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Surface Transportation Engineering Technology

UNIFIED QUANTUM LIFT-AND-TRANSPORT MACHINERY

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Abstract

Introduction: The possibility of energy extraction from the physical vacuum, uncovered in case of potential mastering of the foundations of the theory of Superunification suggested by Leonov, will change the motion mechanics and the pattern of using lift-and-transport machinery if that is equipped with quantum engines (QEs). **Purpose of the study:** The purpose of the study is to develop a conceptual foundation and a working hypothesis for the operation of unified lift-and-transport machinery with quantum thrust – UQLTM. **Methods:** The thrust vector is decomposed into orthogonal components. A generalized force balance equation and its modifications are used. Typical modes of QLTM motion are identified. 3D modeling of force balance with velocity sweeping is carried out. 3D models of force balance are developed using Maple software. Images of surfaces with regard to wind resistance and thrust vector dynamics are built. Calculations as well as graphical-and-analytical studies are performed. **Results:** The paper presents results of calculations with visualization using an example of container transportation from a consolidated terminal to the hold of a container ship with the use of QLTM. **Discussion:** Existing lift-and-transport machines can be replaced by transport machines equipped with QEs (QLTM), and thus it will be possible to make the area of traditional lift-and-transport machinery movement available. Lifting machines can also be replaced by QLTM. Moreover, several types of lift-and-transport machines as well as transport machines used at warehouses to handle cargo can be replaced by unified QLTM (UQLTM) providing continuous transportation of cargo (without any transshipment using different types of vehicles).

Keywords

Quantum engine, quantum thrust, quantum lift-and-transport machinery, force balance.

Introduction

In a number of papers (Kotikov, 2018a, 2018b, 2018c, 2018d, 2019a, 2019b, 2019c, 2019d), the author addressed prospects of using the principles of non-fuel energy production (based on the extraction of energy from the physical vacuum) in the transport industry. The main attention was paid to the issues related to quantum thrust in automobiles with the appearance of a new type of transport – quantomobiles.

Now let us focus on lift-and-transport machinery. The possibility of energy extraction from the physical vacuum, uncovered in case of potential mastering of the foundations of the theory of Superunification (Leonov, 2002, 2010, 2018), will change the motion mechanics and the pattern of using lift-and-transport machinery if that is equipped with quantum engines (QEs).

Unlike ICEs and electric motors, QEs directly generate thrust, which can be applied to the vehicle/machine body (Brandenburg, 2017, Fetta, 2014, Frolov, 2017, Tajmar, 2007. et al.). This creates prerequisites for the appearance of quantum lift-and-transport machinery (QLTM) able to break off the bearing surface and transport cargo hovered over such surface horizontally.

Changing the thrust vector position from horizontal to inclined will make it possible to create a vertical component of thrust, which can be used to overcome gravity and get the QLTM above the bearing surface, allowing it to transport cargo by air (Kotikov, 2018a).

Let us elaborate on this hypothetical thesis.

Purpose and tasks of the study

The purpose of the study is to develop a conceptual foundation and a working hypothesis for the operation of unified lift-and-transport machinery with quantum thrust – UQLTM.

To achieve the purpose, it is required to solve the following tasks:

- to assess specific features and capabilities of QE thrust to ensure lift-and-transport operations related to cargo handling;

- to develop a concept for a new class of unified lift-and-transport machinery – UQLTM;
- to build a mathematical model of QLTM force balance and motion;
- to present basic modes of QLTM operation;
- to analyze a numerical example describing cargo handling with the use of QLTM;
- to summarize the results of the study and offer recommendations for further studies in this area.

Methods

Generalized mathematical model of QLTM force balance

Thrust vector decomposition

The three-dimensional thrust vector can be decomposed into unit vectors (Leonov, 2018, Kotikov, 2019c, 2019d):

$$\mathbf{F}_T = \mathbf{F}_{Tx} + \mathbf{F}_{Ty} + \mathbf{F}_{Tz}. \quad (1)$$

The scalar form of this equation is as follows:

$$F_T = \sqrt{F_{Tx}^2 + F_{Ty}^2 + F_{Tz}^2} \quad (2)$$

If we assume that the thrust vector can be directed in all directions of the 3D space, then the area of thrust vector realization can be represented by a sphere of radius F_T.

