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AUTOMATIC LEVELING IMMERSION COOLING TANK AND METHOD OF OPERATING THE SAME

Abstract

A system including a coolant tank in which a coolant is stored. One or more electrical components that generate thermal energy when in operation are stored within the coolant tank and are immersed (e.g., partially submerged or fully submerged) within the coolant to mitigate the thermal energy generated when in operation. One or more sensors are configured to, in operation, monitor at least one of the following of a surface level of the coolant and a position of the coolant tank or monitor both such that the one or more electrical components remain properly immersed (e.g., partially submerged or fully submerged) within the coolant. One or more actuation structures, which may be active or passive in operation, are in mechanical cooperation with the coolant tank and are configured to, in operation, adjust the position of the coolant tank to maintain proper immersion of the one or more electrical components within the coolant.

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Background/Summary

BACKGROUND

[0001] Electronic components such as servers, GPUs, CPUs, or some other similar or like type of electronic components that generates heat when in use (e.g., running simulations or computations) are placed within a coolant tank and immersed or submerged within a coolant in a liquid state stored within the coolant tank. For example, when operation of the electronic components is initiated by a controller (e.g., a processor or microprocessor) such as to perform intensive simulations or computations, the electronic components generate heat that is dissipated by the coolant in the liquid state in which the electronic components are immersed or submerged. In some situations, as the coolant heats up (e.g., increases in temperature), the coolant in the liquid state is converted to a vapor or gaseous state (i.e., evaporation), which may be referred to as two phase immersion cooling. Alternatively, in some situations, when the coolant heats up (e.g., increase in temperature), the coolant heats up (e.g., increase in temperature), the hot coolant in the liquid state is removed before being converted into a vapor or gaseous state from the tank and new colder coolant is introduced, which may be referred to as single phase immersion cooling. Generally, the cooling tank is placed on the ground. However, if the ground is slightly unlevel such that the ground is not perfectly flat, portions of the electronic components are generally not fully immersed or fully submerged in the coolant when placed within the coolant tank. In other words, these portions of the electronic components may extend outward from a surface of the coolant in the liquid state stored within the coolant tank. Similarly, if there is an external disturbance such as an earthquake, the coolant tank may become unlevel resulting in portions of the electronic components no longer being fully immersed or fully submerged within the coolant stored within the coolant tank. When the electronic components are not fully immersed or fully submerged within the coolant when present within the coolant tank, the efficiency in maintaining an operating temperature of the electronic components is generally reduced. When the electronic components are not fully immersed or fully submerged due to the coolant being unlevel, the coolant being unlevel may also cause an imbalance of coolant flow through the coolant tank and between the electronic components causing and resulting in degraded thermal heat dissipation.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] Aspects of the present disclosure are best understood from the following detailed description when read with the accompanying figures. It is noted that, in accordance with the standard practice in the industry, various features are not drawn to scale. In fact, the dimensions of the various features may be arbitrarily increased or reduced for clarity of discussion.

[0003] FIG. **1**A is a cross-sectional side view of a coolant tank.

[0004] FIG. **1**B is a cross-sectional view of the coolant tank as shown in FIG. **1**A when tilted.

[0005] FIG. **1**C is a cross-sectional view of a coolant tank as shown in FIG. **1**A when exposed to external forces.

[0006] FIG. **2** is a perspective view of a cooling system, in accordance with some embodiments.

[0007] FIG. **3** is a perspective view of an automatic leveling immersion cooling tank system of the cooling system as shown in FIG. **2**, in accordance with some embodiments.

[0008] FIG. **4** is a perspective view of a coolant tank, in accordance with some embodiments.

[0009] FIG. **5**A is a block diagram of one or more sensors monitoring characteristics of a coolant tank, in accordance with some embodiments.

[0010] FIG. **5**B are perspective views of characteristics of the coolant tank monitored by the one or

more sensors of the block diagram as shown in FIG. **5**A, in accordance with some embodiments.
[0011] FIG. **6** is a perspective view of one or more sensors monitoring characteristics of a coolant tank, in accordance with some embodiments.
[0012] FIG. **7** is a cross-sectional side view of one or more sensors monitoring characteristics of a coolant tank, in accordance with some embodiments.
[0013] FIG. **8** is a cross-sectional side view of one or more sensors monitoring characteristics of a coolant tank, in accordance with some embodiments.
[0014] FIG. **9**A is a cross-sectional side view of one or more sensors monitoring characteristics of a coolant tank including a lid removed from the coolant tank, in accordance with some embodiments.
[0015] FIG. **9**B is a cross-sectional side view of the one or more sensors monitoring characteristics of the coolant tank with the lid mounted to the coolant tank as shown in FIG. **9**A, in accordance with some embodiments.
[0016] FIG. **10**A is a cross-sectional side view of a coolant tank including a lid removed from the coolant tank, in accordance with some embodiments.
[0017] FIG. **10**B is a cross-sectional side view of the one or more sensors monitoring characteristics of the coolant tank with the lid mounted to the coolant tank as shown in FIG. **10**A, in accordance with some embodiments.
[0018] FIG. **11** is a cross-sectional side view of one or more sensors monitoring characteristics of a coolant tank, in accordance with some embodiments.
[0019] FIG. **12** is a flowchart of a method of adjusting a position of a coolant tank utilizing an automatic leveling immersion cooling tank system, in accordance with some embodiments.
[0020] FIG. **13** is a perspective view of an automatic leveling immersion cooling tank system, in accordance with some embodiments.
[0021] FIG. **14** is a flowchart of a method of adjusting a position of a coolant tank utilizing an automatic leveling immersion cooling tank system, in accordance with some embodiments.
[0022] FIG. **15** is a perspective view of an automatic leveling immersion cooling tank system, in accordance with some embodiments.
[0023] FIG. **16** is a flowchart of a method of adjusting a position of a coolant tank utilizing an automatic leveling immersion cooling tank system, in accordance with some embodiments.
[0024] FIG. **17** is a cross-sectional side view of an automatic immersion cooling tank system, in accordance with some embodiments.
[0025] FIG. **18** is a cross-sectional view of an automatic immersion cooling tank system, in accordance with some embodiments.

DETAILED DESCRIPTION

[0026] The following disclosure provides many different embodiments, or examples, for implementing different features of the provided subject matter. Specific examples of components and arrangements are described below to simplify the present disclosure. These are, of course, merely examples and are not intended to be limiting. For example, the formation of a first feature over or on a second feature in the description that follows may include embodiments in which the first and second features are formed in direct contact, and may also include embodiments in which additional features may be formed between the first and second features, such that the first and second features may not be in direct contact. In addition, the present disclosure may repeat reference numerals and/or letters in the various examples. This repetition is for the purpose of simplicity and clarity and does not in itself dictate a relationship between the various embodiments and/or configurations discussed.
[0027] Further, spatially relative terms, such as “beneath,” “below,” “lower,” “above,” “upper” and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. The spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. The apparatus may be otherwise oriented (rotated 90 degrees or

at other orientations) and the spatially relative descriptors used herein may likewise be interpreted accordingly.

[0028] The use of “transverse” means that a surface, a sidewall, or similar or like structure or feature is at an angle, any angle, with respect to another respective surface, sidewall, or similar or like respective structure or feature. For example, if a first surface is transverse to a first sidewall, the first surface may be at an angle that is equal to 25-degrees, 35-degrees, 45-degrees, 75-degrees, 90-degrees, 120-degrees, and so forth to the first sidewall.

[0029] FIG. **1**A is a cross-sectional side view of a coolant tank **100**. The coolant tank **100** includes one or more sidewalls **102** and a bottom end **104**, which is based on the orientation as shown in FIG. **1**A. The bottom end **104** is transverse to the one or more sidewalls **102** and extends between the one or more sidewalls **102**. For example, when the coolant tank **100** has a rectangular prism shape or profile, the one or more sidewalls **102** includes four sidewalls. Alternatively, when the coolant tank **100** has a cylindrical shape or profile, the one or more sidewalls **102** may only include a single sidewall. In other words, a number of the one or more sidewalls **102** will depend on the three-dimensional (3D) shape and profile of the coolant tank **100**.

[0030] A cavity **106** of the coolant tank **100** is delimited by the one or more sidewalls **102** and the bottom end **104**. A coolant **108** is stored within the cavity of the coolant tank **100**. The coolant **108** may be a dielectric or non-conductive coolant that is in a liquid state. One or more electrical components or devices **110** are stored within the coolant tank **100** and are immersed within the coolant **108**. As shown in FIG. **1**A, the one or more electrical components **110** are fully submerged within the coolant **108** stored within the cavity **106** of the coolant tank **100** as the entirety of each respective electrical component **110** is below a surface level **112** of the coolant **108**. The one or more electronic components **110** may be one or more servers, one or more GPUs, one or more CPUs, or one or more of some other suitable or like type of electronic component or combination of suitable or like type of electronic components that may be utilized to perform simulations or calculations. For example, when the one or more electronic components **110** are utilized to perform a complex simulation or calculation, the one or more electronic components **110** will generate thermal energy. The coolant **108** in the liquid state will dissipate this thermal energy generated by the one or more electronic components **110** as the coolant **108** is heated up by the thermal energy. When a two phase immersion process is utilized to dissipate thermal energy generated by the one or more electronic components **110**, at least some of the coolant **108** in the liquid state may be converted from the liquid state to a vapor or gaseous state (not shown) due to the coolant **108** in the liquid state evaporating when exposed to this thermal energy generated by the one or more electrical components **110** immersed or submerged within the coolant **108**. Alternatively, when a single phase immersion process is utilized to dissipate thermal energy generated by the one or more electronic components **110**, the coolant **108** remains in the liquid state and is not converted to a vapor or gaseous state as the coolant **108** is removed from the coolant tank **100** and is replaced by new coolant through a flow coolant (see, e.g., FIG. **2** of the present disclosure).

[0031] A force of gravity (F.sub.g) is represented by the arrow **114**. The force of gravity **114** is the force that gravity applies to the coolant tank **100**, the coolant **108**, and the one or more electronic components **110**.

[0032] As shown in FIG. **1**A, the coolant **108** in the liquid state stored within the cavity **106** of the coolant tank **100** is substantially level relative to the coolant tank **100** such that the surface level **112** of the coolant **108** is substantially horizontal and flat. When the coolant tank **100** is properly level such that the surface level **112** of the coolant **108** is horizontal and flat, the surface level **112** is perpendicular or orthogonal (i.e., at ninety (90) degrees) relative to the one or more sidewalls **102** of the coolant tank **100**. This relationship between the surface level **112** and the one or more sidewalls **102** will generally occur when a ground surface **116** on which the coolant tank **100** rests is substantially level and flat. In other words, in FIG. **1**A, the bottom end **104** is substantially parallel with the ground surface **116** such that the angle between the bottom end **104** and the ground surface **116** is substantially equal to zero (0) degrees and the angle between the surface level **112** and respective internal surfaces of the one or more sidewalls **102** is substantially equal to ninety (90) degrees.

