **408** and one or more connecting members **410**. The one or more connecting members **410** may connect the one or more supports **408** to the frame **414**. In some cases (not depicted), some of the gates may position and supported on the one or more supports **408**. In some cases, the one or more supports **408** and the one or more connecting members **410** may hold a net **420** (see FIG. **4**B). In some cases, the one or more supports **408**, the one or more connecting members **410**, and the net **420** may define an internal volume of space where drones and/or users may game or race. The net **420** may provide safety to viewers of the game/race. In some cases, the net **420** may cover the top and sides of the internal volume. In some cases, the net **420** may cover only the sides, while a top of the internal volume may abut a ceiling (or not). In some cases, net **420**/structure may include a door **422** (see, e.g., FIG. **4**B). The door **422** may be sized to allow drones and/or users to enter the internal volume. The internal volume may be defined based on space constraints of the location where first drone gaming/racing infrastructure **402** is installed. In some cases, the internal volume may be defined based on game or race rules.

[0070] In some cases, the frame **414** may include conduits for ethernet and/or power lines **416**. The ethernet and/or power lines **416** may connect the gates to the server **404**A and/or a power outlet. In some cases, the conduits may cover the ethernet and/or power lines **416** so that drones cannot become entangled in and/or cause damage to the ethernet and/or power lines **416**.

[0071] FIG. **4**B depicts a diagram **400**B of the first drone gaming/racing infrastructure **402** as used during gaming/racing. In the diagram **400**B, the first drone gaming/racing infrastructure **402** may depict content **418** displayed on the display(s) **412**. The content **418** may be output by the server **404**A in accordance with data received from drones and/or gates, in accordance with the game/race programmatic rules.

[0072] FIG. **4**C depicts a diagram **400**C of camera vectors of the first drone gaming/racing infrastructure **402**. The camera vectors may include various arrangements based on a number of camera modules each gate has and the arrangement of the first gate arrangement **406**. In some cases, the gates may include at least one camera module. Some of the gates may be configured with only one camera module, while some gates may be configured with two camera modules. The selection and design of such gates and arrangements may be based on field of view of the gates and/or cameras so that every gate may have at least one camera module that can view and sense drones passing through each gate.

[0073] In the case depicted in FIG. **4**C, the gates of a first row may have first camera vectors **424** that point towards a second row of gates. In some cases, the camera modules/gates may be able to sense one or more rows at a time (e.g., because machine vision can determine spatial distance with high enough confidence). In some cases, the camera modules/gates may be able to sense at least one gate of an adjacent row (e.g., the closest gate in a next row). In some cases, the camera modules/gates may be able to sense at least two gates of an adjacent row (e.g., because of field of view and spacing S**1**).

[0074] In some cases, the gates of the second row may have two camera modules that each respectively face a different camera vector, such as second camera vectors **426** that face the first row of gates and third camera vectors **428** that face a third row of gates. In this manner, the second row of gates may sense both the first row of gates and the second row of gates.

[0075] In some cases, the remaining rows (e.g., the third row through N−1 row) may have camera vectors **430** that face a next row of gates. In some case, the last row (e.g., Nth row) may not have or use a camera module.

[0076] During game play/racing, the camera modules of the gates may record sets of images of drones passing through (or near) their respective gates in view and provide such data to their respective microprocessors. The microprocessors may determine various data (such as successful pass indicator, a gate ID of the successful pass indicator, drone ID of the successful pass indicator, and the like) and transmit such data to the server **404**A. In addition to the data from the camera modules, the gates may use any of sensors discussed herein, such as RFID, accelerometer, or vibration sensor and the like, and the microprocessor may check, confirm, or supplement the camera data.

6. Outdoor/Dynamic Drone Gaming/Racing Infrastructure

[0077] FIG. **5** depicts a diagrams of a second drone gaming/racing infrastructure **502**. The features of FIG. **5** may be applied to any of FIGS. **1**, **2**A, **2**B, **3**, **4**A-**4**C, and **6**. The second drone gaming/racing infrastructure **502** may include at least the control system **404** and a second gate arrangement **506**.

