CLAIMS:

1. A positioning system for determination of location data of an object comprising:

at least one transmitting unit configured to transmit a multi-frequency signal comprising at least two different signal frequency components;

a receiver system mounted on the object and configured to receive the multi-frequency signals from said at least one transmitting unit, and to determine phases of each signal frequency component of the multi-frequency signal; and

a processing system being in data communication with the receiver system, and configured to receive the phases of each signal frequency component of the multi-frequency signal, and to determine a distance D between said at least one transmitting unit and the object, and the location data of the object;

wherein the receiver is configured for:

receiving the multi-frequency signals provided by said at least one transmitting unit;

analyzing the multi-frequency signals, wherein the multi-frequency signal includes a sum of a predetermined number L of signal frequency components f_i, where i is a number index of the signal frequency components, i =1, 2, …, L; wherein the signal frequency components f_i are mutually prime numbers; and

determining said number L of the signal frequency components f_i of each of said multi-frequency signals; wherein the distance D between said at least one transmitting unit and the object is determined by $D = c\Delta t$, where c is the light speed, and Δt is the time of propagation of the multi-frequency signals between said at least one transmitting unit and the object, the time is determined from an equation:

$$\Delta t = \frac{\phi_i + 2\pi N_i}{2\pi f_i}$$

where ϕ_i is the phase of an i-th signal frequency component determined by the receiver, N_i is a number of wave cycles of an i-th signal frequency component spanned on the distance D, and where a number i of the signal frequency component f_i is selected from 0, 1, 2 and 3.

2. The positioning system of claim 1, wherein a number of the signal frequency

components f_i transmitted by said at least one transmitting unit is four, f_0 , f_1 , f_2 , and f_3, and wherein the processing system is configured for determining a number N_0 of cycles of the first signal frequency component f_0 by using any one of the following equations:

$$N_0 = -\frac{f_0\phi_1 - f_1\phi_0 + 2\pi M_0 f_0}{2\pi(f_0 - f_1)}$$

$$N_0 = -\frac{f_0\phi_2 - f_2\phi_0 + 2\pi M_1 f_0}{2\pi(f_0 - f_2)}$$

and

$$N_0 = -\frac{f_0\phi_3 - f_1\phi_0 + 2\pi M_2 f_0}{2\pi(f_0 - f_3)},$$

where M_0, M_1, and M_2 are additives to the number of cycles N_0 for the signal frequency components f_1 , f_2 , f_3, correspondingly.

3. The positioning system of claim 2, wherein M_0 and M_1 are determined by using the following algorithm:

for each M_0 selected from 0 to $(M_{0\,max}-1)$ and for each M_1 selected from 0 to $(M_{1\,max}-1)$, the processing system calculates integer numbers corresponding to M_0 and M_1 so as to satisfy an equation:

$$\frac{f_0\phi_1 - f_1\phi_0 + 2\pi M_0 f_0}{f_0 - f_1} = \frac{f_0\phi_2 - f_2\phi_0 + 2\pi M_1 f_0}{f_0 - f_2},$$

where $M_{0\,max} = round[2\pi(f_1 - f_0)T_s]$ and where $M_{1\,max} = [2\pi(f_2 - f_1)T_s]$ where T_s is the measurement rate.

4. The positioning system of claim 2, wherein M_0 and M_1 are determined from an equation:

$$\Delta p_{mx} := \left| \text{floor}\left[-\frac{f0\cdot\phi1 - f1\cdot\phi0 + 2\cdot\pi\cdot\text{mod}(mx, Ma0)\cdot f0}{2\pi\cdot(f0 - f1)} \right] - \text{floor}\left[-\frac{f0\cdot\phi2 - f2\cdot\phi0 + 2\cdot\pi\cdot\text{floor}\left(\frac{mx}{Ma0}\right)\cdot f0}{2\pi\cdot(f0 - f2)} \right] \right|$$

by calculating integer numbers satisfying a condition $\Delta p_{mx}=0$ for each mx selected from 0 to $(M_{0max}\cdot M_{1max}) - 1$, where $M_{0\,max} = round[2\pi(f_1 - f_0)T_s]$ and where $M_{1\,max} = round[2\pi(f_2 - f_1)T_s]$ where T_s is the measurement rate, and Ma0 = M_{0max} or M_{1max}.