If we simplify the task and describe only the longitudinal (course) motion of QLTM in the plane of pitch angle β, then equations (1) and (2) will take the following form:

$$\mathbf{F}_T = \mathbf{F}_{Tx} + \mathbf{F}_{Tz}. \quad (3)$$

The scalar form of this equation is as follows:

$$F_T = \sqrt{F_{Tx}^2 + F_{Tz}^2} \quad (4)$$

Graphically, it is given in Figure 1.

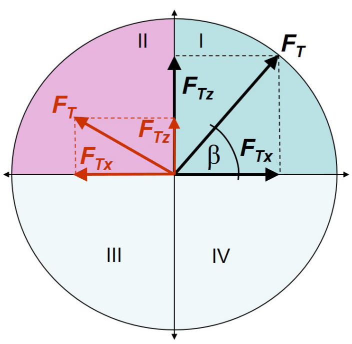

Figure 1. $\mathbf{F}_T$ thrust decomposition into the horizontal ($\mathbf{F}_{Tx}$) and vertical ($\mathbf{F}_{Tz}$) components: β – thrust angle $\mathbf{F}_T$ relative to the horizon.

Equations (3) and (4) are general initial equations for the calculation of QLTM motion both in vertical (with breakoff of cargo from the surface and their lifting) and horizontal direction (transportation of cargo to another location), as well as in case of combined motion along inclined trajectories.

The first (blue) quadrant of the circle formed by the thrust vector tip corresponds to the longitudinal translational forward motion of QLTM (with the realization of direct thrust) (Figure 1). The second (pink) quadrant corresponds to the longitudinal braking modes (reverse).

QLTM and floor-mounted LTM force balance analyses differ. This is due to the fact that the generalized force balance equation involves new entities and physical quantities, which manifest when vertical forces (gravity, hovering, wind resistance to vertical motion, vertical accelerations) are taken into account.

Generalized QLTM force balance equation and its modifications

As a result of equation (4) detalization performed in an analogous way to the way it was performed in other studies (Kotikov, 2019c, 2019d), we obtain the following:

$$F_T^2 = F_{Tx}^2 + F_{Tz}^2 = \left(P_{w.x} + P_{j.x}\right)^2 + \left(P_{w.z} + P_{j.z} + P_g\right)^2 =$$
$$\left(k_{w.x} \cdot S_{front} \cdot V_x^2 + \frac{G_{QLTM}}{g} a_x \cdot\right)^2 + \left(\left(k_{w.z} \cdot S_{plan} \cdot V_z^2 + \frac{G_{QLTM}}{g} a_z\right)\Big|_{F_{Tz} > G_{QLTM}} + \min(F_{Tz}, G_{QLTM})\right)^2, \quad (5)$$

where:

F_T, F_{Tx}, F_{Tz} – thrust and its coordinate components, respectively, N;

$P_{w.x}$ – wind resistance to the horizontal motion, N;

$P_{j.x}$ – force of resistance to horizontal acceleration, N;

$P_{w.z}$ – wind resistance to the vertical motion, N;

$P_{j.z}$ – force of resistance to vertical acceleration, N;

$P_g = G_{QLTM}$ – a part of the vertical component of thrust used to neutralize the gravity of loaded QLTM being transported, N;

V_x – current velocity of QLTM longitudinal (course) motion, m/s;

G_{QLTM} – weight of QLTM (loaded or unloaded as the case may be), N;

$k_{w.x}$ – horizontal (longitudinal) wind shape coefficient, N·s²/m⁴;

S_{front} – frontage area of QLTM, m²;

V_w – longitudinal velocity of QLTM relative to the wind (in the present study, $V_w = V_x$), m/s;

g – gravitational acceleration, m/s²;

a_x – longitudinal acceleration of loaded QLTM, m/s²;

$k_{w.z}$ – vertical wind shape coefficient, N·s²/m⁴;

S_{plan} – area of QLTM in plan view, m²;

V_z – vertical motion velocity of QLTM, m/s;

a_z – vertical acceleration of QLTM, m/s².