[0078] For the second gate arrangement **506**, a plurality of gates, such as gate **506**A, gate **506**B, gate **506**C and so on up to gate **506**N, may be arranged on legs **508** in a location, such as location **102**. The plurality of gates may be connected (e.g., via wires or wirelessly) to the control system **404**, as discussed herein. In some cases, the plurality of gates may be labeled with a sequential order to assist users setting up the plurality of gates. In some cases, the plurality of gates may have a gate ID that they report the control system **404** when connected and/or when transmitting data. In some cases, the gate ID may correspond to a position in the sequential order and/or correspond to the label of a gate. The plurality of gates, such as the gate **506**A, the gate **506**B, the gate **506**C and so on, may be one or combinations of sensing gates described herein, such as the first sensing gate **200**A, the second sensing gate **200**B, the third sensing gate **302**A, fourth sensing gate **302**B, or fifth sensing gate **302**C.

[0079] During game play/racing, the users (e.g., players) may set drones **510** on a starting location. For instance, the users may set drones **510** on a mat, a block, the ground, or the like, or a sensor pad, e.g., to detect when lift off occurs.

[0080] The control system **404** may start a game/race timer after a count down. For instance, the control system **404** may control the speaker(s) **407** or the display(s) **412** to display content/output audio for the count down and start. At the start, the users may control the drones to take off and fly towards and through the plurality of gates. The gates may register (e.g., sense and report) which of the drones **510** flew through the gates, their order, and when each drone flew through the gates. For instance, RFID sensor (or other sensors) may detect a drone passing through the respective gates (e.g., gate **506**A), which drone it was, and what time it occurred.

[0081] In some cases, the gates may control the light indicators (e.g., a LED strip) to changes to different colors. For instance, the gates may change to a color corresponding to a color of the first drone that flew through it (e.g., on a given lap). After a revolution/lap, the gates may reset to a standard/default color (e.g., white). The gates may then change colors again based on the newest first drone to pass through the gate. In some cases, the change in color may b persistent (e.g., until the revolution/lap is complete) or the color may flash. In some cases, the gates may change colors to indicate a strike occurred. For instance, the gate that is struck by a drone may cause the light indicator to change a new color (e.g., corresponding to the second drone or as a point deduction indicator) indicating the second drone struck the gate.

[0082] After a predefined (or user defined) number of revolutions/laps, the control system **404** may determine a ranking based on time, points added, points deducted, in accordance with programmatic rules for game/race play. The control system **404** may cause the display or speak to output content to indicate (1) current status of the game/race, and (2) after the game/race, a winner, stats, points, and the like. In some cases, the control system **404** may output the winner, stats, points, and the like, after a last drone passes a final gate, returns to the starting location, or to a finish location (e.g., a finish line).

7. Example Routine(s) for Smart Gates and Drones

[0083] FIG. **6** depicts a flowchart of a method **600** for drone gaming/racing using sensing gates. The features of FIG. **6** may be applied to any of FIGS. **1**, **2**A, **2**B, **3**, **4**A-**4**C, and **5**.

[0084] The method **600** may be performed by one or more systems, as described herein. For instance, some or all of the operations of the method **600** may be performed by a gate of a gate arrangement and/or a control system (such as local server **112**).

[0085] The method **600** may start at block **602**, where at least two sensors (of a first gate) are configured to sense sensor data for a drone near a gate. As discussed herein, the at least two sensors may be configured to sense sensor data for drones with respect to their own gate (e.g., the first gate) and/or for different gates (e.g., second or other gates, such as in a field of view of a camera module of the first gate). The at least two sensors may provide the sensor data to a microprocessor of the first gate. The microprocessor may receive the sensor data from the at least two sensors.

[0086] At block **604**, the microprocessor may determine at least a gate pass indicator based on the sensor data. For instance, as discussed herein, the microprocessor may determine a drone ID based on RFID data, acceleration or vibration data from the accelerometer and vibration sensor, a drone passing through its own gate or another gate based on camera data, and the like. In the case of camera data, the microprocessor may determine a drone ID based on markings, or the control system may match a drone ID from an RFID sensor of the remote gate to a camera determination that the remote gate was passed at a certain time stamp.

[0087] At block **606**, the control system may obtain the gate pass indicator (and any other data provided by the gate) and update tracking data. For instance, the tracking data may include raw data (from sensors, microprocessors, and the like), gate pass indicators (and their time stamps) for gates and drones, gate strikes and drones that struck the gates and when, and the like. The tracker data may, generally, record any (or portions of) data discussed herein for a given game/race.