[0033] As shown in FIG. **1**B, the coolant **108** in the liquid state stored within the cavity **106** of the coolant tank **100** is substantially unlevel relative to the coolant tank **100** such that while the surface level **112** may be substantially horizontal and flat, the surface level **112** is at an angle less than or greater than ninety (90) degrees relative to respective ones of the one or more sidewalls **102** of the coolant tank **100**. An angle **118** between the ground surface **116** and the bottom end **104** of the coolant tank **100** is greater than zero (0) degrees. When the angle **118** becomes too large, a portion **120** of the coolant **108** in the liquid state spills out of the coolant tank **100** as the surface level **112** extends past respective ends **122** of the one or more sidewalls **102** of the coolant tank **100**. In other words, as shown in FIG. **1**B, the coolant tank **100** is tilted. However, in some instances when the angle **118** is relatively small such that the surface level **112** does not extend past the respective ends **122** of the one or more sidewalls **102** such that the coolant **108** does not spill out of the coolant tank **100**, there may be an increased likelihood of spillage of the coolant **108** spilling out of the coolant tank **100** when exposed to external forces (e.g., an earthquake, an employee bumping into the coolant tank **100**, or some other similar or like type of external force applied to the coolant tank **100**).

[0034] When the coolant tank **100** is tilted as shown in FIG. **1**B, respective portions **124** of respective electrical components of the one or more electrical components **110** extend outward from the surface level **112** of the coolant **108**. For example, some of these respective portions **124** are encircled by the dotted circle **126** as shown in FIG. **1**B.

[0035] As shown in FIG. **1**C, when the coolant tank **100** is exposed to external forces (e.g., an earthquake, an employee bumping into the coolant tank **100**, or some other similar or like type of external force applied to the coolant tank **100**) the portions **120** of the coolant **108** may spill out of the coolant tank **100**. For example, the external force **128** may be vibration **128** due to an earthquake. When this vibration **128** becomes large enough such that the vibration **128** exceeds a vibration threshold, even if the coolant tank **100** is level as shown in FIG. **1**A, the portions **120** of the coolant **108** may still spill out of the coolant tank **100**. Similarly, if the coolant tank **100** is tilted as shown in FIG. **1**B at the angle **118**, the vibration threshold is decreased such that lower vibrations **128** will cause the portions **120** of the coolant **108** to spill from the coolant tank **100** as compared to when the coolant tank **100** is level as shown in FIG. **1**A.

[0036] In view of the above discussions with respect to FIGS. **1**A, **1**B, and **1**C, the present disclosure is directed to providing one or more embodiments of an automatic leveling immersion cooling tank system and one or more embodiments of a method of operating or controlling the one or more embodiments of the automatic leveling immersion cooling tank system to prevent or reduce the likelihood of the coolant **108** spilling out from a coolant tank and to prevent or reduce the likelihood of the coolant **108** from not covering the one or more electronic components.

[0037] The present disclosure is directed to providing one or more embodiments of an automatic leveling immersion cooling tank system that automatically levels itself such that a coolant (e.g., a dielectric coolant or non-conductive coolant) within the coolant tank properly immerses one or more electronic components within the coolant such that thermal energy generated by the one or more electronic components during operation is dissipated by the coolant. For example, in some instances, the proper immersion may be partial submersion of the one or more electronic components within the coolant, whereas, in other instances, the proper immersion may be fully and completely submerging the one or more electronic components within the coolant. In other words, the electronic components are properly immersed (e.g., partially or fully submerged) within the coolant automatically by the automatic leveling immersion cooling tank system to optimize efficiency and effectiveness in dissipating thermal energy generated by the one or more electronic components during operation. For example, the one or more electronic components may be servers, GPUs, CPUs, or some other suitable or like type of electronic component or combination of suitable or like type of electronic components that may be utilized to perform simulations or calculations. The present disclosure is further directed to a method of operating or controlling the automatic leveling immersion cooling tank such that the electronic components remain fully immersed or fully submerged within the coolant.

[0038] For example, at least one embodiment of an automatic leveling immersion cooling tank system of the present disclosure may be summarized as including a coolant tank including a cavity in which a coolant is stored. The coolant tank being configured to, in operation, receive one or more electrical components to immerse the one or more electrical components within the coolant. One or more sensors configured to, in operation, monitor at least one of the following of a surface level of the coolant and a position of the coolant tank. One or more actuation structures in mechanical corporation with the coolant tank, the one or more actuation structure being configured to, in operation, adjust the position of the coolant tank.

[0039] For example, at least one embodiment of a method of operating or controlling the automatic leveling immersion cooling tank system of the present disclosure may be summarized as including detecting at least one of the following of a surface level of a coolant stored within a coolant tank and a position of the coolant tank with one or more sensors. Processing one or more sensor signals output by the one or more sensors with a microprocessor to determine a direction of a zenith of gravity relative to the coolant tank. Outputting a control signal from the microprocessor based on the direction zenith of gravity relative to the coolant tank to adjust the position of the coolant tank with one or more actuation structures. Adjusting the position of the coolant tank in which the coolant is stored with the one or more actuation structures.

[0040] FIG. **2** is a perspective view of a cooling system **200**, in accordance with some embodiments. The same or similar features present within the cooling system **200** will be provided with the same or similar reference numerals as the same or similar features of those as discussed earlier herein with respect to FIGS. **1**A-**1**C. The details of these same or similar features will not be reproduced fully herein for the sake of simplicity and brevity of the present disclosure.

[0041] The cooling system **200** includes an automatic leveling immersion cooling tank system **201** and a coolant distribution unit (CDU) **202**. The automatic leveling immersion cooling tank system **201** includes the coolant tank **100** that is in fluid communication with the CDU **202** through a first coolant line **204** and a second coolant line **206**. The first coolant line **204** may be a respective coolant line for the coolant **108** that is hot, which may be in a liquid state, a vapor or gaseous state, or both, that is transferred from the coolant tank **100** to the CDU **202**, and the second coolant line **206** may be a respective coolant line for the coolant **108** that is cold, which may be in a liquid state, that is transferred from the CDU **202** back to the coolant tank **100**. In other words, the coolant tank **100**, the CDU **202**, the first coolant line **204**, and the second coolant line **206** form a cyclic system of which the coolant **108** may be cycled through when dissipating heat generated by the one or more electronic components **110** present within the coolant tank **100**.

[0042] A flow of the coolant **108** through the first and second coolant lines **204**, **206** is represented by arrows **208**. In view of this flow represented by the arrows **208**, the first coolant line **204** functions as a coolant outlet for the coolant tank **100** and a coolant inlet for the CDU **202**, and the second coolant line functions as a coolant outlet for the CDU **202** and a coolant inlet for the coolant tank **100**.

[0043] The CDU **202** is configured to, in operation, receive the coolant **108** that is in a hot state (i.e., a first temperature) after dissipating heat from the one or more electrical components **110** when in operation through the first coolant line **204**. The CDU **202** receives the coolant **108** in the hot state and cools the coolant **108** back to a cold state (i.e., a second temperature less than the first temperature). The coolant **108** in the cold state is reintroduced back to the coolant tank **100** of the automatic leveling immersion cooling tank system **201** through the second coolant line **206**. In some embodiments, the CDU **202** may include a cooling device or structure (not shown) to cool the coolant **108** from the hot state (i.e., the first temperature) to the cold state (i.e., the second temperature less than the first temperature). In some embodiments, the CDU **202** may include a filter through which the coolant **108** passes to remove any particular or debris that may be present within the coolant **108**. This process is performed cyclically as the one or more electrical components **110** are in operation when performing a simulation or calculation and generating thermal energy that is dissipated by the coolant **108** in the liquid state present within the cooling tank **100** of the automatic leveling immersion cooling tank system **201**.

[0044] While not shown in FIG. **2**, the coolant tank **100** may be in mechanical cooperation with one or more actuation components, structures or devices (see, e.g., FIGS. **11**, **13**, and **15** of the present disclosure), which will be discussed in detail later herein. While not shown in FIG. **2**, one or more sensors (see, e.g., FIGS. **3**, **4**A, **4**B, **5**, **6**, **7**, **8**A, **8**B, **9**A, **9**B, and **10** of the present disclosure), which may include different combinations of different types of sensors, monitor characteristics of the coolant **108** such as the surface level, a position of the coolant tank **100**, or some other type of characteristic that may be utilized in automatically leveling the coolant tank **100**, which will be discussed in detail later herein.

[0045] When the cooling system **200** is utilized to perform a two-phase immersion cooling process, the coolant **108** is converted from a liquid state to a vapor or gaseous state. Once the coolant **108** is in the vapor or gaseous state, the coolant in the vapor or gaseous state passes through the first coolant line **204** to the CDU **202**. Once the coolant **108** in the vapor or gaseous state reached the CDU **202**, the CDU **202** cools the coolant **108** back down such that the coolant **108** is converted back to the liquid state. The coolant **108**, which is now back in the liquid state, passes through the second coolant line **206** back to the coolant tank **100**. This two-phase immersion cooling process is continually performed to dissipate thermal energy generated by the electronic components **110** submerged or immersed within the coolant **108**.

[0046] Alternatively, when the cooling system **200** is utilized to perform a one-phase or single-phase cooling process, the coolant **108** is not converted from a liquid state to a vapor or gaseous state, and, instead, the coolant **108** simply remains in the liquid state for the entire process. For example, once some of the coolant **108** in the liquid state heats up from the thermal energy generated by the one or more electronic components **110**, the hot coolant **108** passes through the first line **204** to the CDU **202**. Once the coolant **108**, which is hot and in the liquid state, reaches the CDU **202**, the CDU **202** cools the coolant **108**, which remains in the liquid state. Once the coolant **108** is cold, the coolant **108**, which is still in the liquid state, passes through the second line **206** back to the coolant tank **100**. This single-phase immersion cooling process is continually performed to dissipate thermal energy generated by the electronic components **110** submerged or immersed within the coolant **108**.

[0047] In view of the above discussion with respect to the flow of the coolant **108** through the cooling system **200**, when the surface level **112** of the coolant **108** within the coolant tank **102** is unlevel, a flow of coolant **108** through the coolant tank **102** may not be optimized when passing by the one or more electronic components **110** reducing an overall efficiency of the coolant **108** to dissipate thermal energy generated by the one or more electronic devices **110**. In view of this, if the surface level **112** of the coolant **108** is maintained in a level state even in the event of external disturbances, the flow of the coolant **108** through the coolant tank **102** and the cooling system **200** will be optimized increasing an overall efficiency of the coolant **108** to dissipate thermal energy generated by the one or more electronic components **110**. This increase in efficiency by maintaining the surface level **112** of the coolant **108** within the coolant tank **102** may readily apply to both when the two-phase immersion cooling process or the single-phase immersion cooling process is being carried out by utilizing the cooling system **200**.