5. The positioning system of claim 3, wherein the processing system is configured to calculate M_2 by solving an equation:

$$\frac{f_0\phi_1 - f_1\phi_0 + 2\pi M_0 f_0}{f_0 - f_1} = \frac{f_0\phi_3 - f_3\phi_0 + 2\pi M_2 f_0}{f_0 - f_3}.$$

6. The positioning system of claim 4, wherein the processing system is configured to calculate M_2 by solving an equation:

$$\frac{f_0\phi_1 - f_1\phi_0 + 2\pi M_0 f_0}{f_0 - f_1} = \frac{f_0\phi_3 - f_3\phi_0 + 2\pi M_2 f_0}{f_0 - f_3}.$$

7. The positioning system of claim 1, wherein the processing system is further configured to receive the phase data ϕ_i of each signal frequency component for each of the multi-frequency signals from the receiver system, and to determine kinematic data based on the phase data ϕ_i, said kinematic data selected from velocity and acceleration of the object.

8. A positioning for determination of location data of an object comprising:

at least one transmitting unit configured to transmit a multi-frequency signal comprising at least two different signal frequency components;

a receiver system mounted on the object and configured to receive the multi-frequency signals from said at least one transmitting unit, and to determine phases of each signal frequency component of the multi-frequency signal; and

a processing system being in data communication with the receiver system, and configured to receive the phases of each signal frequency component of the multi-frequency signal, and to determine a distance D between said at least one transmitting unit and the object, and the location data of the object;

wherein the receiver system is configured for:

receiving the multi-frequency signals provided by said at least one transmitting unit:

analyzing the multi-frequency signals, wherein the multi-frequency signal includes a sum of a predetermined number L of signal frequency components f_i, where *i is a* number index of the signal frequency components, i =1, 2, …, L; wherein the signal frequency components f_i are mutually prime numbers; and

determining said number L of the signal frequency components f_i of each of said multi-frequency signals;

wherein the positioning system comprises three transmitting units having coordinates (x_a, y_a, z_a), (x_b, y_b, z_b) and (x_c, y_c, z_c), correspondingly, and the determination of the location data includes calculating three location coordinates *x(t), y(t)* and *z(t)* of the object at time *t*, and

wherein the processing system is configured to determine the three location coordinates *x(t), y(t)* and *z(t)* of the object (11) by using the following equations:

$$D_a = \sqrt{(x(t) - x_a)^2 + (y(t) - y_a)^2 + (z(t) - z_a)^2}$$

$$D_b = \sqrt{(x(t) - x_b)^2 + (y(t) - y_b)^2 + (z(t) - z_b)^2}$$

$$D_c = \sqrt{(x(t) - x_c)^2 + (y(t) - y_c)^2 + (z(t) - z_c)^2},$$

where D_a, D_b and D_c are distances from said three transmitting units to the receiver system, correspondingly.

9. A positioning system for determination of location data of an objection comprising:

at least one transmitting unit configured to transmit a multi-frequency signal comprising at least two different signal frequency components;

a receiver system mounted on the object and configured to receive the multi-frequency signals from said at least one transmitting unit, and to determine phases of each signal frequency component of the multi-frequency signal, and

a processing system being in data communication with the receiver system, and configured to receive the phases of each signal frequency component of the multi-frequency signal, and to determine a distance D between said at least one transmitting unit and the object, and the location data of the object;

wherein the receiver system is configured for:

receiving the multi-frequency signals provided by said at least one transmitting unit:

analyzing the multi-frequency signals, wherein the multi-frequency signal includes a sum of a predetermined number L of signal frequency components f_i, where *i is a* number index of the signal frequency components, $i = 1, 2, \ldots, L$; wherein the signal frequency components f_i are mutually prime numbers; and

determining said number L of the signal frequency components f_i of each of said multi-frequency signals;

wherein the positioning system comprises four transmitting units having coordinates (x_a, y_a, z_a), (x_b, y_b, z_b), (x_c, y_c, z_c) and (x_d, y_d, z_d), correspondingly, and

wherein the processing system is configured to determine the three location coordinates *x(t), y(t)* and *z(t)* of the object and system time *T* by solving the following system of equations:

$$c(T - \Delta t_a) = \sqrt{(x(t) - x_a)^2 + (y(t) - y_a)^2 + (z(t) - z_a)^2}$$
$$c(T - \Delta t_b) = \sqrt{(x(t) - x_b)^2 + (y(t) - y_b)^2 + (z(t) - z_b)^2}$$
$$c(T - \Delta t_c) = \sqrt{(x(t) - x_c)^2 + (y(t) - y_c)^2 + (z(t) - z_c)^2}$$
$$c(T - \Delta t_d) = \sqrt{(x(t) - x_d)^2 + (y(t) - y_d)^2 + (z(t) - z_d)^2},$$

where T is a system time which is common to said four transmitting units, and where $c(T - \Delta t_a)$, $c(T - \Delta t_b)$, $c(T - \Delta t_c)$ and $c(T - \Delta t_d)$ are the distances between said transmitting units and said receiver system mounted on the object, correspondingly.