[0088] At block **608**, the control system may perform one or more actions based on the tracking data. For instance, the control system may display content on a display during a game/race (e.g., who is leading, rankings, stats, points, and the like), control gates to change colors to indicate leading drones and/or strikes by drones, and display content after the game/race (e.g., winner, stats, points, and the like). In some cases, the control system may be re-arranged an order of gates the users are to pass through, and cause indicator lights of gates to indicate the new order of gates to users. For instance, the control system may use a machine learning module to infer skill level(s) of the users (e.g., based on historical or current game/race play data), and adjust the game/race configuration, route, challenges, and the like based on the inferred skill level(s).

8. Example Routine(s) for Smart Gates without Drones

[0089] FIG. **7** depicts a flowchart of a method **700** of using sensing gates. The features of FIG. **7** may be applied to any of FIGS. **1**, **2**A, **2**B, **3**, **4**A-**4**C, **5**, and **6**.

[0090] The present disclosure relates to sensing gates for sports and educational activities. The sensing gates may provide a versatile platform for tracking and analyzing various metrics in sports training, performance analysis, and interactive learning experiences. In some cases, the sensing gates may be designed with durable, lightweight materials to withstand different environments and activities. This design choice may allow for use in both indoor and outdoor settings, accommodating a range of sports and educational applications.

[0091] The sensing gates may incorporate a modular design, enabling adaptation to various sports and educational scenarios. This modularity may allow users to reconfigure the system for different purposes, such as tracking shot accuracy in basketball, analyzing passing techniques in football, or demonstrating physics concepts in a classroom setting. The adaptability of the system may enhance its utility across diverse fields and user groups.

[0092] By combining advanced sensor technology with a flexible, user-friendly design, the sensing gates may offer a powerful tool for performance enhancement, skill development, and interactive learning. The system may provide real-time data capture and analysis, facilitating immediate feedback and long-term progress tracking. These features may contribute to more effective training methods in sports and more engaging educational experiences in STEM fields.

[0093] The sensing gates may be designed with various structures to accommodate different sports and educational activities. In some cases, the sensing gates may have a circular hoop structure. The circular hoop structure may provide a target for activities such as basketball shooting practice or drone navigation exercises. The circular hoop may be constructed from durable materials capable of withstanding impacts from balls or other objects.

[0094] In some cases, the sensing gates may have a rectangular or square structure. This configuration may be suitable for activities that require a wider target area, such as football passing drills or soccer shooting practice. The rectangular or square structure may allow for more precise measurement of horizontal and vertical accuracy.

[0095] In some cases, the sensing gates may have a hexagonal or triangular structure. These shapes may offer unique challenges for sports training or educational activities, requiring participants to aim for specific angles or corners of the structure.

[0096] The sensing gates may incorporate advanced sensor arrays for precise data capture in sports and educational applications. These sensor arrays may include combinations of optical sensors, infrared sensors, and pressure sensors. The optical sensors may capture high-speed video of objects passing through the gate, allowing for detailed analysis of trajectory and spin. Infrared sensors may detect the heat signature of objects, enabling accurate tracking even in low-light conditions. Pressure sensors integrated into the gate structure may measure the force of impacts, providing data on ball speed and power.

[0097] In some cases, the sensing gates may include tracking capabilities for metrics like shot accuracy, ball speed, and player positioning in sports. The gates may utilize multiple sensor types to gather comprehensive data on each attempt or pass through the gate. For shot accuracy, the sensors may pinpoint the exact location where an object passes through the gate, allowing for precise measurement of deviation from the center or target area. Ball speed may be calculated using time-of-flight measurements between multiple sensors or through analysis of high-speed video data. Player positioning may be tracked using external sensors or cameras that work in conjunction with the gate sensors to provide a complete picture of the activity.

[0098] The sensing gates may be equipped with modular attachment points, allowing for easy reconfiguration or addition of supplementary sensors. This modularity may enable the gates to be adapted for various sports or educational activities without requiring a complete redesign of the structure.

[0099] In some cases, the sensing gates may incorporate wireless communication modules. These modules may allow the gates to transmit collected data in real-time to a central processing unit or mobile devices. This real-time data transmission may enable immediate feedback for athletes or students, as well as facilitate remote coaching or instruction.

[0100] The structures of the sensing gates may also include integrated display systems or remote wireless displays (e.g., mobile phones). These displays may show immediate feedback on performance metrics, such as accuracy percentages or speed measurements. In educational settings, the displays may present questions or challenges related to the current activity, enhancing the interactive learning experience.

[0101] In some cases, the sensing gates may be designed with adjustable dimensions. This feature may allow the gates to be adapted for different skill levels or age groups, ensuring that the challenge level remains appropriate for the users. The adjustability may be achieved through telescoping components or modular sections that can be added or removed as needed.