[0048] FIG. **3** is a perspective view of the automatic leveling immersion cooling tank system **201** of the cooling system **200** as shown in FIG. **2**, in accordance with some embodiments. Additional details of the automatic leveling immersion cooling tank system **201** are shown in FIG. **3** relative to

those features as shown in FIG. **2**. As shown in FIG. **3**, the automatic leveling immersion cooling tank system **201** includes one or more actuators **212***a*, **212***b*, **212***c* that are configured to, in operation, actuate to adjust a position of the coolant tank **100** to level the coolant tank **100** such that the surface level **112** of the coolant **108** within the coolant tank **100** is substantially level (e.g., the surface level **112** being perpendicular or orthogonal to the one or more sidewalls **102** of the coolant tank **100** and parallel with the bottom end **104** of the coolant tank **100**). As shown in FIG. **3**, the one or more actuators **212***a*, **212***b*, **212***c* work together with the one or more motors **214***a*, **214***b*, **214***c* to rotate, move, and adjust the position of the coolant tank **100** as represented by arrows **213**.
[0049] In this embodiment of the automatic leveling immersion cooling tank system **201** as shown in FIG. **3**, the one or more actuators **212***a*, **212***b*, **212***c* are pistons that may be adjusted in length to adjust the position of the coolant tank **100**. In some alternative embodiments, the actuators **212** may be some other type of actuator that is suitable for adjusting the position of the coolant tank **100**. In some embodiments, the one or more actuators **212***a*, **212***b*, **212***c* may be some other similar or like type of linear actuator. In some embodiments, the one or more actuators **212***a*, **212***b*, **212***c* are robotic arms. In some embodiments, the one or more actuators **212***a*, **212***b*, **212***c* may be replaced by some other combination or types of actuators (e.g., rotational actuators, hydraulic actuators, magnetic actuators, rotary actuators, or any other suitable type of actuator) that are configured to, in operation, rotate, move, or reposition the coolant tank **100** such that the surface level **112** of the coolant **108** is level. For the following discussion herein, the one or more actuators **212***a*, **212***b*, **212***c* will be discussed as though the one or more actuators **212***a*, **212***b*, **212***c* are linear actuators.
[0050] One or more motors **214***a*, **214***b*, **214***c* are in mechanical cooperation with the one or more actuators **212**. The one or more motors **214***a*, **214***b*, **214***c* provide power such that respective lengths L1, L2, L3 of the one or more actuators **212***a*, **212***b*, **212***c* may be adjusted to adjust the position of the coolant tank **100**.
[0051] In this embodiment of the automatic leveling immersion cooling tank system **201** as shown in FIG. **3**, the one or more actuators **212***a*, **212***b*, **212***c* include a first actuator **212***a*, a second actuator **212***b*, and a third actuator **212***c*, and the one or more motors **214***a*, **214***b*, **214***c* include a first motor **214***a*, a second motor **214***b*, and a third motor **214***c*. The first motor **214***a* is in mechanical cooperation with the first actuator **212***a*, the second motor **214***b* is in mechanical cooperation with the second actuator **212***b*, and the third motor **214***c* is in mechanical cooperation with the third actuator **212***c*. While there are three motors and three actuators in this embodiment of the automatic leveling immersion cooling tank system **201**, it will be readily appreciated that in alternative embodiments of the automatic immersion cooling tank system **201** there may be only one motor and only one actuator, there may be two motors and two actuators, or there may be any combination of any number of actuators and any number of motors for adjusting the position of the coolant tank **100**. In other words, any number of actuators or any number of motors may be utilized to move, rotate, or reposition the coolant tank **100** to maintain the surface level **112** of the coolant **108** at a level state within the coolant tank **102**.
[0052] When powered on, the first motor **214***a* adjusts a first length L1 of the first actuator **212***a*. When powered on, the second motor **214***b* adjusts a second length L2 of the second actuator **212***b*. When powered on, the third motor **214***c* adjusts a third length L3 of the third actuator **212***c*. The first, second, and third motors **214***a*, **214***b*, **214***c* may be controlled to adjust the first length L1, the second length L2, and the third length L3 by differing amounts to adjust the position of the coolant tank **100**.
[0053] The one or more motors **214***a*, **214***b*, **214***c* and the one or more actuators **212***a*, **212***b*, **212***c* are in electrical communication with an analog to digital (A/D) converter **216**. The A/D converter **216** converts analog signals to digital signals that are then provided to a microprocessor **218**. The microprocessor **218** is in electrical communication with the A/D converter **216**. The microprocessor **218** may then process the digital signals based on the analog signals output by the one or more motors **214***a*, **214***b*, **214***c* to determine whether to provide power to the one or more motors **214***a*,

214*b*, **214***c* or activate selected ones of the one or more motors **214***a*, **214***b*, **214***c*. For example, an external power source (not shown) may be coupled to the one or more motors **214***a*, **214***b*, **214***c* that provides power to the one or more motors **214***a*, **214***b*, **214***c*, and the microprocessor may output control signals such that the external power source only provides power to individual ones of the one or motors **214***a*, **214***b*, **214***c* to adjust the respective lengths L1, L2, L3 of the actuators **212***a*, **212***b*, **212***c* to adjust the position of the coolant tank **100**.

[0054] While not shown in FIG. **3**, the one or more actuators **212***a*, **212***b*, **212***c* may include one or more actuator sensors that are configured to, in operation, monitor characteristics such as the respective lengths L1, L2, L3 of the one or more actuators **212***a*, **212***b*, **212***c*. These one or more actuator sensors are in electrical communication with the A/D converter **216** such that the A/D converter can convert the analog signals to the digital signals that are then provided to the microprocessor **218**. The microprocessor **218** then processes the digital signals based on the analog signals output by the one or more actuator sensors to determine the respective lengths L1, L2, L3 of the one or more actuators **212***a*, **212***b*, **212***c*, which may be utilized in determining whether to adjust the position of the coolant tank **100**. While not shown in FIG. **3**, one or more sensors (see, e.g., FIGS. **4**, **5**A, **5**B, **6**, **7**, **8**, **9**A, **9**B, **10**A, **10**B, and **11**) monitoring various characteristics of the coolant tank **100** (e.g., the surface level **112** of the coolant **108** within the coolant tank **100**, the position of the coolant tank **100**, or some other characteristic with respect to the coolant tank **100**) are in electrical communication with the A/D converter **216**. Various options and combinations of options for these one or more sensors will become readily apparent in view of the following discussions herein with respect to FIGS. **4**, **5**A, **5**B, **6**, **7**, **8**, **9**A, **9**B, **10**A, **10**B, and **11** of the present disclosure.

[0055] While in the embodiment as shown in FIG. **3**, the A/D converter **216** is provided between the various sensors and the microprocessor **218**, in some alternative embodiments, the A/D converter **216** may be part of the microprocessor **218** itself or the microprocessor **218** may be able to directly receive the analog signals such that the A/D converter **216** is not present.

[0056] The A/D converter **216** may be in wired or wireless connection with the one or more actuators sensors of the one or more actuators **212***a*, **212***b*, **212***c*, with the one or more motors **214***a*, **214***b*, **214***c*, and the one or more sensors that monitor characteristics relative to the coolant tank **100**.

[0057] The microprocessor **218** may monitor the various characteristics of the one or more actuators **212***a*, **212***b*, **212***c*, of the one or more motors **214***a*, **214***b*, **214***c*, and with respect to the coolant tank **100** to control the position of the coolant tank **100** to prevent or reduce the likelihood of the coolant **108** spilling out of the coolant tank **100**. For example, when the coolant tank **100** is unlevel due to the ground surface **116** being unlevel, the microprocessor **218** may determine that the position of the coolant tank **100** is to be adjusted to prevent or reduce the likelihood of the coolant **108** spilling out the coolant tank **100** or to maintain proper immersion or submersion of the one or more electronic components **110** within the coolant **108**. The microprocessor **218** performs this determination in real time such that the coolant tank **100** remains level resulting in the surface level **112** of the coolant **108** remaining level within the coolant tank **100**.

[0058] The microprocessor **218** may monitor the various characteristics of the one or more actuators **212***a*, **212***b*, **212***c*, of the one or more motors **214***a*, **214***b*, **214***c*, and with respect to the coolant tank **100** to control the position of the coolant tank **100** to improve immersion of the one or more electronic components **110** present within the coolant tank **100**. For example, when the coolant tank **100** is exposed to external forces (e.g., an earthquake, an employee bumping into the coolant tank **100**, or some other similar or like type of external force applied to the coolant tank **100**) generating the vibration **128**, the microprocessor **218** may determine that the position of the coolant tank **100** is to be adjusted to prevent or reduce the likelihood of the coolant **108** spilling out the coolant tank **100** or to maintain proper immersion or submersion of the one or more electronic components **110** within the coolant **108**. The microprocessor **218** performs this determination in real time such that the coolant tank **100** remains level resulting in the surface level **112** of the coolant **108** remaining level within the coolant tank **100**.

[0059] This real time monitoring by the microprocessor **218** preventing or reducing the likelihood of spilling of the coolant **108** from the coolant tank **100** prevents or reduces the likelihood of generating a dangerous work environment within a semiconductor manufacturing plant (FAB). This real time monitoring by the microprocessor **218** preventing or reducing the likelihood of spilling of the coolant **108** from the coolant tank **100** reduces operating costs as the coolant **108** is not wasted due to being spilled out of the coolant tank **100** resulting in the introduction of new coolant into the cooling system **200** to maintain proper heat dissipation efficiency.

[0060] Maintaining proper immersion or submersion of the one or more electronic components **110** within the coolant **108** maintains or increases an efficiency of the cooling system **200** to dissipate thermal energy or heat generated by the one or more electronic components **110** when in operation. Maintaining optimized efficiency of the cooling system **200** in dissipating thermal energy or heat generated by the one or more electronic components **110** reduces operating costs as less overall energy or power is needed to operate the cooling system **200**.

[0061] In other words, in view of the above discussion, the automatic leveling immersion cooling tank system **201** prevents or reduces the likelihood of the issues as discussed with respect to FIGS. **1**A and **1**B as discussed in detail earlier herein.

[0062] FIG. **4** is a perspective view of the coolant tank **100** of the automatic leveling immersion cooling tank system **201**, in accordance with some embodiments. As shown in FIG. **4**, a g-sensor **220** (gravity sensor) is mounted to a respective sidewall of the one or more sidewalls **102** of the coolant tank **100**. In some embodiments, the g-sensor **220** may be mounted to a different respective sidewall **102** of the coolant tank **100**, may be mounted to the bottom end **104** of the coolant tank **100**, or may be mounted to a lid (see, e.g., FIGS. **9**A, **9**B, **10**A, and **10**B of the present disclosure) that is coupled to the coolant tank **100** to close off the cavity **106** from an external environment. The g-sensor **220** is configured to, in operation, measure the gravity **114** and the direction of gravity **114** relative to the coolant tank **100**.

[0063] The g-sensor **220** is in electrical communication with the A/D converter **216**. The g-sensor **220** may be in wired communication or may be in wireless communication with the A/D converter **216**. In some embodiments, the g-sensor **220** may be in electrical communication with the microprocessor **218** directly when the A/D converter **216** is part of the microprocessor **218** or is not present as the microprocessor **218** can process the analog signals output by the g-sensor **220**.

