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SECTION 4. Computer science, computer engineering and automation.

MATHEMATICAL MODEL OF DRIVING A FRONT WHEEL IN STATIONARY ROTATION MODE

Abstract: *The article considers steering, for which it is necessary to create a mathematical model of driving a front wheel in a stationary mode on the basis of mathematical friction theory.*

Key words: *stationary mode, mathematical model, friction theory*

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Introduction

Arduino is a tool for designing electronic devices (electronic constructor) that is closely interconnected with the surrounding environment, with a standard non-virtual PC. This platform is based on a simple print board with open-source software for "physical computing", with a modern software.

Arduino is used to create electronic devices that are connected to itself and managed by various executive instruments, which can receive signals from different analog and digital transmitters. Designed on Arduino, the tool can work individually or with software on the computer (Flash, Processing, MaxMSP). Arduino also offers many possibilities, including the process of moving the car through the mobile phone.

Materials and Methods

In order to drive the car, first, it is necessary to create a mathematical model of driving a front wheel in a stationary mode on the basis of mathematical friction theory. The result of the report is as follows. Determination of multiple environments by tracking the direction of the car's rotation through the unknown coordinates, tracking the wheel area slipping. The use of this technique allows evaluating the structural movement of the car's parameters and its curvature behavior.

He most commonly used method of walking is to learn the traffic on a turn. These methods are the method of using differentiation between the wheel and the wheel on the sliding track.

For wheels accounting, the tractor recommends the use of the curve simulation technique, which is regarded as a controlled object, providing a curve, projection and control system, and bonds.

The vehicle (automobile) is connected to the ground by the number of wheels with 4 contact points. In the center of each shift, the frictional moment and force (Ty_i Tx_i M_i), and (x_i, y_i) are the coordinates of the function.

$$T_{xi} = -\varphi \frac{G_i}{a_i b_i} \int_{-\frac{a_i}{2}}^{\frac{a_i}{2}} \int_{-\frac{b_i}{2}}^{\frac{b_i}{2}} \frac{y_i-\eta}{\sqrt{(x_i-\zeta)^2+(y_i-\eta)^2}} d\zeta d\eta \qquad (2.1)$$

$$T_{yi} = \varphi \frac{G_i}{a_i b_i} \int_{-\frac{a_i}{2}}^{\frac{a_i}{2}} \int_{-\frac{b_i}{2}}^{\frac{b_i}{2}} \frac{x_i-\zeta}{\sqrt{(x_i-\zeta)^2+(y_i-\eta)^2}} d\zeta d\eta \qquad (2.2)$$

$$M_i = \varphi \frac{G_i}{a_i b_i} \int_{-\frac{a_i}{2}}^{\frac{a_i}{2}} \int_{-\frac{b_i}{2}}^{\frac{b_i}{2}} \sqrt{(x_i-\zeta)^2+(y_i-\eta)^2} d\zeta d\eta \qquad (2.3)$$

where: G_i - i wheel oriented, unit of measure - kg;

φ - friction coefficient of wheel and wheel;

Length, width and length of a_i, b_i - i wheel, unit of measurement - mm.

The width of the wheel (b_i), i_e (Gi), does not move, so we take the standard dimension of the tire. Using the Pythagorean theorem, we estimate the length of the trail:

$$a_i = 2\sqrt{r_{\text{св}i}^2 - r_{di}^2} \qquad (2.4)$$

where: $r_{\text{св}i} = D_i/2$ - i the arbitrary radius of the wheel, unit of measurement mm;

$r_{di} = r_{\text{св}i} - h_i$- i wheel radius, unit of measurement mm.

Since the spinning of the spindle depends on its design parameter (bi, Di), the tire internal pressure (r) and the vertical weight of the wheel (Gi) correspond to the following formula:

$$h_i = \frac{G_i}{\pi\rho\sqrt{bD}} \qquad (2.5)$$

where: ρ - mean tire pressure, unit of measurement KPa;

bi - width i wheel width, unit of measurement mm;

Di - outer diameter of the outer diameter *i* wheel, unit of measurement mm;

Calculating the curvature of the radius and the wheel (1.4), we use the following formula for calculating the length of your length:

$$a_i = 2\sqrt{\frac{D_i^2}{4} - \left(\frac{D_i}{2} - h_i\right)^2} = 2\sqrt{D_i h_i - h_i^2} \qquad (2.6)$$

To define a momentary shift environment, we use the following coordinate system: The common system for all vehicles, from the beginning of the rotation center (X_0, Y_0- the internal coordinates of the rear tire in the system);

Four stand-alone systems for each stand site, starting from the initial coordinates in the geometric center of your geomorphic center (x_i, y_i -coordinates of a single displacement system on the local coordinate system). (Fig. 2.8) The calculation scheme of the transport device turns.