It should be noted that $G_{QLTM} = G_{QLTM.0} + G_c$, where $G_{QLTM.0}$ is the weight of unloaded QLTM and G_c is the weight of transported cargo with the package.

Equation (5) represents a generalized expression of QLTM force balance that comprises all typical cases of QLTM operation:

1. initial rest mode (lashing) of cargo, $F_{Tz} = 0$;
2. transition mode of partial hovering of cargo, when $0 < F_{Tz} < G_{QLTM}$;

3. boundary mode – with zero contact between cargo and the bearing surface (without QLTM breakoff), when $F_{Tz} = G_{QLTM}$;
4. QLTM vertical breakoff mode, when $F_{Tz} > G_{QLTM}$;
5. QLTM flight mode (at $F_{Tz} > G_{QLTM}$);
6. mode of vertical descent to the bearing surface;
7. mode of final fixation of cargo.

The use of equation (5) is associated with particular specifics:

- the term of equation "min(F_{Tz}, G_{QLTM})" represents a force to overcome gravity created by the weight of loaded QLTM: partially – when at $F_{Tz} \le G_{QLTM}$ it is not physically possible for the unit to go upwards, or at $F_{Tz} > G_{QLTM}$, when gravity is overcome completely, it is possible for QLTM to break off the bearing surface due to the remaining force $R_{FTz} = F_{Tz} - G_{QLTM}$;
- equation (5) does not take into account the vertical movement of QLTM when the value F_{Tz} changes in cases of motion 1)–3), which (though insignificant) can occur because of the deformation of tires or suspension of an individual delivery vehicle, or soil flexibility. Vertically oriented speed and acceleration actualized in this case will be massively smaller than the speed V_z and acceleration a_z at QLTM breakoff with $F_{Tz} > G_{QLTM}$ – therefore, in case of adequate substantiation, we can neglect those values.

When considering force balance in uniform steady motion of loaded QLTM close to the bearing surface but without breakoff (i.e. at $F_{Tz} \approx G_{QLTM}$) (mode 3), it is possible to use the following reduced (in relation to equation (5)) equation:

$$F_T{}^2 = F_{Tx}{}^2 + F_{Tz}{}^2 = \left(P_{w.x}\right)^2 + \left(P_g\right)^2 = \left(k_{w.x} \cdot S_{front} \cdot V_x{}^2\right)^2 + \left(F_{Tz}\right)^2. \quad (6)$$

Let us further focus on this option of force balance. Equation (6) is implicit with regard to $x = F_{Tx}$, $z = F_{Tz}$, $y = V_x$ arguments.

In case of calculation studies, it may be more convenient to use explicit equations with regard to the indicator under consideration.

Implicit equation (6) can be reduced to the explicit form with regard to F_{Tx}:

$$F_{Tx} = \left(k_{w.x} \cdot S_{front} \cdot V_x^2\right). \quad (7)$$

Equation (6) can be reduced to the explicit form with regard to F_{Tz}:

$$F_{Tz} = G_{QLTM} + \frac{k_{w.x} \cdot S_{front} \cdot V_x^2 - F_{Tx}}{}. \quad (8)$$

Equation (6) can be reduced to the explicit form with regard to V_x:

$$V_x = \sqrt{\frac{F_{Tx}}{k_{w.x} \cdot S_{front}}}. \quad (9)$$

The following can be written for the longitudinal acceleration of QLTM in the mode of full hovering (at $F_{Tz} = G_{QLTM}$):

$$a_x = \frac{g}{G_{QLTM}}\left(F_{Tx} - k_{w.x} \cdot S_{front} \cdot V_x{}^2\right). \quad (10)$$