[0064] The g-sensor **220** outputs electrical signals representative of the measurement of gravity **114** and the direction of gravity **114** relative to the coolant tank **100**. The microprocessor **218** then utilizes these electrical signals, which passed through the A/D converter **216**, to determine a zenith **222** that is in a direction opposite to the direction of gravity **114**, which is represented by the arrow **114** as discussed earlier herein. For example, once the zenith **222** is determined, the microprocessor may utilize the zenith either alone or along with other information collected and processed by the microprocessor **218** (e.g., the lengths L1, L2, L3 of the one or more actuators **212***a*, **212***b*, **212***c*, the surface level of the coolant **108** within the coolant tank **100**, the position of the coolant tank **100**, or other similar or like type of information with respect to the automatic leveling immersion cooling tank system **201**), the microprocessor **218** outputs one or more control signals that results in respective motors of the one or more motors **214***a*, **214***b*, **214***c* providing power to respective actuators of the one or more actuators **212***a*, **212***b*, **212***c*. The microprocessor **218** makes various determinations and outputs various control signals in real time to automatically adjust the one or more actuators **212***a*, **212***b*, **212***c* based on the zenith **222** to prevent or reduce the likelihood of spilling and improve the efficiency of the cooling system **200** to cool and maintain the temperatures of the one or more electronic components **110** immersed (e.g., partially submerged or fully submerged) within the coolant **108**. The microprocessor **218** may perform this process in real time. In some embodiments, the microprocessor **218** continuously performs this process in real time. In

some embodiments, the microprocessor **218** discretely performs this process in real time.
[0065] FIG. **5**A is a block diagram **224** of one or more sensors monitoring characteristics of the coolant tank **100** of the automatic leveling immersion cooling tank system **201**, in accordance with some embodiments. FIG. **5**B are perspective views of characteristics of the coolant tank monitored by the one or more sensors of the block diagram as shown in FIG. **5**A, in accordance with some embodiments.
[0066] As shown in the block diagram **224** in FIG. **5**A, a tilt sensor **226** and a gyroscope or accelerometer **228** are coupled to the coolant tank **100**. The tilt sensor **226** is configured to, in operation, monitor a tilting of the coolant tank **100** (e.g., pitch and roll) and the gyroscope **228** is configured to, in operation, monitor angular motion of the coolant tank **100**. While not shown, the gyroscope **228** may include one or more magnetic or magnetometer sensors to monitor angular motion of the coolant tank **100** about one or more axes (e.g., the x-axis, the y-axis, and the z-axis). For example, the gyroscope **228** may include three magnetic sensors to monitor angular motion about three different axes (e.g., the x-axis, the y-axis, and the z-axis).
[0067] In some embodiments, the gyroscope **228** may be replaced with one or more accelerometers or acceleration sensors to detect motion such as angular motion of the coolant tank **100**.
[0068] The tilt sensor **226** and the gyroscope **228** are in electrical communication with the A/D converter **216**. The tilt sensor **226** outputs one or more tilt signals **230***a*, **230***b* and the gyroscope **228** outputs one or more angular motion signals **232***a*, **232***b*, **232***c*. In this embodiment, the one or more tilt signals **230***a*, **230***b* includes a first tilt signal **230***a* that is representative of a measurement of tilt in a pitch direction (see, e.g., an arrow **234** as shown in FIG. **5**B representative of the pitch direction) and a second tilt signal **230***b* that is representative of a measurement of tilt in a roll direction (see, e.g., an arrow **235** as shown in FIG. **5**B representative of the roll direction).
[0069] The tilt detected and measured by the tilt sensor **226** may be due to the ground surface **116** being unlevel as discussed earlier herein with respect to FIG. **1**B. The angular motion and tilt detected and measured by the gyroscope **228** and the tilt sensor **226**, respectively, may be due to the vibration **128** as discussed earlier herein with respect to FIG. **1**C.
[0070] The tilt sensor **226** and the gyroscope **228** output the tilt signals **230***a*, **230***b* and the angular motion signals **232***a*, **232***b*, **232***c* representative of the measurement of tilt and angular motion of the coolant tank **100**. The microprocessor **218** then utilizes these electrical signals, which passed through the A/D converter **216**, to determine the tilt, the position, or both of the coolant tank **100** and determine whether the coolant tank **100** is undergoing any current angular motion. For example, once the tilt, the position, and the angular motion of the coolant tank **100** are determined, the microprocessor **218** may utilize this information either alone or along with other information collected and processed by the microprocessor **218** (e.g., the lengths L1, L2, L3 of the one or more actuators **212***a*, **212***b*, **212***c*, the surface level of the coolant **108** within the coolant tank **100**, the position of the coolant tank **100**, or other similar or like type of information with respect to the automatic leveling immersion cooling tank system **201**), the microprocessor **218** outputs one or more control signals that results in respective motors of the one or more motors **214***a*, **214***b*, **214***c* providing power to respective actuators of the one or more actuators **212***a*, **212***b*, **212***c*. The microprocessor **218** makes various determinations and outputs various control signals in real time to automatically adjust the one or more actuators **212***a*, **212***b*, **212***c* based on the tilt and the angular motion of the coolant tank **100** to prevent or reduce the likelihood of spilling and improve the efficiency of the cooling system **200** to cool and maintain the temperatures of the one or more electronic components **110** immersed (e.g., partially submerged or fully submerged) within the coolant **108**. The microprocessor may perform this process in real time based on the tilt and the angular motion, which may be occurring in real time. In some embodiments, the microprocessor continuously performs this process in real time. In some embodiments, the microprocessor discretely performs this process in real time.
[0071] FIG. **6** is a perspective view of one or more sensors monitoring characteristics of a coolant

tank, in accordance with some embodiments.

[0072] As shown in FIG. **6**, one or more level sensors **234***a*, **234***b* are coupled to the coolant tank **100**. In this embodiment, the one or more level sensors **234***a*, **234***b* include a pair of level sensors **234***a*, **234***b* that include a first level sensor **234***a* and a second level sensor **234***b*. The first and second level sensors **234***a*, **234***b* are positioned at respective upper ends **122** of the one or more sidewalls **102** of the coolant tank **100**. The first level sensor **234***a* is positioned at a first upper end of a first sidewall of the one or more sidewalls **102** and the second level sensor **234***b* is positioned at a second upper end of a second sidewall of the one or more sidewalls **102** that is transverse to the first sidewall of the one or more sidewalls. In some embodiments, the one or more level sensors **234***a*, **234***b* may be that are provided along various ones of the upper ends **122** of the one or more sidewalls **102**, along respective internal and external surfaces of the one or more sidewalls **102**, and along respective internal and external surfaces of the bottom end **104** of the coolant tank **100**. In some embodiments, there may be only one level sensor instead of a pair of level sensors or a greater number of level sensors. In some embodiments, multiple level sensors may be provided along the same axis either in close proximity to each other or spaced apart from each other such that multiple measurements of the levelness of the coolant tank **100** may be collected to improve accuracy in results output by the microprocessor **218**.

[0073] The levelness detected and measured by the one or more level sensors **234***a*, **234***b* may be due to the ground surface **116** being unlevel as discussed earlier herein with respect to FIG. **1**B. The levelness detected and measured by the one or more level sensors **234***a*, **234***b* may be due to the vibration **128** as discussed earlier herein with respect to FIG. **1**C.

[0074] The one or more level sensors **234***a*, **234***b* are in electrical communication either wired or wirelessly with the A/D converter **216**. The one or more level sensors **234***a*, **234***b* output one or more level signals representative of the measurement of levelness of the coolant tank **100**. These one or more level signals may be similar to the one or more tilt signals **230***a*, **230***b* as discussed earlier herein with respect to the one or more tilt sensors **226**. The microprocessor **218** then utilizes these electrical signals, which passed through the A/D converter **216**, to determine the levelness, the position, or both of the coolant tank **100**. For example, once the levelness and the position of the coolant tank **100** are determined, the microprocessor **218** may utilize this information either alone or along with other information collected and processed by the microprocessor **218** (e.g., the lengths L1, L2, L3 of the one or more actuators **212***a*, **212***b*, **212***c*, the surface level of the coolant **108** within the coolant tank **100**, the position of the coolant tank **100**, or other similar or like type of information with respect to the automatic leveling immersion cooling tank system **201**), the microprocessor **218** outputs one or more control signals that results in respective motors of the one or more motors **214***a*, **214***b*, **214***c* providing power to respective actuators of the one or more actuators **212***a*, **212***b*, **212***c*. The microprocessor **218** makes various determinations and outputs various control signals in real time to automatically adjust the one or more actuators **212***a*, **212***b*, **212***c* based on the levelness of the coolant tank **100** to prevent or reduce the likelihood of spilling and improve the efficiency of the cooling system **200** to cool and maintain the temperatures of the one or more electronic components **110** immersed (e.g., partially submerged or fully submerged) within the coolant **108**. The microprocessor may perform this process in real time based on the levelness of the coolant tank **100**, which may be occurring in real time. In some embodiments, the microprocessor continuously performs this process in real time. In some embodiments, the microprocessor discretely performs this process in real time.

[0075] FIG. **7** is a cross-sectional side view of one or more sensors monitoring characteristics of a coolant tank, in accordance with some embodiments.

[0076] As shown in FIG. **7**, a first transceiver **236** and a second transceiver **238** are at internal surfaces of opposite sidewalls of the one or more sidewalls **102** of the coolant tank **100**. The first transceiver **236** may be an emitter that emits a laser **240** and the second transceiver **238** may be a detector that detects the laser **240** emitted by the first transceiver **236**. The first and second transceivers **236**, **238** are aligned with each other such that when the first transceiver **236** emits the laser, the second transceiver **238** readily receives and detects the laser **240**.

[0077] In some embodiments, the first and second transceivers **236**, **238** may be some other suitable type of optical sensors.

[0078] The laser **240** is generated to detect when the surface level **112** of the coolant **108** within the coolant tank **100** or the portion **120** of the coolant **108** passes into the path of the laser **240**. The coolant **108** passing into the path of the laser **240** interrupts the laser **240** from being received by the second transceiver **238**. When the laser **240** is interrupted, an interrupt signal may be output by either one of the first and second transceiver **236**, **238** and output to the A/D converter **216**. This interrupt signal may then be processed by the A/D converter **216** and sent to the microprocessor **218** for further processing. Based on this detection of the interrupt in the laser **240**, the microprocessor **218** utilizes this indication of the interrupt in the laser **240** to determine whether control signals are to be output to the one or more motors **214***a*, **214***b*, **214***c* to actuate the one or more actuators **212***a*, **212***b*, **212***c* to rotate and move the coolant tank **100**. In this determination, the microprocessor **218** may utilize this information either alone or along with other information collected and processed by the microprocessor **218** (e.g., the lengths L1, L2, L3 of the one or more actuators **212***a*, **212***b*, **212***c*, the surface level of the coolant **108** within the coolant tank **100**, the position of the coolant tank **100**, or other similar or like type of information with respect to the automatic leveling immersion cooling tank system **201**). Once the microprocessor **218** outputs the one or more control signals, the respective motors of the one or more motors **214***a*, **214***b*, **214***c* receive power to actuate respective actuators of the one or more actuators **212***a*, **212***b*, **212***c*. The microprocessor **218** makes various determinations and outputs various control signals in real time to automatically adjust the one or more actuators **212***a*, **212***b*, **212***c* based on the interruption of the laser **240** to prevent or reduce the likelihood of spilling and improve the efficiency of the cooling system **200** to cool and maintain the temperatures of the one or more electronic components **110** immersed (e.g., partially submerged or fully submerged) within the coolant **108**. The microprocessor may perform this process in real time based on the interruption of the laser **240**, which may be occurring in real time. In some embodiments, the microprocessor continuously performs this process in real time. In some embodiments, the microprocessor discretely performs this process in real time.

[0079] FIG. **8** is a cross-sectional side view of one or more sensors monitoring characteristics of a coolant tank, in accordance with some embodiments.

[0080] As shown in FIG. **8**, a transceiver **242** and a mirror **244** are at internal surfaces of opposite sidewalls of the one or more sidewalls **102** of the coolant tank **100**. The transceiver **242** may include a laser emitter (not shown) and a laser detector (not shown). The laser emitter of the transceiver **242** emits an emitted laser **246** at the mirror **244** as the mirror **244** is aligned with the transceiver **242**. The emitted laser **246** reflects off the mirror **244** and becomes a reflected laser **248** that is directed back at the transceiver **242**. The reflected laser **248** is detected by the laser detector of the transceiver **242**. In some embodiments, the transceiver **242** may be a time-of-flight (TOF) sensor.