10. A positioning method for determining location data of an object, comprising:

providing the system of claim 1;

transmitting a multi-frequency signal comprising at least two different frequencies;

measuring the phases of each signal frequency component of the multi-frequency signal; and

determining a distance D between said at least one transmitting unit and the object, and the location data of the object;

wherein the receiver of the positioning system is configured for:

receiving the multi-frequency signals provided by said at least one transmitting unit;

analyzing the multi-frequency signals, wherein the multi-frequency signal includes a sum of a predetermined number L of signal frequency components f_i, where i is a number index of the signal frequency components, i =1, 2, …, L; wherein the signal frequency components f_i are mutually prime numbers; and

determining said number L of the signal frequency components f_i of each of said multi-frequency signals;

wherein the distance D between said at least one transmitting unit and the object is determined by $D = c\,\Delta t$, where c is the light speed, and Δt is the time of propagation of the multi-frequency signals between said at least one transmitting unit and the object, the time is determined from an equation:

$$\Delta t = \frac{\phi_i + 2\pi N_i}{2\pi f_i}$$

where ϕ_i is the phase of an i-th signal frequency component determined by the receiver, and N_i is a number of wave cycles of an i-th signal frequency component spanned on the distance D, and where a number i of the signal frequency component f_i is selected from 0, 1, 2 and 3.

11. The positioning method of claim 10, wherein a number of the signal frequency components f_i transmitted by said at least one transmitting unit is four, f_0 , f_1 , f_2 , and f_3, and wherein the method includes determining a number N_0 of cycles of the first signal frequency component f_0 by using any one of the equations:

$$N_0 = -\frac{f_0\phi_1 - f_1\phi_0 + 2\pi M_0 f_0}{2\pi(f_0 - f_1)}$$

$$N_0 = -\frac{f_0\phi_2 - f_2\phi_0 + 2\pi M_1 f_0}{2\pi(f_0 - f_2)}$$

and

$$N_0 = -\frac{f_0\phi_3 - f_1\phi_0 + 2\pi M_2 f_0}{2\pi(f_0 - f_3)}$$

where M_0, M_1, and M_2 are additives to the number of cycles N_0 for the signal frequency components f_1, f_2, f_3, correspondingly.

12. The positioning method of claim 11, comprising determining M_0 and M_1 by using the following algorithm:

for each M_o selected from 0 to ($M_{0\,max}$-1) and for each M_1 selected from 0 to ($M_{1\,max}$-1), calculating, by the processing system, integer numbers corresponding to M_o and M_1, which satisfy an equation:

$$\frac{f_0\phi_1 - f_1\phi_0 + 2\pi M_0 f_0}{f_0 - f_1} = \frac{f_0\phi_2 - f_2\phi_0 + 2\pi M_1 f_0}{f_0 - f_2}$$

where $M_{0\,max} = round[2\pi(f_1 - f_0)T_s]$ and where $M_{1\,max} = [2\pi(f_2 - f_1)T_s]$ where T_s is the measurement rate.

13. The positioning method of claim 11, comprising determining M_o and M_1 from an equation:

$$\Delta p_{mx} := \left| \mathrm{floor}\left[-\frac{f0\cdot\phi1 - f1\cdot\phi0 + 2\cdot\pi\cdot\mathrm{mod}(mx, Ma0)\cdot f0}{2\pi\cdot(f0 - f1)} \right] - \mathrm{floor}\left[-\frac{f0\cdot\phi2 - f2\cdot\phi0 + 2\cdot\pi\cdot\mathrm{floor}\left(\frac{mx}{Ma0}\right)\cdot f0}{2\pi\cdot(f0 - f2)} \right] \right|$$

by calculating integer numbers satisfying a condition $\Delta p_{mx}=0$ for each mx selected from 0 to ($M_{0max}\cdot M_{1max}$) – 1, where $M_{0\,max} = round[2\pi(f_1 - f_0)T_s]$ and where $M_{1\,max} = round[2\pi(f_2 - f_1)T_s]$ where T_s is the measurement rate, and Ma0 = M_{0max} or $M_{1max.}$

14. The positioning method of claim 12, comprising calculating M_2 by solving an equation:

$$\frac{f_0\phi_1 - f_1\phi_0 + 2\pi M_0 f_0}{f_0 - f_1} = \frac{f_0\phi_3 - f_3\phi_0 + 2\pi M_2 f_0}{f_0 - f_3}$$

15. The positioning method of claim 13, comprising calculating M_2 by solving an equation:

$$\frac{f_0\phi_1 - f_1\phi_0 + 2\pi M_0 f_0}{f_0 - f_1} = \frac{f_0\phi_3 - f_3\phi_0 + 2\pi M_2 f_0}{f_0 - f_3}$$

16. The method of claim 10, wherein determining of kinematic data includes receiving the phase data ϕ_i of each signal frequency component for each of the multi-frequency signals from the receiver system and to determining the kinematic data based on the phase data ϕ_i, said kinematic data selected from velocity and acceleration of the object.