The maximum possible longitudinal velocity of hovering QLTM can be determined by setting $a_x = 0$:

$$V_{x.\max} = \sqrt{F_{Tx} / k_{w.x} \cdot S_{front}}. \quad (11)$$

The longitudinal acceleration at the initial moment of longitudinal motion of hovering QLTM can be determined by setting $V_x = 0$:

$$a_x = \frac{F_{Tx} \cdot g}{G_{QLTM}}. \quad (12)$$

The following can be written for the vertical acceleration of QLTM (at $F_{Tz} > G_{QLTM}$):

$$a_z = \frac{g}{G_{QLTM}}\left(F_{Tz} - G_{QLTM} - k_{w.z} \cdot S_{plan} \cdot V_z{}^2\right). \quad (13)$$

Setting $V_z = 0$, it is possible to calculate the vertical acceleration at the initial moment of QLTM ascent:

$$a_z = \frac{g}{G_{QLTM}}\left(F_{Tz} - G_{QLTM}\right) \quad (14)$$

The analysis based on equations (3)…(14) can be complemented with corresponding graphical models. The author used Maple software to program the mentioned equations with different graphical representations.

Numerical example. Results

For a numerical example, the author used hypothetical QLTM with own weight $G_{QLTM.0}$ = 30 kN (Container spreaders, 2018, Alfa Group. Spreader for 20-feet containers, 2019), intended to transport standard loaded 20-feet containers with weight G_c = 240 kN, i.e. G_{QLTM}= 270 kN. Let us assume that the QLTM structure represents a container spreader with a QE. The loaded QLTM also has the following characteristics: $k_{w.x}$ = 0.6 N·s²/m⁴; S_{front} = 8 m²; $k_{w.z}$ = 0.9 N·s²/m⁴; S_{plan} = 15 m² (the initial data are substantiated in other papers (Kotikov, 2018d, 2019a, 2019b)).

Let us also assume that the loaded QLTM moves along a simple rectilinear trajectory: 1) vertical ascent to a height of 40 m (maximum height for existing ship-to-shore cranes (Sagizly, 2005)) with constant acceleration; 2) horizontal transportation for a conventional distance of 500 m: with constant acceleration – constant motion – with constant deceleration; 3) vertical descent to a conventional height of 0 m with constant deceleration.

1. Vertical acceleration is conditioned by the fact that the value of vertical thrust exceeds the QLTM weight

(i.e. 280 – 270 = 10 kN): $a_z = \frac{g}{G_{QLTM}}\left(F_{Tz} - G_{QLTM}\right)$ =

9.8 (280 – 270)/270= 0.363 m/s² (which can be accepted). This is acceleration at the initial moment when V_z = 0. Then the time required for the ascent to a height of 40 m is as follows: t = sqrt(2h/a_z) = sqrt(2*40/0.363) = 14.85 s.

The vertical speed at the moment of approximating 40 m height is as follows: V_z= sqrt(2a_z*h) = sqrt(2*0.363*40) = 5.4 m/s.

Let us calculate the value of wind resistance at this speed:

$P_{w.z} = k_{w.z} \cdot S_{plan} \cdot V_z^2$ = 0.9 N·s²/m⁴ * 15 m² * 29 m²/s² = 391.5 N = 0.391 kN. Thus, we obtain a rather small value (4%) (when compared with the excess vertical thrust). Therefore, we can neglect wind resistance at such QLTM speeds.

2. The horizontal motion at the section of 500 m comprises the following stages: acceleration – steady motion at a set speed (let us set the speed at 10 m/s) – deceleration.

Acceleration:

$a_x = \frac{F_{Tx} \cdot g}{G_{QLTM}} \cdot$ = 74,000 N * 9.8 m/s² /27,000 N = 2.69 m/s².

Acceleration time to reach the set speed of 10 m/s: t = v/ax = 10/2.69 = 3.72 s.

Acceleration distance: $S = v^2/2a_x$ = 100/(2*2.69) = 18.59 m.

If we take the value of deceleration as –2.69 m/s², then the time and distance will be the same as in case of acceleration, and the distance of uniform motion will be as follows: 500 – 2*18.59 = 463.82 m. The time will be as follows: 463.82/10 = 46.38 s.