[0081] The emitted laser **246** and the reflected laser **248** are generated to detect when the surface level **112** of the coolant **108** within the coolant tank **100** or the portion **120** of the coolant **108** passes into the path of emitted laser **246** and the reflected laser **248**. The coolant **108** passing into the path of the emitted laser **246**, the reflected laser **248**, or both interrupts the reflected laser **248** from being received by the light detector of the transceiver **242**. When the reflected laser **248** is interrupted from being received by the light detector of the transceiver **242**, an interrupt signal may be output by the transceiver **242** and output to the A/D converter **216**. This interrupt signal may then be processed by the A/D converter **216** and sent to the microprocessor **218** for further processing. Based on this detection of the interrupt signal in the reflected laser **248** being received by the light detector of the transceiver **242**, the microprocessor **218** utilizes this indication of the interrupt signal in the reflected laser **248** from being received by the light detector of the transceiver **242** to determine whether control signals are to be output to the one or more motors **214***a*, **214***b*, **214***c* to actuate the one or more actuators **212***a*, **212***b*, **212***c* to rotate and move the coolant tank **100**. In this determination, the microprocessor **218** may utilize this information either alone or along with other information collected and processed by the microprocessor **218** (e.g., the lengths L1, L2, L3 of the one or more actuators **212***a*, **212***b*, **212***c*, the surface level of the coolant **108** within the coolant tank **100**, the position of the coolant tank **100**, or other similar or like type of information with respect to the automatic leveling immersion cooling tank system **201**). Once the microprocessor **218** outputs the one or more control signals, the respective motors of the one or more motors **214***a*, **214***b*, **214***c* receive power to actuate respective actuators of the one or more actuators **212***a*, **212***b*, **212***c*. The microprocessor **218** makes various determinations and outputs various control signals in real time to automatically adjust the one or more actuators **212***a*, **212***b*, **212***c* based on the interruption of the laser **240** to prevent or reduce the likelihood of spilling and improve the efficiency of the cooling system **200** to cool and maintain the temperatures of the one or more electronic components **110** immersed (e.g., partially submerged or fully submerged) within the coolant **108**. The microprocessor may perform this process in real time based on the interruption of the laser **240**, which may be occurring in real time. In some embodiments, the microprocessor continuously performs this process in real time. In some embodiments, the microprocessor discretely performs this process in real time.

[0082] FIG. **9**A is a cross-sectional side view of one or more sensors monitoring characteristics of a coolant tank including a lid removed from the coolant tank, in accordance with some embodiments. FIG. **9**B is a cross-sectional side view of the one or more sensors monitoring characteristics of the coolant tank with the lid mounted to the coolant tank as shown in FIG. **9**A, in accordance with some embodiments.

[0083] As shown in FIGS. **9**A, a lid **250** is mountable to the coolant tank **100**. For example, the lid **250** may mechanically engage with the upper ends **122** of the one or more sidewalls **102** of the coolant tank **100** such that the cavity **106** of the coolant tank **100** is sealed shut to prevent spilling of the coolant **108** out of the coolant tank **100**. A first wave sensor **252** is coupled to an internal surface of the bottom end **104** of the coolant tank **100**, and a second wave sensor **254** is coupled to an internal surface of the lid **250**. For example, as shown in FIG. **9**B, the coolant **108** takes up a first portion of the cavity **106** and the air takes up a space **255**, which takes up a second portion of the cavity **106**, when the lid **250** is mounted to the coolant tank **100**.

[0084] As shown in FIG. **9**B, when the lid **250** is mounted to the coolant tank **100**, the cavity **106** is delimited by the internal surfaces of the one or more sidewalls **102** of the coolant tank **100**, the internal surface of the bottom end **104** of the coolant tank **100**, and the internal surface of the lid **250**. When the lid **250** is mounted to the coolant tank **100**, the second wave sensor **254** is spaced apart and is over the surface level **112** of the coolant **108** stored within the coolant tank **100**. In other words, the first wave sensor **252** is within the coolant **108** and the second wave sensor **254** is within air that is present within a space **255** located between the surface level **112** of the coolant **108** and the internal surface of the lid **250**.

[0085] The first wave sensor **252** outputs one or more first waves **256**. The second wave sensor **254** outputs one or more second waves **258**. The first and second wave sensors **252**, **254** are in electrical communication either wired or wirelessly with the A/D converter **216**. The first wave sensor **252** generates the one or more first waves **256** and detects reflected waves. The second sensor **254** generates the one or more second waves **258** and detects reflected waves.

[0086] In operation, the first wave sensor **252** and the second wave sensor **254** are utilized to determine a position of the surface level **112** of the coolant **108** by determining the position of the interface between the air within the space **255** and the coolant **108**. This interface between the air within the space **255** and the coolant **108** is present at the surface level **112** of the coolant **108**.

[0087] In operation, the first wave sensor **252** generates the one or more first waves **256** that are directed away from the bottom end **104** of the coolant tank **100** and towards the interface at the surface level **112**. After generation, as the one or more first waves **256** reach the interface at the surface level **112**, the one or more first waves **256** fully or partially reflect off the interface at the surface level **112**. These reflected waves (not shown) move away from the interface at the surface level **112** back towards the first wave sensor **252**. Once these reflected waves reach the first wave sensor **252**, the first wave sensor **252** detects the reflected waves and outputs a signal that is provided to the A/D converter **216**. The A/D converter **216** processes the signal output by the first wave sensor **252** and outputs a signal to the microprocessor **218** that the microprocessor **218** processes to determine the position of the surface level **112**.

[0088] In operation, the second wave sensor **254** generates the one or more second waves **258** that are directed away from the lid **250** of the coolant tank **100** and towards the interface at the surface level **112**. After generation, as the one or more second waves **258** reach the interface at the surface level **112**, the one or more second waves **258** fully or partially reflect off the interface at the surface level **112**. These reflected waves (not shown) move away from the interface at the surface level **112** back towards the second wave sensor **254**. Once these reflected waves reach the second wave sensor **254**, the second wave sensor **254** detects the reflected waves and outputs a signal that is provided to the A/D converter **216**. The A/D converter **216** processes the signal output by the second wave sensor **252** and outputs a signal to the microprocessor **218** that the microprocessor **218** processes to determine the position of the surface level **112**.

[0089] The microprocessor **218** utilizes the information collected from the first and second wave sensors **252**, **254**, respectively, to determine the position of the surface level **112**. If the microprocessor **218** determines that the surface level **112** is at a position in which the one or more electronic components **110** are properly immersed (e.g., partially or fully submerged within the coolant **108** depending on a depth of the coolant **108** present within the coolant tank **100**), the microprocessor **218** does not output any control signals to the one or more motors **214***a*, **214***b*, **214***c*. Alternatively, if the microprocessor determines that the surface level **112** is at a position in which the one or more electronic components **110** are not properly immersed (e.g., partially or fully submerged within the coolant **108** depending on a depth of the coolant **108** present within the coolant tank **100**), the microprocessor **218** does output one or more control signals to the one or more motors **214***a*, **214***b*, **214***c* to adjust the position of the coolant tank **100** such that the surface level **112** is adjusted in position and the one or more electronic components **110** become properly immersed (e.g., partially or fully submerged within the coolant **108** depending on a depth of the coolant **108** present within the coolant tank **100**) within the coolant **108** present within the coolant tank **100**.

[0090] In some embodiments, the first wave sensor **252** and the second wave sensor **254** may be ultrasound wave sensors that propagate ultrasound waves. In some embodiments, the first wave sensor **252** and the second wave sensor **254** may propagate waves different from ultrasound waves. In some embodiments, the first wave sensor **252** and the second wave sensor **254** may generate waves with the same or similar wavelength. In some embodiments, the first wave sensor and the second wave sensor may generate waves with different wavelengths. For example, the waves generated by the first wave sensor **252** and the second wave sensor **254** may be ultrasound waves, electromagnetic waves, radar waves, or some other suitable type of wave with a suitable wavelength for detecting the position of the surface level **112** of the coolant **108**.

[0091] In some embodiments, only one of the first wave sensor **252** and the second wave sensor **254** may be provided and present (see FIGS. **10**A and **10**B of the present disclosure). In some embodiments, there is a plurality of wave sensors including the first wave sensor **252** and the second wave sensor **254** that is provided at different positions along an internal surface delimiting the cavity **106** of the coolant tank **100** to provide further feedback and more accurate feedback with respect to the position of the surface level **112**.

[0092] FIG. **10**A is a cross-sectional side view of one or more sensors monitoring characteristics of a coolant tank including a lid removed from the coolant tank, in accordance with some embodiments. FIG. **10**B is a cross-sectional side view of the one or more sensors monitoring characteristics of the coolant tank with the lid mounted to the coolant tank as shown in FIG. **10**A, in accordance with some embodiments. As shown in FIGS. **10**A and **10**B, only the second wave sensor **254** is present on the internal surface of the lid **250**. In an alternative embodiment, the second wave sensor **254** is not present on the internal surface of the lid **250**, and, instead, the first wave sensor **252** is present at the internal surface of the bottom end **104**.

[0093] The functionality of the second wave sensor **254** as shown in FIGS. **10**A and **10**B is the same or similar to the functionality of the second wave sensor **254** as discussed above with respect to FIGS. **9**A and **9**B. Accordingly, for the sake of simplicity and brevity of the present disclosure, the discussion of the functionality of the second wave sensor **254** when in operation is not reproduced here.

[0094] FIG. **11** is a cross-sectional side view of one or more sensors monitoring characteristics of a coolant tank, in accordance with some embodiments. As shown in FIG. **11**, a surface level sensor **260** extends into the coolant **108** and is immersed within the coolant **108** within the coolant tank **100**. In this embodiment, the surface level sensor **260** extends from the bottom end **104** of the coolant tank **100** at least up to the upper ends **122** of the one or more sidewalls **102** of the coolant tank **100**. In this embodiment, the surface level sensor **260** includes a probe head **262** and a probe **264**. The probe head **262** may contain active and passive electrical components for outputting a signal to the A/D converter **216**. The probe **264** extends into the coolant **108** and is immersed within the coolant **108** within the coolant tank **100**.

[0095] The surface level sensor **260** may be a capacitance surface level sensor that forms a capacitor **266** between the probe **264** and a respective sidewall of the one or more sidewalls **102** in close proximity to the probe **264**. In this embodiment, the respective sidewall of the one or more sidewalls **102** in close proximity to the probe **264** is the respective sidewall of the one or more sidewalls **102** at the right-hand side of FIG. **11**. As the surface level **112** of the coolant **108** aligned with and overlying the probe **264** increases (i.e., depth of coolant **108** increases), a capacitance of the capacitor **266** increases, and, alternatively, as the surface level **112** of the coolant **108** aligned with and overlying the probe decreases (i.e., depth of coolant **108** decreases), the capacitance of the capacitor **266** decreases. The microprocessor **218** may monitor these changes in the capacitance of the capacitor **266** to determine the position of the surface level to determine whether the one or more control signals need to be provided to power on the one or more motors **214***a*, **214***b*, **214***c* to actuate the one or more actuators **212***a*, **212***b*, **212***c* to move, rotate, and adjust the position of the coolant tank **100** to improve immersion of the one or more electronic components **110** within the coolant **108**.