17. A positioning method for determining location date of an object, comprising:

providing a positioning system for determination of a location data of an object comprising:

at least one transmitting unit configured to transmit a multi-frequency signal comprising at least two different signal frequency components;

a receiver system mounted on the object and configured to receive the multi-frequency signals from said at least one transmitting unit, and to determine phases of each signal frequency component of the multi-frequency signal; and

a processing system being in data communication with the receiver system, and configured to receive the phases of each signal frequency component of the multi-frequency signal, and to determine a distance D between said at least one transmitting unit and the object, and the location data of the object;

wherein the receiver system is configured for:

receiving the multi-frequency signals provided by said at least one transmitting unit;

analyzing the multi-frequency signals, wherein the multi-frequency signal includes a sum of a predetermined number L of signal frequency components fi, where i is a number

index of the signal frequency components, i=1, 2, …, L; wherein the signal frequency components fi are mutually prime numbers; and

determining said number L of the signal frequency components fi of each of said multi-frequency signals;

transmitting a multi-frequency signal comprising at least two different frequencies;

measuring the phases of each signal frequency component of the multi-frequency signal; and

determining a distance *D* between said at least one transmitting unit and the object, and the location data of the object;

wherein the positioning system comprises three transmitting units having coordinates (x_a, y_a, z_a), (x_b, y_b, z_b) and (x_c, y_c, z_c), correspondingly, the method includes determining location data, and includes calculating three location coordinates *x(t), y(t)* and *z(t)* of the object at time *t*, correspondingly; and

wherein the processing system of the positioning system is configured to determine the three location coordinates *x(t), y(t)* and *z(t)* of the object by using equations:

$$D_a = \sqrt{(x(t) - x_a)^2 + (y(t) - y_a)^2 + (z(t) - z_a)^2}$$

$$D_b = \sqrt{(x(t) - x_b)^2 + (y(t) - y_b)^2 + (z(t) - z_b)^2}$$

$$D_c = \sqrt{(x(t) - x_c)^2 + (y(t) - y_c)^2 + (z(t) - z_c)^2},$$

where D_a, D_b and D_c are distances from said three transmitting units to the receiver system, correspondingly.

18. A positioning method for determining location data of an object, comprising:

providing a positioning system for determination of location data of an object comprising:

at least one transmitting unit configured to transmit a multi-frequency signal comprising at least two different signal frequency components;

a receiver system mounted on the object and configured to receive the multi-frequency signals from said at least one transmitting unit, and to determine phases of each signal frequency component of the multi-frequency signal; and

a processing system being in data communication with the receiver system, and configured to receive the phases of each signal frequency component of the multi-frequency signal, and to determine a distance D between said at least

one transmitting unit and the object, and the location data of the object;

wherein the receiver system is configured for:

receiving the multi-frequency signals provided by said at least one transmitting unit;

analyzing the multi-frequency signals, wherein the multi-frequency signal includes a sum of a predetermined number L of signal frequency components fi, where i is a number index of the signal frequency components, i =1, 2, …, L; wherein the signal frequency components fi are mutually prime numbers; and

determining said number L of the signal frequency components fi of each of said multi-frequency signals;

transmitting a multi-frequency signal comprising at least two different frequencies;

measuring the phases of each signal frequency component of the multi-frequency signal; and

determining a distance *D* between said at least one transmitting unit and the object, and the location data of the object;

wherein the positioning system comprises four transmitting units having coordinates (x_a, y_a, z_a), (x_b, y_b ,z_b), (x_c, y_c, z_c) and (x_d, y_d, z_d), correspondingly, the method includes determining location data and system time *T*; and

wherein the processing system of the positioning system is configured to determine the three location coordinates *x(t), y(t)* and *z(t)* of the object and the system time *T* by solving the following system of equations:

$$c(T - \Delta t_a) = \sqrt{(x(t) - x_a)^2 + (y(t) - y_a)^2 + (z(t) - z_a)^2}$$

$$c(T - \Delta t_b) = \sqrt{(x(t) - x_b)^2 + (y(t) - y_b)^2 + (z(t) - z_b)^2}$$

$$c(T - \Delta t_c) = \sqrt{(x(t) - x_c)^2 + (y(t) - y_c)^2 + (z(t) - z_c)^2}$$

$$c(T - \Delta t_d) = \sqrt{(x(t) - x_d)^2 + (y(t) - y_d)^2 + (z(t) - z_d)^2},$$

wherein *T* is the system time which is common to said four transmitting units, and where $c(T - \Delta t_a)$, $c(T - \Delta t_b)$, $c(T - \Delta t_c)$ and $c(T - \Delta t_d)$ are the distances between said transmitting unit and said receiver system mounted on the object, correspondingly.