[0102] The materials used in the construction of the sensing gates may be selected for durability and weather resistance, allowing for use in both indoor and outdoor environments. In some cases, the gates may be made from lightweight materials to facilitate easy transportation and setup, while still maintaining the structural integrity necessary for accurate sensor readings.

[0103] FIG. **7** illustrates a flowchart for processing sensor data and providing user feedback in a smart hoop system. The process begins at step **702**, where at least two sensors sense sensor data for an object near a gate. These sensors may include radio frequency identification (RFID) sensors, cameras, accelerometers, or vibration sensors, as described earlier.

[0104] Following the data collection, the process moves to step **704**, where a microprocessor determines at least one parameter for the object based on the sensor data. This parameter may include, but is not limited to, object identification, position, velocity, or trajectory.

[0105] The process concludes at step **706**, where a control system outputs a graphical user interface depicting data related to the object based on the at least one parameter determined in the previous step. This output may be displayed on a screen or mobile device, providing real-time feedback to users.

[0106] In some cases, the smart hoop system may integrate with cloud-based data storage for long-term performance analysis. This integration may allow users to track their progress over time and identify areas for improvement.

[0107] The system may use AI-powered real-time analysis and feedback for performance enhancement. For example, in a basketball training scenario, the AI may analyze a player's shooting form and provide immediate suggestions for improvement.

[0108] In some cases, the smart hoop system may integrate with a mobile app for a user-friendly interface and data visualization. This integration may allow users to access their performance data and analytics on their personal devices.

[0109] The system may use wireless communication, enabling real-time feedback and remote coaching. This feature may be particularly useful in educational settings or for athletes training remotely.

[0110] The smart hoop system may be adapted for various sports and educational activities. In sports applications, the system may be used for basketball shot tracking, football passing accuracy, or tennis serve precision. For educational purposes, the system may be used to demonstrate physics concepts such as projectile motion or to create interactive math challenges.

[0111] For example, in a basketball training scenario, step **702** may involve sensors detecting a basketball passing through the hoop. At step **704**, the microprocessor may determine parameters such as the ball's trajectory, speed, and spin. Finally, at step **706**, the control system may output a visual representation of the shot, along with statistics and suggestions for improvement.

[0112] In an educational context, the same process may be used to demonstrate concepts in physics. The sensors at step **702** may detect an object launched through the hoop. At step **704**, the microprocessor may calculate parameters such as velocity and acceleration. At step **706**, the control system may display these calculations alongside theoretical predictions, helping students visualize abstract concepts.

[0113] By providing immediate, data-driven feedback, this process enables users to quickly identify areas for improvement and track their progress over time, whether in sports training or educational activities.

[0114] The sensing gate system may provide a versatile platform for various sports and educational activities, offering real-time feedback and interactive experiences. The system may operate through a series of steps, beginning with sensor data collection and culminating in user feedback.

[0115] In some cases, the sensing gates may be configured to provide interactive physics and mathematics demonstrations for STEM education. The sensors in the gates may collect data on objects passing through or near the gates. This data may be processed to illustrate concepts such as velocity, acceleration, or trajectory. For example, students may observe how changing the angle of a projectile affects its path through multiple gates, providing a tangible demonstration of parabolic motion.

[0116] The system may utilize customizable training programs powered by artificial intelligence (AI) for personalized skill development. The AI may analyze data collected from multiple sessions to identify patterns in a user's performance. Based on this analysis, the system may generate tailored training regimens. For instance, in a basketball shooting drill, the AI may recognize that a user consistently misses shots to the left and adjust the gate positions or provide specific feedback to address this tendency.

[0117] In some cases, the sensing gate system may offer gamified learning experiences combining physical activity with coding and data analysis. Users may interact with the gates through physical movements while simultaneously engaging with coding challenges. For example, students may write code to predict the path of an object through the gates and then physically test their predictions. The system may collect data on both the physical performance and the accuracy of the code, providing a comprehensive learning experience that bridges theoretical knowledge with practical application.

[0118] The overall workflow of the sensing gate system may involve several steps. Initially, the sensors in the gates may collect data on objects or users interacting with the system. This data may then be processed by the system's microprocessors, which may extract relevant information such as speed, accuracy, or trajectory. The processed data may be analyzed by AI algorithms to identify patterns, assess performance, or generate personalized feedback. Finally, the system may present this information to users through visual displays, audio cues, or adjustments to the physical configuration of the gates.