[0096] In this embodiment as shown in FIG. **11**, only a single surface level sensor **260** is provided. In some alternative embodiments, a plurality of surface level sensors **260** may be provided at various locations within the coolant tank **100** in close proximity to respective sidewalls of the one or more sidewalls **102** of the coolant tank **100** such that the position and depth of the surface level **112** of the coolant **108** may more accurately be determined by the microprocessor as additional data points are provided at various locations.

[0097] The respective sensors **220**, **226**, **228**, **234***a*, **234***b*, **236**, **238**, **242**, **244**, **252**, **254**, **260** as discussed above with respect to FIGS. **4**, **5**A, 5B, **6**, **7**, **8**, **9**A, **9**B, **10**A, **10**B, and **11** may be combined together in various fashions to optimize functionality of the automatic leveling immersion cooling tank system **201**. In other words, various combinations of the respective sensors **220**, **226**, **228**, **234***a*, **234***b*, **236**, **238**, **242**, **244**, **252**, **254**, **260** at varying selected locations along the coolant tank **100** can provide different types of information and data to the microprocessor **218**, which can then be processed by the microprocessor **218** to in real time adjust the position of the coolant tank **100** to prevent or reduce the likelihood of spillage or to improve or maintain immersion or submersion of the one or more electronic components **110** within the coolant **108**. By providing different numbers, types, and combinations of these varying sensors along the coolant tank **100**, the microprocessor is capable of more accurately determining the position of the surface level **112**, the position of the coolant tank **100**, and accurately and quickly move, rotate, and adjust the position of the coolant tank **100** to improve overall efficiency of the automatic leveling immersion cooling tank system **201** while at the same time preventing or reducing the likelihood of the coolant **108** from spilling out of the coolant tank **100** when the lid **250** is not mounted to the coolant tank **100**.

[0098] FIG. **12** is a flowchart **300** of a method of adjusting a position of a coolant tank utilizing the automatic leveling immersion cooling tank system **201** as shown in FIGS. **2** and **3**, in accordance with some embodiments. The flowchart **300** of the method of adjusting the position of the coolant tank utilizing the automatic leveling immersion cooling tank system **201** includes a first step **302**, a second step **304**, and a third step **306**.

[0099] In the first step **302**, the respective sensors **220**, **226**, **228**, **234***a*, **234***b*, **236**, **238**, **242**, **244**, **252**, **254**, **260** detect various characteristics of the surface level **112** of the coolant **108**, the position of the coolant tank **100**, or some other suitable type of quantity, quality, or characteristics with respect to the coolant **108** and the coolant tank **100** that may be utilized by the microprocessor **218** to determine whether the position of the coolant tank **100** is to be moved, rotated, and adjusted to optimize efficiency of the automatic leveling immersion cooling tank system **201**, as well as prevent or reduce the likelihood of the coolant **108** spilling from the coolant tank **100** when the lid **250** is not mounted to the coolant tank **100**. In this first step **302**, the respective sensors **220**, **226**, **228**, **234***a*, **234***b*, **236**, **238**, **242**, **244**, **252**, **254**, **260** collect the data to which they are configured to detect in operation and output one or more sensor signals.

[0100] In the first step **302**, the respective sensors **220**, **226**, **228**, **234***a*, **234***b*, **236**, **238**, **242**, **244**, **252**, **254**, **260** detect various characteristics of the surface level **112** of the coolant **108**, the position of the coolant tank **100**, or some other suitable type of quantity, quality, or characteristics with respect to the coolant **108** and the coolant tank **100** that may be utilized by the microprocessor **218** to monitor the position of the coolant tank **100** and monitor the position of the surface level **112** to monitor efficiency of the automatic leveling immersion cooling tank system **201**, as well as monitor the likelihood of the coolant **108** spilling from the coolant tank **100** when the lid **250** is not mounted to the coolant tank **100**. In this first step **302**, the respective sensors **220**, **226**, **228**, **234***a*, **234***b*, **236**, **238**, **242**, **244**, **252**, **254**, **260** collect the data to which they are configured to detect in operation and output one or more sensor signals.

[0101] In the second step **304**, the one or more sensor signals output by the respective sensors **220**, **226**, **228**, **234***a*, **234***b*, **236**, **238**, **242**, **244**, **252**, **254**, **260** are output to the A/D converter **216**. The A/D converter **216** then converts or processes any analog signals as needed. The digital signals and any other signals that pass through the A/D converter **216** are output to the micro[processor **218**. Once the microprocessor **218** receives the signals output from the A/D converter **216**, the microprocessor further processes these signals and determines whether the position of the coolant tank **100** needs to be moved, rotated, or adjusted to optimize efficiency of the automatic leveling immersion cooling tank system **201**, as well as prevent or reduce the likelihood of the coolant **108** spilling from the coolant tank **100** when the lid **250** is not mounted to the coolant tank **100**.

[0102] In the third step **306**, when the microprocessor **218** determines that the coolant tank **100** does not need to be moved, rotated, and adjusted in position, the microprocessor **218** may not output any control signals such that the coolant tank **100** remains in the same position. Alternatively, when the microprocessor **218** determines that the coolant tank **100** does need to be moved, rotated, and adjusted in position, the microprocessor **218** outputs one or more control signals that result in at least one respective motor of the one or more motors **214***a*, **214***b*, **214***c* being powered out to actuate at least one respective actuator of the one or more actuators **212***a*, **212***b*, **212***c* to move, rotate, and adjust the position of the coolant tank **100** to optimize efficiency of the automatic leveling immersion cooling tank system **201**, as well as prevent or reduce the likelihood of the coolant **108** spilling from the coolant tank **100** when the lid **250** is not mounted to the coolant tank **100**.

[0103] In some embodiments, the first, second, and third steps **306** may be performed continuously such that the automatic leveling immersion coolant tank system **201** continuously in real time moves, rotates, and adjusts the position of the coolant tank **100** to optimize efficiency of the automatic leveling immersion cooling tank system **201**, as well as prevent or reduce the likelihood of the coolant **108** spilling from the coolant tank **100** when the lid **250** is not mounted to the coolant tank **100**. Alternatively, in some alternative embodiments, the first, second, and third steps **306** may be performed at discrete periods of time selected by a user. For example, each time a selected period of time, which may be selected by a user, passes, the method in the flowchart **300** is performed.

[0104] In view of the above discussion, the automatic leveling immersion cooling tank system **201** is an active system that is controlled by the one or more motors **214***a*, **214***b*, **214***c*.

[0105] FIG. **13** is a perspective view of an automatic leveling immersion cooling tank system **400**, in accordance with some embodiments.

[0106] In this embodiment as shown in FIG. **13**, the automatic leveling immersion cooling tank system **400**, which may be utilized as an alternative of the automatic leveling immersion cooling tank system **201** as shown in FIGS. **2** and **3** of the present disclosure, a gimbal **401** includes a base **402** and a gyroscope frame **404** including one or more gimbal structures **406**. In this embodiment, the one or more gimbal structures **406** include three gimbal structures such that the gimbal **401** is an aerotrim.

[0107] In this embodiment, the one or more gimbal structures **406** are in mechanical cooperation with one or more motors **408** that are in electrical communication with the A/D converter **216** either wired or wirelessly. The one or more motors **408** provide power such that the one or more gimbal structures **406** are rotated and moved to rotate, move, and adjust the position of the coolant tank **100** to optimize efficiency of the automatic leveling immersion cooling tank system **400**, as well as prevent or reduce the likelihood of the coolant **108** spilling from the coolant tank **100** when the lid **250** is not mounted to the coolant tank **100**.

[0108] The gimbal **401** includes three degrees of rotation about three different axes. For example, these three different axes are the x-axis, the y-axis, and the z-axis. In other words, each axis of the three axes is transverse to the other respective axes of the three different axes. These degrees of rotation allow for the one or more motors **408** to actively rotate and move the one or more gimbal structures **406** to re-position the coolant tank **100**.

[0109] In some embodiments, the gimbal **401** may only include a single gimbal structure **406** such that there is only one degree of freedom (e.g., rotatable about only one axis of the x, y, and z axes). In some embodiments, the gimbal **401** may only include a pair of gimbal structures **406** such that there are only two degrees of freedom (e.g., rotatable about only two axes of the x, y, and z axes). In some embodiments, the gimbal **401** may include more than three gimbal structures **406** to provide more precise control of the position of the coolant tank **100**.

[0110] FIG. **14** is a flowchart **410** of a method of adjusting a position of the coolant tank **100** utilizing the automatic leveling immersion cooling tank system **400** as shown in FIG. **13**, in accordance with some embodiments. The flowchart of the method of adjusting the position of the coolant tank **100** utilizing the automatic leveling immersion cooling tank system **400** includes a first step **412**, a second step **414**, and a third step **416**.

[0111] In the first step **412**, the respective sensors **220**, **226**, **228**, **234***a*, **234***b*, **236**, **238**, **242**, **244**, **252**, **254**, **260** detect various characteristics of the surface level **112** of the coolant **108**, the position of the coolant tank **100**, or some other suitable type of quantity, quality, or characteristics with respect to the coolant **108** and the coolant tank **100** that may be utilized by the microprocessor **218** to determine whether the position of the coolant tank **100** is to be moved, rotated, and adjusted to optimize efficiency of the automatic leveling immersion cooling tank system **201**, as well as prevent or reduce the likelihood of the coolant **108** spilling from the coolant tank **100** when the lid **250** is not mounted to the coolant tank **100**. In this first step **412**, the respective sensors **220**, **226**, **228**, **234***a*, **234***b*, **236**, **238**, **242**, **244**, **252**, **254**, **260** collect the data to which they are configured to detect in operation and output one or more sensor signals.

[0112] In the first step **412**, the respective sensors **220**, **226**, **228**, **234***a*, **234***b*, **236**, **238**, **242**, **244**, **252**, **254**, **260** detect various characteristics of the surface level **112** of the coolant **108**, the position of the coolant tank **100**, or some other suitable type of quantity, quality, or characteristics with respect to the coolant **108** and the coolant tank **100** that may be utilized by the microprocessor **218** to monitor the position of the coolant tank **100** and monitor the position of the surface level **112** to monitor efficiency of the automatic leveling immersion cooling tank system **201**, as well as monitor the likelihood of the coolant **108** spilling from the coolant tank **100** when the lid **250** is not mounted to the coolant tank **100**. In this first step **412**, the respective sensors **220**, **226**, **228**, **234***a*, **234***b*, **236**, **238**, **242**, **244**, **252**, **254**, **260** collect the data to which they are configured to detect in operation and output one or more sensor signals.

[0113] In the second step **414**, the one or more sensor signals output by the respective sensors **220**, **226**, **228**, **234***a*, **234***b*, **236**, **238**, **242**, **244**, **252**, **254**, **260** are output to the A/D converter **216**. The A/D converter **216** then converts or processes any analog signals as needed. The digital signals and any other signals that pass through the A/D converter **216** are output to the microprocessor **218**. Once the microprocessor **218** receives the signals output from the A/D converter **216**, the microprocessor further processes these signals and determines whether the position of the coolant tank **100** needs to be moved, rotated, or adjusted to optimize efficiency of the automatic leveling immersion cooling tank system **201**, as well as prevent or reduce the likelihood of the coolant **108** spilling from the coolant tank **100** when the lid **250** is not mounted to the coolant tank **100**.