In this case, it is necessary to consider wind resistance overcoming. When the vertical component of thrust F_{Tz} = 270 kN is maintained, the horizontal component $F_{Tx} = k_{w.x} \cdot S_{front} \cdot V_x^2$ = 0.6 * 8 * 100 = 480 N = 0.48 kN shall be ensured. This is shown in Figure 3b.

3. Vertical descent of the QLTM: let us assume that the QLTM descends in a mirror-like manner with respect to the ascent, with an acceptable acceleration of –0.363 m/s². It should be noted that in this case the F_T thrust characteristic will differ from the thrust during the ascent. As acceleration a_z is directly proportional to the difference (F_{Tz} - G_{QLTM}), then instead of excess, deficiency shall be used to obtain the same value of G_{QLTM} weight, i.e. (F_{Tz} - G_{QLTM}) = –10kN, and then F_{Tz}= 270 kN – 10 kN = 260 kN.

Thus, the total time required for the delivery of cargo from a consolidating terminal aboard a container ship will amount to 14.85 + 3.72 + 46.38 + 3.72 + 14.85 = 83.52 s.

Figure 2 shows a trajectory of the thrust vector (its tip) to ensure QLTM motion along the trajectory described in the numerical example in coordinates $x = F_{Tx}$, $z = F_{Tz}$ $y = V_x$. Here, the dark-blue surface is a surface of maximum thrust FTmax, and the pink surface is a level of weight G_{QLTM}.

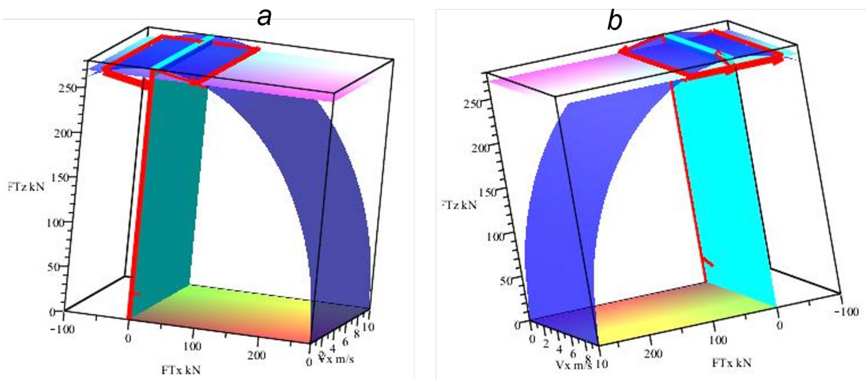

Figure 2. Vector tip trajectory (red line) by phases of QLTM motion: a) view from the side of low speeds; b) view from the side of high speeds.

The analysis can be facilitated by the detalization of the specific features, implemented graphically by changing the range of the arguments presented and their scale (Figure 3).

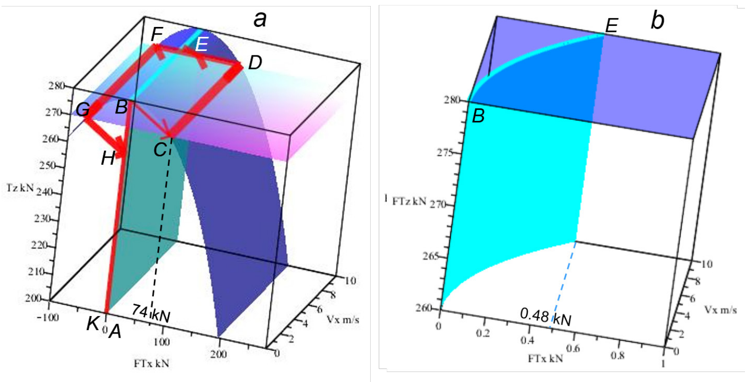

Figure 3. Detalization of the specific features of thrust vector generation to ensure motion along the rectilinear trajectory in the numerical example: a) vector changing by phases of QLTM motion; b) surface of wind resistance to horizontal QLTM motion (blue surface).