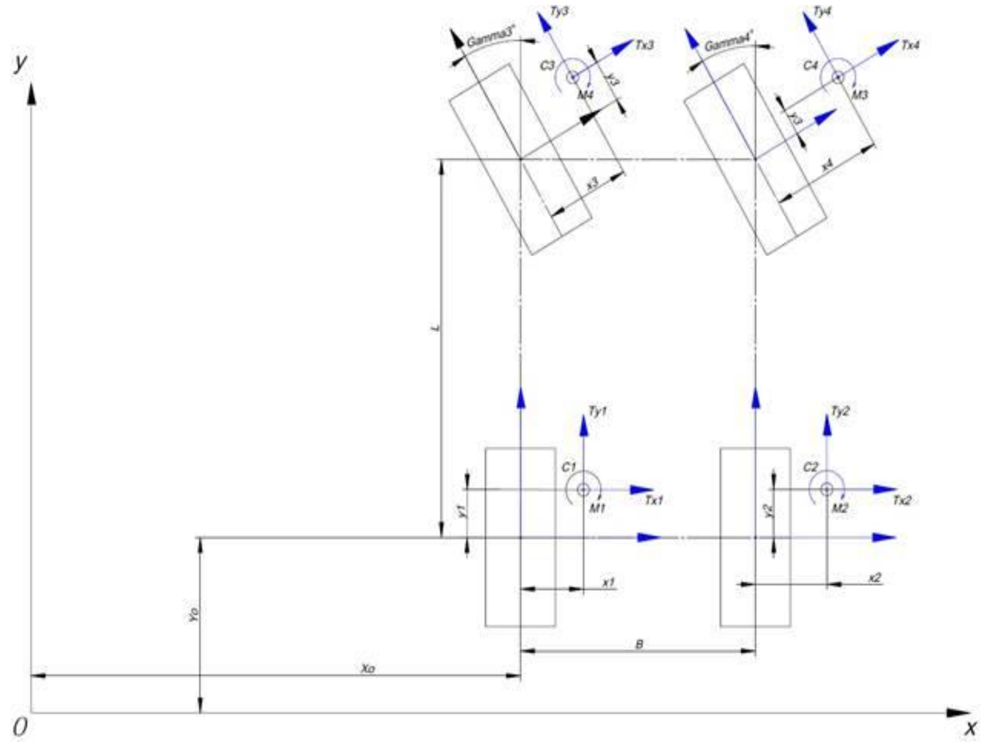

Figure 2.1. Calculation scheme of transport equipment turn

Together with the coordinates of the general and local system, we will coordinate the BOS coordinates of all wheels (Figure 2.1):

$$x_{c1} = x_0 + x_1, \quad y_{c1} = y_0 + y_1, \qquad (2.7)$$

$$x_{c2} = x_0 + B + x_2, \; y_{c2} = y_0 + y_2, \qquad (2.8)$$

$$x_{c3} = x_0 + x_3 cos\gamma_3 - y_3 sin\gamma_3,$$
$$y_{c3} = y_0 + L + x_3 sin\gamma_3 + y_3 cos\gamma_3, \qquad (2.9)$$

$$x_{c4} = x_0 + B + x_4 cos\gamma_4 - y_4 sin\gamma_4$$
$$y_{c4} = y_0 + L + x_4 sin\gamma_4 + y_4 cos\gamma_4 \qquad (2.10)$$

where: B, L - track and longitudinal base;

g3, g4 - the rotation angles of the relative front wheel;

Create a curvilinear rotation system for free transport equipment. For the stationary rotation, three equations of motion [37]

$$-m\omega^2 y_0 = Tx_1 + Tx_2 + Tx_3\cos\gamma_3 - Ty_3\sin\gamma_3 + Tx_4\cos\gamma_4 - Ty_4\sin\gamma_4 \quad (2.11)$$

$$-m\omega^2 x_0 = Ty_1 + Ty_2 + Tx_3\sin\gamma_3 + Ty_3\cos\gamma_3 + Tx_4\sin\gamma_4 - Ty_4\cos\gamma_4 \quad (2.12)$$

$$0 = M_1 + M_2 + M_3 + M_4 - Ty_1 x_{c1} - Ty_2 x_{c2} - Ty_3\sqrt{x_{c3}^2 + y_{c3}^2} - Ty_4\sqrt{x_{c4}^2 + y_{c4}^2} \quad (2.13)$$

where: m - mass CC, unit of measurement;
w - is the angular velocity of the motion.

The radius of the rotational motion velocity of any point in the body decreases from the rotation center of the machine when perpendicular to the vector. Since the BSI does not slide, the velocity of the point is always equal to the theoretical velocity along the rotation plane. As a result, we can write a geometric equation:

$$\tan\gamma_3 = y_{c3}/x_{c3} \quad (2.14)$$

$$\tan\gamma_4 = y_{c4}/x_{c4}, \quad (2.15)$$

For the rear wheel:

$$y_{c1} = 0 \quad (2.16)$$

$$y_{c2} = 0 \quad (2.17)$$

Three equations of kinematical bonding determine the relationship between role management and transmissions of the joints.

The presence of a horizontal differential on the front axle indicates the equality of the moment of rotation for the front drive, when the equality of wheel rays corresponds to the friction force:

$$Ty_3 = Ty_4 \quad (2.18)$$

As the rear wheels play a leading role, they have no gravity:

$$Ty_1 = 0 \quad (2.19)$$

$$Ty_2 = 0 \quad (2.20)$$

(1-3) and (18-19) equations, the following result is given:

$$x_1 = 0 \text{ and } x_2 = 0 \quad (2.21)$$

If the rear wheel has an additional braking, the following formula is used:

$$x_{c1} = 0 \quad (2.22)$$

Conclusion

As a result of calculating the above equations system, we define the unknown coordinates of all the wheels of the wheels (x1, y1, x2, y2, x3, y3, x4, y4) and the rotation environment (x0, y0). We define the basic parameters of the rotation using these data:

1. The power and moments that appear on your contact (Formula 2.1-2.3),
2. The sliding of each wheel

$$\delta_i = x_i/\sqrt{x_{ci}^2 + y_{ci}^2} \quad (2.23)$$

3. Rotational Radius Range:

$$R = \sqrt{(x_0 + B)^2 + (y_0 + L)^2} \quad (2.24)$$

In the stationary revolutions, the curve of TF curve at the moment of the front wheels was detected. As a result of this kind of motion, we increase the steering force in the wheels and the degree of vehicle optimization.

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