[0114] In the third step **416**, when the microprocessor **218** determines that the coolant tank **100** does not need to be moved, rotated, and adjusted in position, the microprocessor **218** may not output any control signals such that the coolant tank **100** remains in the same position. Alternatively, when the microprocessor **218** determines that the coolant tank **100** does need to be moved, rotated, and adjusted in position, the microprocessor **218** outputs one or more control signals that result in at least one respective motor of the one or more motors **408** being powered to actuate the one or more gimbal structures **406** of the gimbal **401** to move, rotate, and adjust the position of the coolant tank **100** to optimize efficiency of the automatic leveling immersion cooling tank system **201**, as well as prevent or reduce the likelihood of the coolant **108** spilling from the coolant tank **100** when the lid **250** is not mounted to the coolant tank **100**.

[0115] In some embodiments, the first, second, and third steps **306** may be performed continuously such that the automatic leveling immersion coolant tank system **201** continuously in real time moves, rotates, and adjusts the position of the coolant tank **100** to optimize efficiency of the automatic leveling immersion cooling tank system **201**, as well as prevent or reduce the likelihood of the coolant **108** spilling from the coolant tank **100** when the lid **250** is not mounted to the coolant tank **100**. Alternatively, in some alternative embodiments, the first, second, and third steps **306** may be performed at discrete periods of time selected by a user. For example, each time a selected period of time, which may be selected by a user, passes, the method in the flowchart **300** is performed.

[0116] In some embodiments, the microprocessor **218** may check at least one of the following of the surface level **112** of the coolant **108** stored within the coolant tank **100** and the position of the coolant tank with one or more sensors after the first, second, and third steps **412**, **414**, **416** are performed to confirm that the coolant tank **100** is properly positioned and the one or more electronic components **110** are properly immersed (e.g., partially or fully submerged depending on the depth of the coolant **108** and the desired outcome).

[0117] In view of the above discussion, the automatic leveling immersion cooling tank system **400** is an active system that is controlled by the one or more motors **408** similar to the automatic leveling immersion cooling tank system **201**.

[0118] FIG. **15** is a perspective view of an automatic leveling immersion cooling tank system **500**, in accordance with some embodiments. The automatic leveling immersion cooling tank system **500** as shown in FIG. **15** has several of the same or similar features of the automatic leveling immersion cooling tank system **400** as shown in FIG. **13**. These same or similar features of the automatic leveling immersion cooling tank system **500** relative to the automatic leveling immersion cooling tank system **400** have been provided with the same or similar reference numerals. For the sake of simplicity and brevity of the present disclosure, the details of these same or similar features will not be redescribed in detail in view of the earlier detailed discussion of these features with respect to FIG. **13**.

[0119] Unlike the automatic leveling immersion cooling tank system **500**, which is an active system, that includes the one or more motors **408** to actively control the one or more gimbal structures **406**, the one or more motors **408** are not present in the automatic leveling immersion cooling tank system **600**, which is a passive system. Instead, the one or more gimbal structures **406** of the automatic leveling immersion cooling tank system **600** are passively controlled by the force of gravity **114** as the gimbal **401** includes three degrees of freedom about which the one or more gimbal structures **406** may freely rotate. This free rotation of the one or more gimbal structures **406** allows for the coolant tank **100** to be level even when the ground surface **116** is unlevel and the one or more gimbal structures will passively position (e.g., without being controlled by the one or more motors **214***a*, **214***b*, **214***c*, **408**) the coolant tank **100** such that the coolant tank **100** is level and the one or more electronic components **110** are properly immersed. Furthermore, when exposed to the vibrations **128**, the one or more gimbal structures **406** may passively react and re-position the coolant tank **100** such that the coolant **108** does not spill out of the coolant tank **100**. For the passive system of the automatic leveling immersion cooling tank system **600** as shown in FIG. **15**, a center of mass of the coolant tank **102** when filled with the coolant **108** and the electronic components **110** (e.g., servers, GPUs, CPUs, or some other suitable electronic component) is lower than a gimbal axis of the gimbal **401**.

[0120] However, it will be readily appreciated that if large external forces are applied to the one or more gimbal structures **406**, the coolant tank **100** may be flipped or drastically placed out of position. To avoid this type of occurrence, while not shown, in some embodiments of the automatic leveling immersion cooling tank system **600** as shown in FIG. **15**, if the microprocessor **218** determines that a failure or large external force is occurring, the microprocessor **218** may output a potential failure signal to engage a brake (not shown) that stops operation of the various the automatic leveling immersion cooling tank system **600** to prevent a major spill of the coolant **108** from the coolant tank **100** or to prevent damage to the one or more electronic components **110** within the coolant tank **100**.

[0121] In this embodiment of the automatic leveling immersion cooling tank system **600** as shown in FIG. **15**, the gimbal **401** similarly includes three gimbal structures **406** similar to the embodiment of the automatic immersion cooling tank system **400** as discussed earlier herein. However, in some embodiments, the gimbal **401** may only include a single gimbal structure **406** such that there is only one degree of freedom (e.g., rotatable about only one axis of the x, y, and z axes). In some embodiments, the gimbal **401** may only include a pair of gimbal structures **406** such that there are only two degrees of freedom (e.g., rotatable about only two axes of the x, y, and z axes). In some embodiments, the gimbal **401** may include more than three gimbal structures **406** to provide more precise control of the position of the coolant tank **100**.

[0122] FIG. **16** is a flowchart **700** of a method of adjusting a position of the coolant tank **100** utilizing the automatic leveling immersion cooling tank system **600** as shown in FIG. **15**, in accordance with some embodiments. The flowchart **700** of the method of adjusting the position of the coolant tank **100** with the automatic leveling immersion cooling tank system **600** includes a first step **702**, a second step **704**, and a third step **706**.

[0123] In the first step **702**, the respective sensors **220**, **226**, **228**, **234***a*, **234***b*, **236**, **238**, **242**, **244**, **252**, **254**, **260** detect various characteristics of the surface level **112** of the coolant **108**, the position of the coolant tank **100**, or some other suitable type of quantity, quality, or characteristics with respect to the coolant **108** and the coolant tank **100**. In this first step **702**, the respective sensors **220**, **226**, **228**, **234***a*, **234***b*, **236**, **238**, **242**, **244**, **252**, **254**, **260** collect the data to which they are configured to detect in operation and output one or more sensor signals.

[0124] In the second step **704**, the A/D converter **216** and the microprocessor **218** process the collected data to monitor the position of the coolant tank **100** and monitor the position of the surface level **112** to monitor efficiency of the automatic leveling immersion cooling tank system **201**, as well as monitor the likelihood of the coolant **108** spilling from the coolant tank **100** when the lid **250** is not mounted to the coolant tank **100**.

[0125] In the third step **706**, the microprocessor **218** monitors the position of the coolant tank **100** and monitors the surface level **112** of the coolant **108** within the coolant tank **100**. The microprocessor monitoring the position of the coolant tank **100** and the surface level **112** of the coolant allows for the microprocessor to determine whether the automatic leveling immersion cooling tank system **600** is functioning at optimized efficiency, as well as monitoring whether there is a high likelihood of the coolant **108** spilling out from the coolant tank **100** when the lid **250** is not mounted to the coolant tank **100**. While not shown, in some embodiments of the automatic leveling immersion cooling tank system **600**, if the microprocessor **218** determines that a failure is occurring, the microprocessor **218** may send a warning signal to an employee of a semiconductor manufacturing plant (FAB) providing the employee with information as to the potential failure or issue that may be occurring causing the automatic leveling immersion cooling tank system **600** to not function in an optimized fashion.

[0126] In view of the above discussion, unlike the actively controlled embodiments of the automatic leveling immersion cooling tank systems **201**, **400** as shown in FIGS. **2**, **3**, and **13** of the present disclosure, the automatic leveling immersion cooling tank system **500** is a passive system that is controlled by the one or more motors **214***a*, **214***b*, **214***c*. In other words, while the one or more motors **214***a*, **214***b*, **214***c* are utilized to control the position of the coolant tank **100**, the automatic leveling immersion cooling tank system **500** is simply controlled by passively reacting to the force of gravity, as well as other external forces.

[0127] While the automatic leveling immersion cooling tank system **400**, which is an active system, and the automatic leveling immersion cooling tank system **600**, which is a passive system, are discussed as being mounted to the ground surface **116**, in alternative situations, these leveling immersion cooling tank systems **400**, **600** may be slightly reoriented to be mounted to a wall surface or a ceiling surface. In other words, the leveling immersion cooling tank systems **400**, **600** may be mounted to any surface regardless of that surface having a vertical orientation (e.g., wall surface) or a horizontal orientation (e.g., ground surface or ceiling surface).

[0128] Furthermore, it will be readily appreciated that automatic leveling immersion cooling tank systems **201** including any number of the respective sensors or control options as discussed herein may be structured to be mounted to a ground surface, a wall surface, or a ceiling surface. In other words, the embodiments of the present disclosure for the various the automatic leveling immersion cooling tank systems **201**, **400**, **600** may be mounted to any surface regardless of that surface having a vertical orientation (e.g., wall surface) or a horizontal orientation (e.g., ground surface or ceiling surface).

[0129] FIG. **17** is a cross-sectional view of an automatic leveling immersion cooling tank system **800**, in accordance with some embodiments. The automatic leveling immersion cooling tank system **800** includes a gimbal **802** to which the coolant tank **100** is coupled. The gimbal **802** includes one or more mounting structures **804** and a gimbal structure **806**.

[0130] The coolant tank **100** is mounted to the one or more mounting structures **804**. In this embodiment, there is only one mounting structure **804** and the one mounting structure **804** is coupled to an external surface of the bottom end **104** of the coolant tank **100**. In some alternative embodiments, the one or more mounting structures **804** may include more than one mounting structure that are coupled at various external surfaces of the coolant tank **100** of the one or more sidewalls **102** and the bottom end **104** of the coolant tank **100**.

[0131] The gimbal structure **806** is coupled to the one or more mounting structures **804** and is coupled to the ground surface **116**. The gimbal structure **806** is in mechanical cooperation with the one or more motors **408**, and the one or more motors **408** are in electrical communication either wired or wirelessly with the A/D converter **216**. The microprocessor **218** is in electrical communication with the A/D converter either wired or wirelessly. While not shown, selected ones of the respective sensors **220**, **226**, **228**, **234***a*, **234***b*, **236**, **238**, **242**, **244**, **252**, **254**, **260** are present along the coolant tank **100** and are in electrical communication either wired or wirelessly with the microprocessor **218**. The gimbal structure **806** includes one or more actuation points**2 808** that may be actuated by the one or more motors **408**. For example, when the microprocessor **218** determines that the position of the coolant tank **100** needs to be moved, rotated, or adjusted, the one or more motors **408** may be powered on to actuate the one or more actuation points to re-position the coolant tank **100**. In this embodiment, there is only one actuation point **808** shown. In some alternative embodiments, there may be more than one actuation point **808** such that the coolant tank **100** may be adjusted in position more swiftly and easily as compared to when there is only one actuation point **808**.

[0132] The gimbal **802** functions in the same or similar fashion as the gimbal **401**. However, while the gimbal **401** is an aerotrim, the gimbal **802** is more similar to a camera gimbal in functionality and form. Accordingly, the functionality of the gimbal **802** is not discussed in detail herein.

[0133] In view of the above discussion, the automatic leveling immersion cooling tank system **400** is an active system that is controlled by the one or more motors **408** similar to the automatic leveling immersion cooling tank system **201**.

