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LOCATION ESTIMATION OF MOBILE DEVICES

ODHAD POLOHY MOBILNÝCH ZARIADENÍ

Abstract

This contribution describes mathematical model (kinematics) for Mobile Robot carriage. The mathematical model is fully parametric. Model is designed universally for any measures three or four wheeled carriage. The next conditions are: back wheels are driving-wheel, front wheels change angle of Robot turning. Position of the front wheel gives the actual position of the robot. Position of the robot is described by coordinates x, y and by angle of the front wheel α in reference position. Main reason for model implementation is indoor navigation. We need some estimation of robot position especially after turning of the Robot. Next use is for outdoor navigation especially for precising GPS information.

Abstrakt

Príspevok popisuje matematický model (kinematiku) podvozku mobilného robota. Matematický model je plne parametrický a je navrhnutý univerzálne pre ľubovoľné rozmery troj- alebo štvor-kolesového podvozku s prihliadnutím na tieto podmienky: zadné kolesá sú hnacie, predné kolesá menia smer pohybu. Využitie pre navigáciu vo vnútorných priestoroch. Matematický odhad je potrebný hlavne pri otáčaní robota. Ďalšie využitie môže byť aj pri navigácii vo vonkajších priestoroch na spresnenie GPS informácie. Pozícia predných kolies dáva aktuálnu pozíciu robota. Poloha robota je popísaná súradnicami x, y a uhlom predných kolies α.

1 INTRODUCTION

Depicted Application is shown graphical implementation of mathematical model. You can change main measures of robot carriage. According this basic parameter are computed all other values. This contribution represents implementation possibilities simple mathematics based on goniometrical function for graphical estimation of robot position after movement. With this system we were also able to predict next movement or improve precision with combination with other sensors or correct value if sensors fail or generate error value. On the Figure 1 is shown graphical interface and basic scheme for mathematical model.

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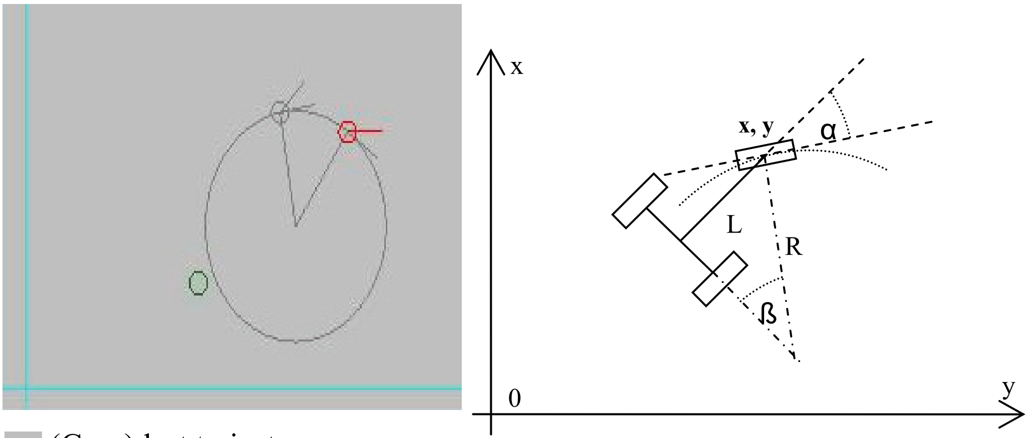

(Gray) last trajectory,
(Red) mobile robot with direction line,
(Green) final point,

Fig. 1 Graphical representation description, Basic scheme of robot

2 LEFT, RIGHT MOVEMENT

When we want turn with robot left or right we must at first compute angle of turning (R). Turning angle(R) depends on actual angle of front wheel (Steer Angle) and distance between front and back wheel axles (L). On the Figure 1 is depicted scheme for computing basic value of R. Next computation is schematically depicted on the Figure 2. Rotation angle γ is value from 0 to 360 Degree for changing device angular position. Steer angle □ decrease or increase turning radius.

