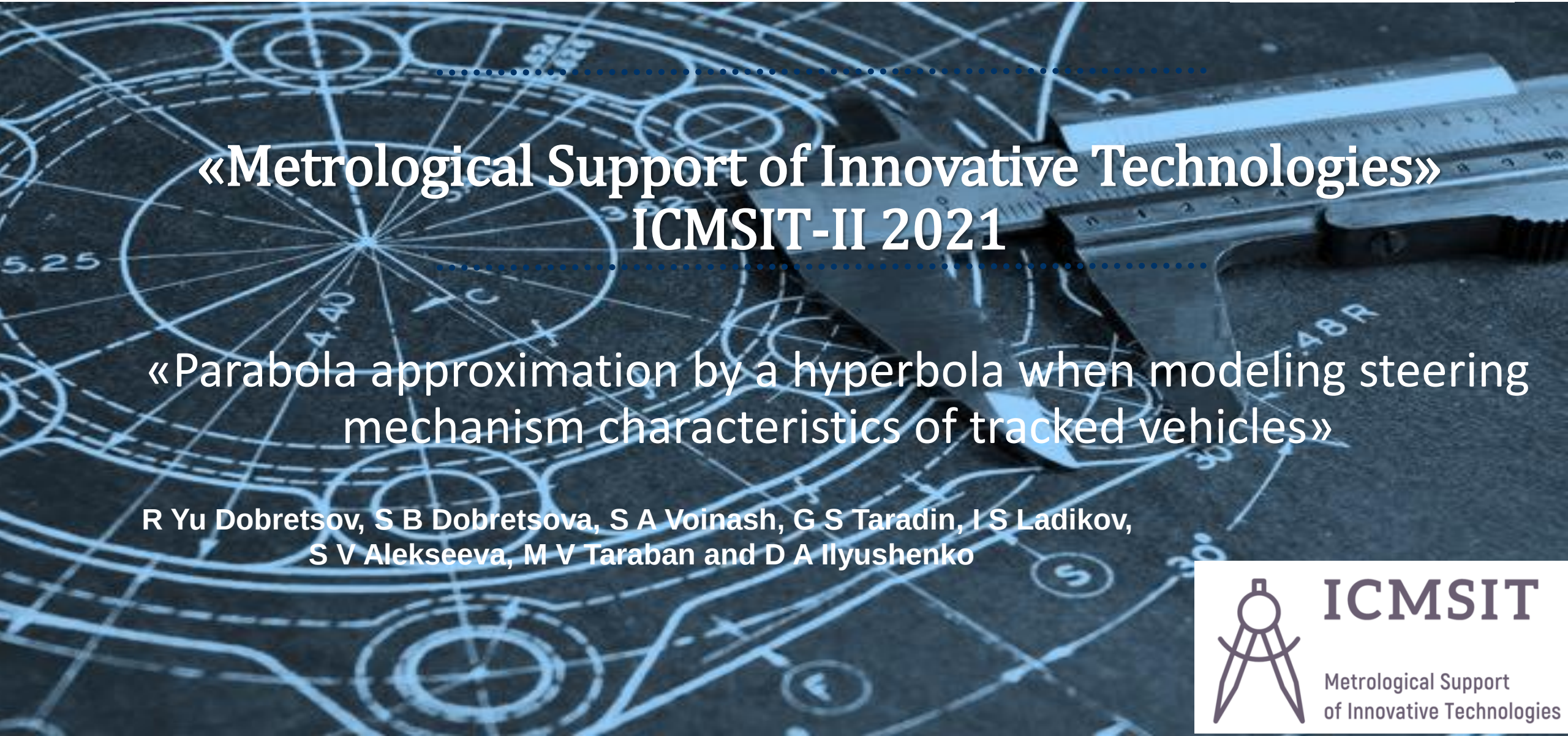
II INTERNATIONAL CONFERENCE
Krasnoyarsk-St Petersburg, RUSSIA
3-6 March 2021

SUAI State University of Aerospace Instrumentation

Science & Technology City Hall



«Metrological Support of Innovative Technologies» ICMSIT-II 2021

«Parabola approximation by a hyperbola when modeling steering mechanism characteristics of tracked vehicles»

R Yu Dobretsov, S B Dobretsova, S A Voinash, G S Taradin, I S Ladikov, S V Alekseeva, M V Taraban and D A Ilyushenko