[0134] While not shown, in some embodiments of the automatic leveling immersion cooling tank systems **201**, **400**, **500**, **600** of the present disclosure, if the microprocessor **218** determines that a failure is occurring, the microprocessor **218** may send a warning signal to an employee of a semiconductor manufacturing plant (FAB). While not shown, in some embodiments of the automatic leveling immersion cooling tank systems **201**, **400**, **500**, **600** of the present disclosure, if the microprocessor **218** determines that a failure is occurring, the microprocessor **218** may output a potential failure signal to engage a brake (not shown) that stops operation of the various embodiments of the automatic leveling immersion cooling tank systems **201**, **400**, **500**, **600** of the present disclosure.

[0135] FIG. **18** is a cross-sectional view of an automatic leveling immersion cooling tank system **900**, in accordance with some embodiments. The automatic leveling immersion cooling tank system **900** includes the gimbal **802** to which the coolant tank **100** is coupled. The gimbal **802** includes one or more mounting structures **902** and the gimbal structure **806**. The one or more mounting structures **902** are similar to the one or more mounting structures **804** as shown in FIG. **17**. However, unlike the one or more mounting structures **804** that are structured to support the coolant tank **100** when the gimbal **802** is mounted to the ground surface **116**, the one or more mounting structures **902** have a first portion **904** and one or more second portions **906**. The first portion is a straight portion whereas the one or more second portions **906** have an L-like shape as shown in the cross-sectional view as shown in FIG. **18**. In other words, the functionality of the automatic leveling immersion cooling tank system **900** is very similar the functionality of the automatic leveling immersion cooling tank system **800** but the automatic leveling immersion cooling stank system **900** is instead structured to be mounted to a ceiling surface **908** instead of the ground surface **116**.

[0136] While not shown in each and every embodiment of the automatic leveling immersion cooling tank systems **201**, **400**, **500**, **600**, **800**, **900** of the present disclosure, respective lids may be provided and coupled to the coolant tank **100** to further prevent or reduce the likelihood of the coolant **108** from spilling out of the coolant tank **100**.

[0137] While not shown, in some embodiments of the automatic leveling immersion cooling tank systems **201**, **400**, **500**, **600**, **800**, **900** of the present disclosure, respective sensors of one or more sensors of these respective systems **201**, **400**, **500**, **600**, **800**, **900** include at least one of the following of one or more gyroscopes, one or more acceleration sensors, one or more surface level sensors, one or more magnetometer sensors, one or more laser sensors, one or more optical sensors, one or more level sensors, one or more position sensors, and one or more wave detection sensors. While not shown, the various embodiments of the automatic leveling immersion cooling tank systems **201**, **400**, **500**, **600**, **800**, **900** of the present disclosure may be restructured or adapted to be mounted to any number of surfaces with various orientations (e.g., a wall surface, a ground surface, a ceiling structure, or some other surface with some other type of orientation).

[0138] In view of the above discussion within the present disclosure, the microprocessor **218** may monitor the various characteristics, quantities, and qualities with respect to the coolant tank **100** to control the position of the coolant tank **100** utilizing the various embodiments of the automatic leveling immersion cooling tank systems **201**, **400**, **600**, **800** to improve immersion of the one or more electronic components **110** present within the coolant tank **100**, as well as to prevent or reduce the likelihood of spillage of the coolant **108** from the coolant tank **100** when the lid **250** is not present. For example, when the coolant tank **100** is exposed to external forces (e.g., an earthquake, an employee bumping into the coolant tank **100**, or some other similar or like type of external force applied to the coolant tank **100**) generating the vibration **128**, the microprocessor **218** may determine that the position of the coolant tank **100** is to be adjusted to prevent or reduce the likelihood of the coolant **108** spilling out the coolant tank **100** or to maintain proper immersion or submersion of the one or more electronic components **110** within the coolant **108**. The microprocessor **218** performs this determination in real time such that the coolant tank **100** remains level resulting in the surface level **112** of the coolant **108** remaining level within the coolant tank **100**.

[0139] This real time monitoring by the microprocessor **218** preventing or reducing the likelihood of spilling of the coolant **108** from the coolant tank **100** prevents or reduces the likelihood of generating a dangerous work environment within a semiconductor manufacturing plant (FAB). This real time monitoring by the microprocessor **218** preventing or reducing the likelihood of spilling of the coolant **108** from the coolant tank **100** reduces operating costs as the coolant **108** is not wasted due to being spilled out of the coolant tank **100** resulting in the introduction of new coolant into the cooling system **200** to maintain proper heat dissipation efficiency.

[0140] At least one embodiment of a system of the present disclosure may be summarized as including a coolant tank including a cavity in which a coolant is stored, the coolant tank being configured to, in operation, receive one or more electrical components to immerse the one or more electrical components within the coolant; one or more sensors configured to, in operation, monitor at least one of the following of a surface level of the coolant and a position of the coolant tank; and one or more actuation structures in mechanical cooperation with the coolant tank, the one or more actuation structures being configured to, in operation, adjust the position of the coolant tank.

[0141] At least one embodiment of a method of the present disclosure may be summarized as including detecting at least one of the following of a surface level of a coolant stored within a coolant tank and a position of the coolant tank with one or more sensors; processing one or more sensor signals output by the one or more sensors with a microprocessor to determine a direction of a zenith of gravity relative to the coolant tank; outputting a control signal from the microprocessor based on the direction of the zenith of gravity relative to the coolant tank to adjust the position of the coolant tank with one or more actuation structures; and adjusting the position of the coolant tank in which the coolant is stored with the one or more actuation structures.

[0142] At least one embodiment of a system of the present disclosure may be summarized as including a coolant tank configured to, in operation, store a coolant and store one or more electrical components immersed within the coolant; and a gimbal in mechanical cooperation with the coolant tank, the gimbal including one or more degrees of freedom, the gimbal is configured to, in operation, passively adjust a position of the coolant tank relative to a surface on which the gimbal rests.

[0143] The foregoing outlines features of several embodiments so that those skilled in the art may better understand the aspects of the present disclosure. Those skilled in the art should appreciate that they may readily use the present disclosure as a basis for designing or modifying other processes and structures for carrying out the same purposes and/or achieving the same advantages of the embodiments introduced herein. Those skilled in the art should also realize that such equivalent constructions do not depart from the spirit and scope of the present disclosure, and that they may make various changes, substitutions, and alterations herein without departing from the spirit and scope of the present disclosure.

Claims

1. A system, comprising: a coolant tank including a cavity in which a coolant is stored, the coolant tank being configured to, in operation, receive one or more electrical components to immerse the one or more electrical components within the coolant; one or more sensors configured to, in operation, monitor at least one of a surface level of the coolant or a position of the coolant tank; and one or more actuation structures in mechanical cooperation with the coolant tank, the one or more actuation structures being configured to, in operation, adjust the position of the coolant tank.

2. The system of claim 1, wherein the one or more sensors are at least one of one or more gyroscopes, one or more acceleration sensors, one or more surface level sensors, one or more magnetometer sensors, one or more laser sensors, one or more optical sensors, one or more level sensors, one or more position sensors, or one or more wave detection sensors.

3. The system of claim 1, further comprising a microprocessor coupled to the one or more sensors, the microprocessor is configured to, in operation, collect data from the one or more sensors to determine whether to adjust a position of the coolant tank.

4. The system of claim 3, wherein each respective actuation structure of the one or more actuation structures is configured to, in operation, adjust the position of the coolant tank in response to control signals output by the microprocessor.

5. The system of claim 4, wherein each respective actuation structure of the one or more actuation structures are linear actuators.

6. The system of claim 5, wherein each respective actuation structure of the one or more actuation structures includes a motor in mechanical cooperation with a piston.

7. The system of claim 5, wherein the one or more actuation structures are one or more robotic arms.

8. The system of claim 4, wherein the one or more actuation structures is a gimbal including one or more degrees of freedom.

9. A method, comprising: detecting at least one of a surface level of a coolant stored within a coolant tank or a position of the coolant tank with one or more sensors; processing one or more sensor signals output by the one or more sensors with a microprocessor to determine a direction of a zenith of gravity relative to the coolant tank; outputting a control signal from the microprocessor based on the direction of the zenith of gravity relative to the coolant tank to adjust the position of the coolant tank with one or more actuation structures; and adjusting the position of the coolant tank in which the coolant is stored with the one or more actuation structures.

10. The method of claim 9, wherein adjusting the position of the coolant tank in which the coolant is stored with the one or more actuation structures further includes adjusting the surface level of the coolant to improve immersion of one or more electrical components immersed within the coolant

stored within the coolant tank.
11. The method of claim 10, wherein adjusting the surface level of the coolant to improve immersion of the one or more electrical components immersed within the coolant stored within the coolant tank further includes fully submerging the one or more electrical components within the coolant stored within the coolant tank.
12. The method of claim 9, further comprising, after adjusting the position of the coolant tank in which the coolant is stored with the one or more actuation structures, checking at least one of the surface level of the coolant stored within the coolant tank or the position of the coolant tank with one or more sensors.
13. The method of claim 12, wherein checking at least one of the surface level of the coolant stored within the coolant tank or the position of the coolant tank with one or more sensors further includes confirming one or more electrical components are at least partially submerged within the coolant stored within the coolant tank.
14. The method of claim 12, wherein checking at least one of the surface level of the coolant stored within the coolant tank or the position of the coolant tank with the one or more sensors further includes confirming the one or more electrical components are fully submerged within the coolant stored within the coolant tank.
15. The method of claim 9, wherein the one or more sensors are at least one of one or more gyroscopes, one or more acceleration sensors, one or more surface level sensors, one or more magnetometer sensors, one or more laser sensors, one or more optical sensors, one or more level sensors, one or more position sensors, or one or more wave detection sensors.
16. A system, comprising: a coolant tank configured to, in operation, store a coolant and store one or more electrical components within the coolant; and a gimbal in mechanical cooperation with the coolant tank, the gimbal including one or more degrees of freedom, the gimbal is configured to, in operation, passively adjust a position of the coolant tank relative to a surface on which the gimbal rests.
17. The system of claim 16, wherein the one or more degrees of freedom of the gimbal includes at least one axis of free rotation configured to, in operation, passively adjust the position of the coolant tank based on one or more external forces on the coolant tank.
18. The system of claim 16, wherein the one or more degrees of freedom of the gimbal includes a first axis of free rotation and a second axis of free rotation configured to, in operation, passively adjust the position of the coolant tank based on one or more external forces on the coolant tank, and the first axis of free rotation is transverse to the second axis of free rotation.
19. The system of claim 16, wherein the one or more degrees of freedom of the gimbal includes a first axis of free rotation, a second axis of free rotation, and a third axis of free rotation configured to, in operation, passively adjust the position of the coolant tank based on one or more external forces on the coolant tank, and the first axis of free rotation is transverse to the second axis of rotation and the third axis of free rotation, the second axis of free rotation is transverse to the first axis of free rotation and the third axis of free rotation, and the third axis of free rotation is transverse to the first axis of free rotation and the second axis of free rotation.
20. The system of claim 16, further comprising: one or more sensors configured to, in operation, monitor at least one of a surface level of the coolant stored within the coolant tank or the position of the coolant tank; and a microprocessor in electrical communication with the one or more sensors configured to, in operation, collect and processor signals output by the one or more sensors.