[0119] This integrated approach may allow the sensing gate system to adapt to various use cases, from sports training to educational activities, providing users with immediate, actionable feedback to enhance their learning and performance.

9. Computer System

[0120] FIG. **8** depicts an example system that may execute techniques presented herein. FIG. **8** is a simplified functional block diagram of a computer that may be configured to execute techniques described herein, according to exemplary cases of the present disclosure. Specifically, the computer (or "platform" as it may not be a single physical computer infrastructure) may include a data communication interface **860** for packet data communication. The platform may also include a central processing unit ("CPU") **820**, in the form of one or more processors, for executing program instructions. The platform may include an internal communication bus **810**, and the platform may also include a program storage and/or a data storage for various data files to be processed and/or communicated by the platform such as ROM **830** and RAM **840**, although the system **800** may receive programming and data via network communications. The system **800** also may include input and output ports **850** to connect with input and output devices such as keyboards, mice, touchscreens, monitors, displays, etc. Of course, the various system functions may be implemented in a distributed fashion on a number of similar platforms, to distribute the processing load. Alternatively, the systems may be implemented by appropriate programming of one computer hardware platform.

[0121] The general discussion of this disclosure provides a brief, general description of a suitable computing environment in which the present disclosure may be implemented. In some cases, any of the disclosed systems, methods, and/or graphical user interfaces may be executed by or implemented by a computing system consistent with or similar to that depicted and/or explained in this disclosure. Although not required, aspects of the present disclosure are described in the context of computer-executable instructions, such as routines executed by a data processing device, e.g., a server computer, wireless device, and/or personal computer. Those skilled in the relevant art will appreciate that aspects of the present disclosure can be practiced with other communications, data processing, or computer system configurations, including: Internet appliances, hand-held devices (including personal digital assistants ("PDAs")), wearable computers, all manner of cellular or mobile phones (including Voice over IP ("VoIP") phones), dumb terminals, media players, gaming devices, virtual reality devices, multi-processor systems, microprocessor-based or programmable consumer electronics, set-top boxes, network PCs, mini-computers, mainframe computers, and the like. Indeed, the terms "computer," "server," and the like, are generally used interchangeably herein, and refer to any of the above devices and systems, as well as any data processor.

[0122] Aspects of the present disclosure may be embodied in a special purpose computer and/or data processor that is specifically programmed, configured, and/or constructed to perform one or more of the computer-executable instructions explained in detail herein. While aspects of the present disclosure, such as certain functions, are described as being performed exclusively on a single device, the present disclosure may also be practiced in distributed environments where functions or modules are shared among disparate processing devices, which are linked through a communications network, such as a Local Area Network ("LAN"), Wide Area Network ("WAN"), and/or the Internet. Similarly, techniques presented herein as involving multiple devices may be implemented in a single device. In a distributed computing environment, program modules may be located in both local and/or remote memory storage devices.

[0123] Aspects of the present disclosure may be stored and/or distributed on non-transitory computer-readable media, including magnetically or optically readable computer discs, hard-wired or preprogrammed chips (e.g., EEPROM semiconductor chips), nanotechnology memory, biological memory, or other data storage media. Alternatively, computer implemented instructions, data structures, screen displays, and other data under aspects of the present disclosure may be distributed over the Internet and/or over other networks (including wireless networks), on a propagated signal on a propagation medium (e.g., an electromagnetic wave(s), a sound wave, etc.) over a period of time, and/or they may be provided on any analog or digital network (packet switched, circuit switched, or other scheme).

[0124] Program aspects of the technology may be thought of as "products" or "articles of manufacture" typically in the form of executable code and/or associated data that is carried on or embodied in a type of machine-readable medium. "Storage" type media include any or all of the tangible memory of the computers, processors or the like, or associated modules thereof, such as various semiconductor memories, tape drives, disk drives and the like, which may provide non-transitory storage at any time for the software programming. All or portions of the software may at times be communicated through the Internet or various other telecommunication networks. Such communications, for example, may enable loading of the software from one computer or processor into another, for example, from a management server or host computer of the mobile communication network into the computer platform of a server and/or from a server to the mobile device. Thus, another type of media that may bear the software elements includes optical, electrical and electromagnetic waves, such as used across physical interfaces between local devices, through wired and optical landline networks and over various air-links. The physical elements that carry such waves, such as wired or wireless links, optical links, or the like, also may be considered as media bearing the software. As used herein, unless restricted to non-transitory, tangible "storage" media, terms such as computer or machine "readable medium" refer to any medium that participates in providing instructions to a processor for execution.