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Thrust vector movement by phases and characteristic points of the trajectory is as follows: *A* – QLTM start position; *B* – ascent phase; *BC* – vector switching to horizontal acceleration; *C* – start of horizontal motion; *CD* – longitudinal acceleration to 10 m/s; *E* – steady motion with a speed of 10 m/s; *EF* – vector switching to deceleration; *FG* – longitudinal deceleration to 0 m/s; *GH* – vector switching to descent; *H* – descent phase; *K* – QLTM final position.

Discussion

Despite the fact that the example of QLTM motion along the rectilinear trajectory with sudden changes in the nature of motion (switching from vertical motion to horizontal and vice versa, rough thrust vector switching, and, as a consequence, rough changes in QLTM accelerations) is rather simple, in the author's opinion, it is possible to get an overview of QLTM motion.

Sure enough, QLTM motion can be more complex and elegant, with inclined ascents and descents, maneuvering over the facilities of a terminal, consideration of the difference between accent and descent stages as well as their specifics (in contrast with their "mirror-like" nature).

In case of mass use of QLTM, dispatching can be performed with the distribution of trajectories in a 3D space, where all QLTM units are unified by a single purpose (e.g. fast loading of a ship with containers).

In some cases, existing lift-and-transport machines can be replaced by transport machines equipped with QEs (QLTM), and thus it will be possible to make the area of traditional lift-and-transport machinery movement available. Lifting machines (cranes, etc.) can also be replaced by QLTM. Moreover, several types of lift-and-transport machines as well as transport machines used at warehouses to handle cargo can be replaced by unified QLTM (UQLTM) providing continuous transportation of cargo (without any transshipment using different types of vehicles). For instance, a container located at an open container port can be transported from a consolidated terminal (or even from a vehicle or railway platform) directly to the hold/deck of a container ship. A consolidated terminal becomes available, and a new work method as well as the use of a 3D space of a port will make it possible to significantly increase cargo flow.

All aspects mentioned need to be elaborated in further studies.

Conclusions

According to the results of the study, given the actual realization of the idea and implementation of the principles of non-fuel energy production based on the extraction of energy from the physical vacuum, the presented QLTM concept is rather sound.

In the author's opinion, programming and graphical tools of modern Maple software can ensure future calculations, studies and design activities related to QLTM.

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УНИВЕРСАЛЬНАЯ КВАНТОВАЯ ПОДЪЕМНО-ТРАНСПОРТНАЯ МАШИНА

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Аннотация.
Введение. Возможность извлечения энергии из физического вакуума, открывающаяся с перспективой освоения положений теории Суперобъединения Леонова, изменит механику движения и характер использования подъемно-транспортных средств, при установке на них квантовых двигателей (КвД). **Цель.** Формирование концепции и рабочей гипотезы функционирования комплексной (unified) ПТМ с квантовой тягой – UQLTM. **Методы.** Разложение вектора траста на ортогональные компоненты. Использование обобщенного уравнения силового баланса и его модификаций. Определение характерных режимов QLTM. 3D-моделирование силового баланса с разверткой по скорости. Программирование 3D моделей силового баланса в ППП Maple. Построение образов поверхностей сопротивлений и динамики вектора траста. Расчетные и графоаналитические исследования. **Результаты.** Представлены результаты вычислений с визуализацией на конкретном примере переноса контейнера с накопительной площадки в трюм морского контейнеровоза посредством QLTM. **Обсуждение.** Существующие ПТМ могут быть заменены транспортирующими машинами с КвД в их конструкциях (QLTM), что позволит высвободить полосу движения привычного ПТМ. Подъёмные машины также могут быть заменены QLTM. Более того, несколько типов ПТМ и ТМ, используемых на складах в последовательности технологических операций обработки конкретного груза, могут быть заменены одним универсальным UQLTM, осуществляющим непрерывное перемещение груза, без перегрузки с одного вида ТС на другой.

Ключевые слова
Квантовый двигатель, квантовая тяга, квантовая подъемно-транспортная машина, силовой баланс.