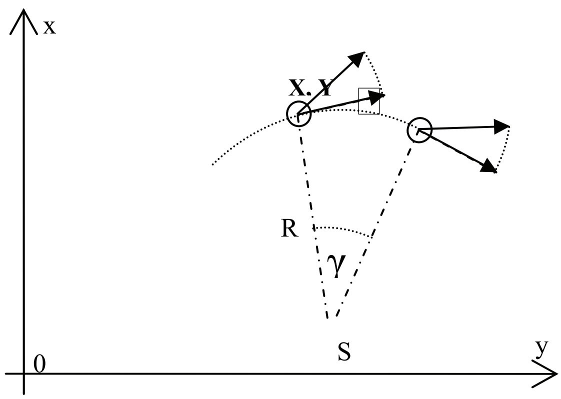

Fig. 2 Left, Right Movement Scheme

On the Figure 3 is depicted graphical interpretation of mathematics model for right turning. There is shown actual robot position, turning circle and its last position.

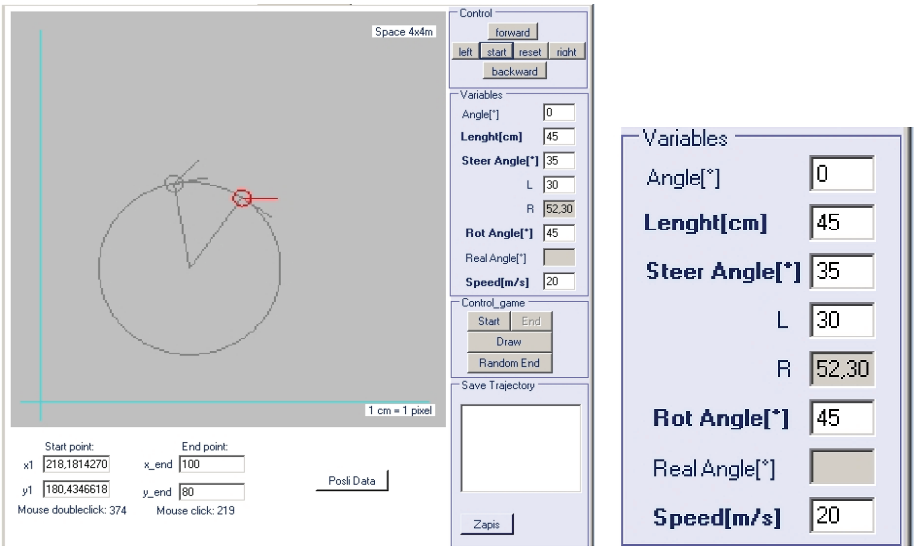

Fig. 3 Left, Right movements

Turning algorithm was divided to five separate groups. That make possible to easy check that partially result values are right. Full algorithm description exceeds permitted size of article.

In the computation we must ignore rearrangement of front and back wheels too. To minimize that effect in real construction, we can use Ackerman Steering theory for front turning wheels or use 3 wheeled carriages instead. For minimalization of rearrangement back wheels we can use differential system.

3 FORWARD, BACKWARD MOVEMENT

Forward and backward movement is very easy to compute from supposed speed and time of real model. Graphical representation of forward movement is depicted on Figure 4.