10. Terminology

[0125] The terminology used above may be interpreted in its broadest reasonable manner, even though it is being used in conjunction with a detailed description of certain specific examples of the present disclosure. Indeed, certain terms may even be emphasized above; however, any terminology intended to be interpreted in any restricted manner will be overtly and specifically defined as such in this Detailed Description section. Both the foregoing general description and the detailed description are exemplary and explanatory only and are not restrictive of the features, as claimed.

[0126] As used herein, the terms "comprises," "comprising," "having," including," or other variations thereof, are intended to cover a non-exclusive inclusion such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements, but may include other elements not expressly listed or inherent to such a process, method, article, or apparatus.

[0127] In this disclosure, relative terms, such as, for example, "about," "substantially," "generally," and "approximately" are used to indicate a possible variation of +10% in a stated value.

[0128] The term "exemplary" is used in the sense of "example" rather than "ideal." As used herein, the singular forms "a," "an," and "the" include plural reference unless the context dictates otherwise.

11. Examples

[0129] Exemplary embodiments of the systems and methods disclosed herein are described in the numbered paragraphs below.

[0130] A1. A drone gaming/racing system, comprising: a plurality of gates, wherein each of the plurality of gates include: at least two sensors configured to capture sensor data, and a microprocessor configured to process the sensor data to determine at least gate pass indicator(s); a control system communicatively coupled to the plurality of gates, wherein the control system is configured to: receive the sensor data and the gate pass indicator(s); update, based on the sensor data and the gate pass indicator(s), tracking data for a plurality of drones while the plurality of drones navigate the plurality of gates; and perform at least one action based on the tracking data.

[0131] A2. The drone gaming/racing system of A1, wherein the at least two sensors include an RFID sensor and a camera.

[0132] A3. The drone gaming/racing system of A2, wherein the RFID sensor is configured to detect an RFID tag attached to a drone passing through or near a gate.

[0133] A4. The drone gaming/racing system of A2, wherein the camera is positioned to capture images of drones passing through its own gate and/or other gates.

[0134] A5. The drone gaming/racing system of any of A1-A4, wherein the gates are arranged in a specific sequence for gameplay or racing.

[0135] A6. The drone gaming/racing system of any of A1-A5, wherein the gates include indicator lights, and the indicator lights are controlled to change color based on a drone passing through a defined volume of space associated with a gate.

[0136] A7. The drone gaming/racing system of any of A1-A6, wherein the gates are powered by an onboard battery, power over ethernet, or a power cord to a power source external to the gates.

[0137] A8. The drone gaming/racing system of any of A1-A7, wherein, to perform the at least one action based on the tracking data, the control system is configured to adjust gameplay or race arrangement based on skill level(s) of user(s).

[0138] A9. The drone gaming/racing system of A8, wherein the control system is configured to infer the skill level(s) of the user(s) using a machine learning model.

[0139] A10. The drone gaming/racing system of any of A1-A9, wherein the gates are configured to withstand impacts from drones.

[0140] A11. The drone gaming/racing system of any of A1-A10, wherein the gates are (1) circular hoops and/or (2) polygonal hoops.

[0141] A12. The drone gaming/racing system of any of A1-A11, wherein the gates are arranged (1) in a grid pattern or (2) in a circuit.

[0142] A13. The drone gaming/racing system of any of A1-A12, wherein the system is configured for (1) outdoor use or (2) inside use.

[0143] A14. The drone gaming/racing system of any of A1-A13, wherein the gates are arranged on adjustable legs in the specific sequence.

[0144] A15. The drone gaming/racing system of any of A1-A14, wherein the gates are arranged on a frame in the specific sequence.

[0145] A16. The drone gaming/racing system of A15, wherein the frame and an adjacent volume of space is enclosed by a net.

[0146] A17. A drone racing system, comprising: a plurality of drones, wherein each of the plurality of drones include an RFID tag; a racecourse, wherein the racecourse includes a plurality of gates in a sequential order, and each gate incudes a sensor module for capturing sensor data and a microprocessor for processing the sensor data; and a control system configured to: receive and manage the sensor data for tracking the plurality of drones, and referee a race of the plurality of drones through the sequential order of the plurality of gates.

[0147] A18. The drone racing system of A17, wherein each gate is hardwired to the control system for data transmission and power supply.