ICMSIT

Metrological Support of Innovative Technologies

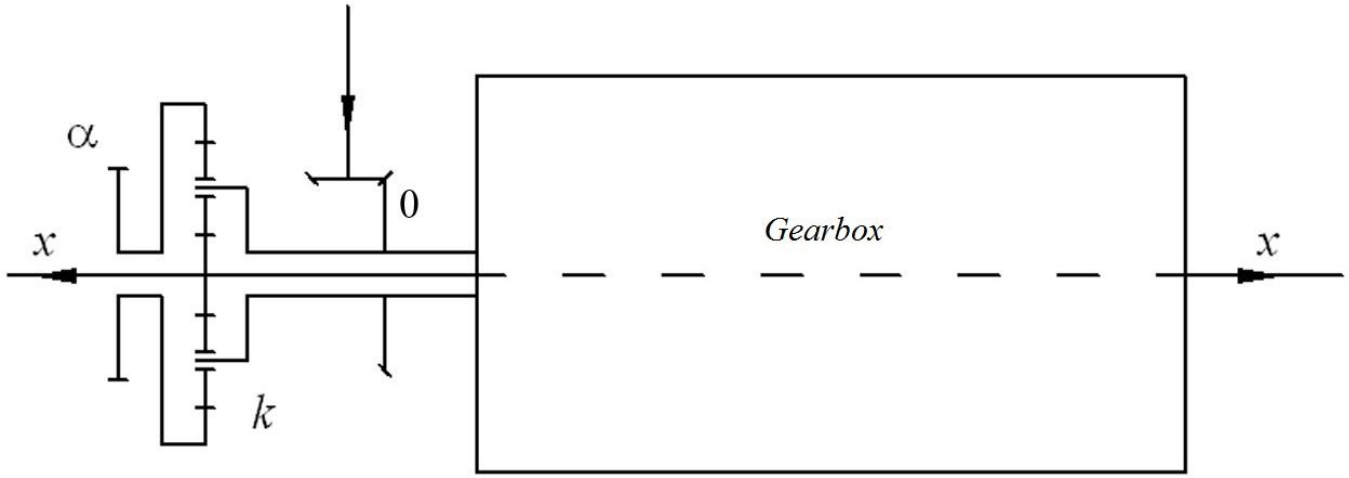
Relevance

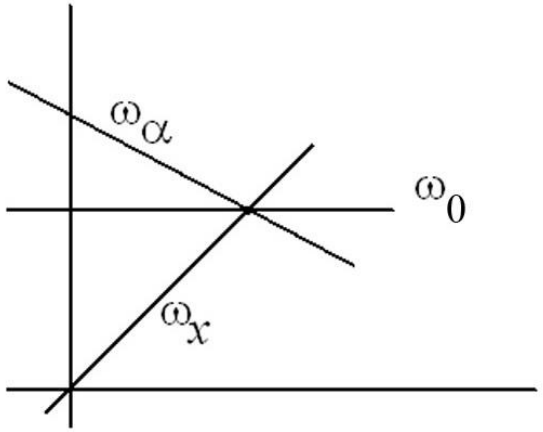
- For transmissions of tracked and wheeled vehicles using the on-board steering control method, there is usually a fact of almost linear dependence of the maximum turning radius of the gears on the speed of movement.
- The consequence is the kinematic limitation of the turning radius. This leads to a decrease in the average speed of movement, underutilization of the traction and dynamic capabilities of the chassis and an increase in driver fatigue. It is preferable to have a quadratic dependence.

- To overcome this disadvantage, you can use a steering device with a nonlinear characteristic in the form of a hyperbola (shown on slide 3). The question of choosing the parameters of the hyperbola that best approximates the parabola becomes relevant.

Relevance

- The scheme of the differential drive of the branches of the steering device and a plan view of angular velocities of differential: 0 – supply of power from the engine; α is the drive parallel branches of the steering device; an x – challenge of power by summing the rows; k is the kinematic parameter planetary gear





ICMSIT
Метрологическое обеспечение инновационных технологий

ICMSIT
Metrological Support of Innovative Technologies

Materials and methods

- The parabola $P(x)=x^2$ on the interval $x\in[a,b]$ is approximated by the hyperbola $f(x)=\bar{b}/(\bar{a}-x)-\bar{d}$, ($\bar{a}>1,\quad \bar{b}>0,\quad \bar{d}>0.$) with the condition that the error of the uniform approximation of the original function is minimal: $\Delta(f)=\max\limits_{[a,b]}\left|P(x)-f(x)\right|$.
- The following expressions are obtained. On the interval $[0,1]$, ($a=0,\quad b=1$):

$$f(x)=\frac{1}{2}\frac{\left(\sqrt{5}+2\right)}{\sqrt{5}+1-2x}-\frac{1}{8}\left(1+2\sqrt{5}\right),\quad \Delta f=\frac{1}{4}\left(\sqrt{5}-2\right).$$

- The minimum approximation error Δf is achieved at four points, two of which are boundary points, and the remaining ones are given by expressions:

$$x_1=\frac{2v-u-\sqrt{u^2-v^2}}{2}=\frac{3-\sqrt{5}}{4},\quad x_2=\frac{2v-u+\sqrt{u^2-v^2}}{2}=\frac{5-\sqrt{5}}{4}.$$

- If the parabola is given with a coefficient $\tilde{P}(x)=kx^2$, a scaling factor is entered: $\tilde{a}=a/\sqrt{k}$, $\tilde{b}=b/\sqrt{k}$.

ICMSIT
Метрологическое обеспечение инновационных технологий

ICMSIT
Metrological Support of Innovative Technologies

Conclusions

Results, implementation

- The proposed expressions can be used in the calculated determination of the parameters of the" hyperbolic " steering device for a tracked vehicle.
- The use of a "hyperbolic" steering device will increase the average speed of tracked vehicles, reduce the destructive impact of the engine on the soils, improve traffic safety and reduce the load on the driver.
- For wheeled vehicles, "hyperbolic" power distribution device will improve the environmental characteristics of the engine and open up additional opportunities in the future for unmanned agricultural tractor.

Contacts

Dobretsov Roman Yu.
Peter the Great St.Petersburg Polytechnic University
E-mail: dobretsov_ryu@spbstu.ru

II INTERNATIONAL CONFERENCE
Krasnoyarsk - St Petersburg, RUSSIA
3-6 March 2021

«Metrological Support of Innovative Technologies»
ICMSIT-II 2021