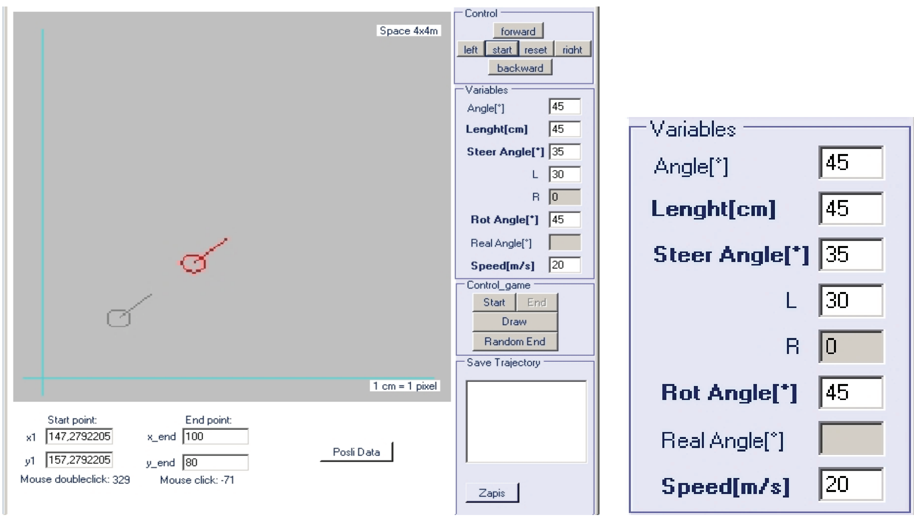

Fig. 4 Forward, Backward movements

3 TESTING PROGRAM

Testing application was used for measuring deviation between mathematical values and real robot trajectory. In testing subprogram we can select 10 steps which real robot realizes: forward, backward left and right movements. We had mobile robot without incremental optical sensor (selected speed value of robot was relative to kind of surface) for testing. Deviation from mathematical model was very increased in rough terrain. For flat surfaces mathematical model is copied robot trajectory in acceptable boundaries. On the Figure 5 is depicted easy programming interface used for testing mathematical model.

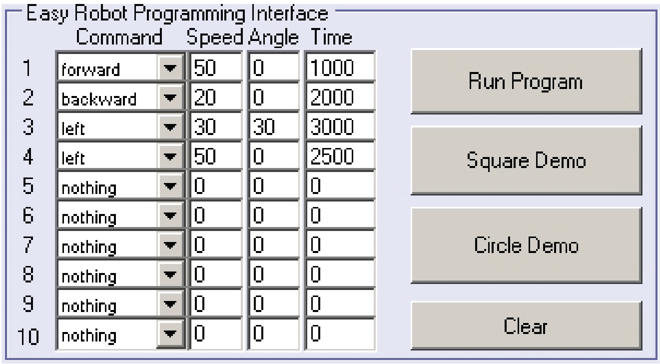

Fig. 5 Testing application

3 NEXT WORKS

Below is depicted next implementation of mathematical model to 3D Environment, which is driven by true vision 6.5 3D Engine. Below on the right is depicted implementation of mathematics model to remote robot control web application. Mathematical model is written as C# object library and it is possible easy transform this library to other application, for example web application based on AJAX technology, Compact Framework based application for porting to Pocket PC with Windows Mobile or Windows CE. Currently we are working to port model under Linux application and combining values from mathematical model with other sensor information for example précising information from GPS sensor.

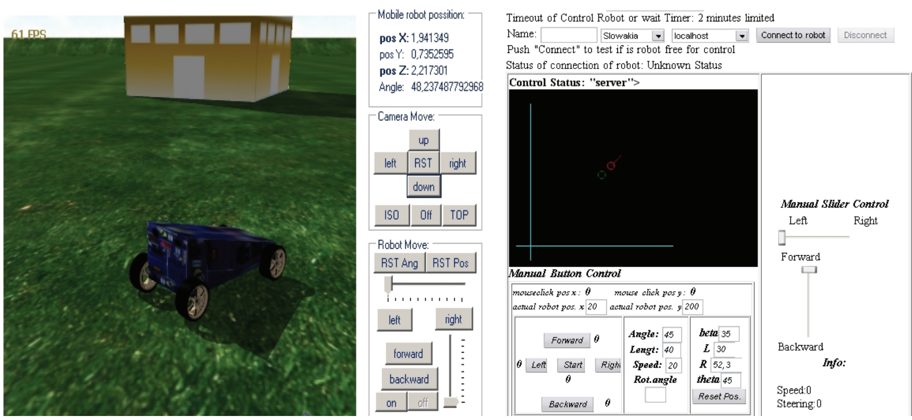

Fig. 6 Math 3D Engine Implementation, Remote Robot Application

3 CONCLUSIONS

Result of this development is graphical implementation of mathematical model. You can change main measures of robot carriage. Model is designed universally for any measures three or four wheeled carriage. The mathematical model is fully parametric. According basic dimension and initial values is automatically computed all other final values. This contribution represents possibilities of implementation simple mathematics based on goniometrical function for graphical estimation of robot position after movement. With this system we were also able to predict next movement or improve precision with combination with other sensors or correct value if sensors fail or generate error value. Model is possible to use in many mobile application for example in Service robotics for indoor or outdoor environments.

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