[0148] A19. The drone racing system of A17 or A18, wherein the race is conducted by having the drones fly through the gates in the sequential order, with the sensor modules in the gates registering which drone flew through each gate and at what time.

[0149] A20. The drone racing system of any of A17-A19, wherein the sensor modules in the gates comprise an RFID sensor for detecting the RFID tags on the drones, and one or combinations of: (1) a camera for visually tracking the movement of the drones, (2) an accelerometer for detecting physical contact between the drones and the gates, and/or (3) a vibration sensor for detecting physical contact between the drones and the gates.

[0150] A21. The drone racing system of A20, wherein the microprocessor is configured to process the data captured by the sensor modules in real-time during the race.

[0151] A22. The drone racing system of A21, wherein the microprocessors are configured to determine gate pass indicators based on the sensor data from the sensor modules.

[0152] A23. The drone racing system of any of A17-A22, wherein the control system is configured to: (1) update tracking data based on the sensor data from the sensor modules, (2) determine an order of the drones, and (3) allocate points based on performance of the drones.

[0153] A24. The drone racing system of A23, wherein the control system is further configured to adjust race dynamics in real-time based on skill level(s) of drone operator(s)

[0154] A25. The drone racing system of A24, wherein the control system is further configured to determine the skill level(s) using a machine learning model that processes the real-time data captured by the sensor modules.

[0155] A26. A drone gaming system, comprising: a plurality of hoops, wherein each of the plurality of hoops include a set of sensors, the set of sensors include one or combinations of: an RFID sensor, camera, and accelerometer, and the set of sensors are configured to sense drones passing through the hoops; and a control system configured to: manage data from the plurality of hoops, and referee gameplay based on the data from the plurality of hoops.

[0156] A27. The drone gaming system of A26, wherein each hoop is hardwired to the control system for data transmission and power supply.

[0157] A28. The drone gaming system of any of A26-A27, wherein the real-time data captured by the set of sensors is processed by a machine learning model to respond during gameplay in ways that challenge the skill level of user(s).

[0158] A29. The drone gaming system of any of A26-A27, wherein the plurality of hoops each include light indicators.

[0159] A30. The drone gaming system of A29, wherein the light indicators are controlled to (1) change color based on a first drone to pass through a hoop during a game round, (2) change color based on a drone impact with a hoop, (3) change color to indicate a change in gameplay.

[0160] A31. The drone gaming system of A29, wherein the light indicators are controlled to reset to a default color after each game round.

[0161] A32. The drone gaming system of A31, wherein the light indicators are controlled to change color of a next first drone to pass through the hoop in a subsequent game round.

[0162] B1. A gaming system, comprising: a plurality of gates, each gate including at least two sensors configured to capture sensor data for an object and a microprocessor configured to process the sensor data to determine at least one parameter for the object; and a control system communicatively coupled to the plurality of gates, the control system configured to: receive the sensor data and the at least one parameter for the object, and generate and output a graphical user interface based on the at least one parameter.

[0163] B2. The gaming system of B1, wherein the at least two sensors include at least one of: an RFID sensor, a camera, an accelerometer, or a vibration sensor.

[0164] B3. The gaming system of any of B1-B2, wherein each gate further includes at least one indicator light, and wherein the control system is further configured to control the at least one indicator light based on the at least one parameter.

[0165] B4. The gaming system of B3, wherein controlling the at least one indicator light includes changing a color of the at least one indicator light based on the object passing through a corresponding gate.

[0166] B5. The gaming system of any of B1-B4, wherein the control system is further configured to: infer a skill level of at least one user based on the at least one parameter; and adjust a configuration of the plurality of gates based on the inferred skill level.

[0167] B6. The gaming system of B5, wherein adjusting the configuration of the plurality of gates includes changing an order of the plurality of gates.

[0168] B7. The gaming system of any of B1-B6, wherein the system is configured for basketball training, and wherein the at least one parameter includes at least one of: shot accuracy, ball trajectory, or shooting form.

[0169] B8. The gaming system of any of B1-B7, wherein the system is configured for football training, and wherein the at least one parameter includes at least one of: passing accuracy, throw distance, or spiral rotation.

[0170] B9. The gaming system of any of B1-B8, wherein the system is configured for tennis training, and wherein the at least one parameter includes at least one of: serve speed, ball spin, or court placement.

[0171] B10. The gaming system of any of B1-B9, wherein the system is configured for physics education, and wherein the at least one parameter includes at least one of: velocity, acceleration, or trajectory of the object passing through or near the gates.

[0172] B11. The gaming system of any of B1-B10, wherein the system is configured for mathematics education, and wherein the control system is further configured to generate interactive math challenges based on the at least one parameter.

[0173] B12. The gaming system of any of B1-B11, wherein the system is configured for coding education, and wherein the control system is further configured to: receive user-generated code predicting object behavior; compare actual object behavior based on the at least one parameter to the predicted behavior; and provide feedback on the accuracy of the user-generated code.

[0174] B13. The gaming system of any of B1-B12, wherein the system is configured for multi-sport training, and wherein the control system is further configured to adjust the configuration of the plurality of gates to accommodate different sports.

[0175] B14. The gaming system of any of B1-B13, wherein the system is configured for adaptive learning, and wherein the control system is further configured to: analyze performance data over multiple sessions; identify performance patterns; and generate personalized training programs based on the identified patterns.

[0176] Other aspects of the disclosure will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims.

What is claimed is:

1. A drone gaming/racing system, comprising:

a plurality of gates, wherein each of the plurality of gates include:

at least two sensors configured to capture sensor data, and

a microprocessor configured to process the sensor data to determine at least gate pass indicator(s);

a control system communicatively coupled to the plurality of gates, wherein the control system is configured to:

receive the sensor data and the gate pass indicator(s);

update, based on the sensor data and the gate pass indicator(s), tracking data for a plurality of drones while the plurality of drones navigate the plurality of gates; and

perform at least one action based on the tracking data.

2. The drone gaming/racing system of claim **1**, wherein the at least two sensors include an RFID sensor and a camera.

3. The drone gaming/racing system of claim **2**, wherein the RFID sensor is configured to detect an RFID tag attached to a drone passing through or near a gate.

4. The drone gaming/racing system of claim **2**, wherein the camera is positioned to capture images of drones passing through its own gate and/or other gates.

5. The drone gaming/racing system of claim **1**, wherein the gates are arranged in a specific sequence for gameplay or racing.

6. The drone gaming/racing system of claim **1**, wherein the gates include indicator lights, and the indicator lights are controlled to change color based on a drone passing through a defined volume of space associated with a gate.

7. The drone gaming/racing system of claim **1**, wherein the gates are powered by an onboard battery, power over ethernet, or a power cord to a power source external to the gates.

8. The drone gaming/racing system of claim **1**, wherein, to perform the at least one action based on the tracking data, the control system is configured to adjust gameplay or race arrangement based on skill level(s) of user(s).

9. The drone gaming/racing system of claim **8**, wherein the control system is configured to infer the skill level(s) of the user(s) using a machine learning model.

10. The drone gaming/racing system of claim **1**, wherein the gates are configured to withstand impacts from drones.

11. The drone gaming/racing system of claim **1**, wherein the gates are (1) circular hoops and/or (2) polygonal hoops.

12. The drone gaming/racing system of claim **1**, wherein the gates are arranged (1) in a grid pattern or (2) in a circuit.

13. The drone gaming/racing system of claim **1**, wherein the system is configured for (1) outdoor use or (2) inside use.

14. The drone gaming/racing system of claim **1**, wherein the gates are arranged on adjustable legs in the specific sequence.

15. The drone gaming/racing system of claim **1**, wherein the gates are arranged on a frame in the specific sequence.

16. The drone gaming/racing system of claim **15**, wherein the frame and an adjacent volume of space is enclosed by a net.

17. A drone racing system, comprising:

a plurality of drones, wherein each of the plurality of drones include an RFID tag;

a racecourse, wherein the racecourse includes a plurality of gates in a sequential order, and each gate incudes a sensor module for capturing sensor data and a microprocessor for processing the sensor data; and

a control system configured to:

receive and manage the sensor data for tracking the plurality of drones, and referee a race of the plurality of drones through the sequential order of the plurality of gates.

18. The drone racing system of claim **17**, wherein each gate is hardwired to the control system for data transmission and power supply.

19. The drone racing system of claim **17**, wherein the race is conducted by having the drones fly through the gates in the sequential order, with the sensor modules in the gates registering which drone flew through each gate and at what time.

20. A drone gaming system, comprising:

a plurality of hoops,

wherein each of the plurality of hoops include a set of sensors,

the set of sensors include one or combinations of: an RFID sensor, camera, and accelerometer, and

the set of sensors are configured to sense drones passing through the hoops; and

a control system configured to:

manage data from the plurality of hoops, and

referee gameplay based on the data from the plurality of hoops.

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