Simulation of the odometric model for the purpose of the numerical analysis

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***Abstract*—The odometric model is simulated herein. We described the trajectory of such one odometric model, with the delta of the heading angle given as one parameter of the simulation. The iterations show that the trajectory is well in the continuity of the variations of the heading angle. Moreover the distance in X and in Y are shown for the vehicle to be driven in the trajectory of the odometric model.**

***Index Terms*—Odometry; Vehicle location and navigation systems; Mobile positioning systems ; Trajectory; Discretisation of a model.**

I. Introduction

According to the odometric model given first by the article « Odometric navigation with matching of landscape features » [1] and then improved by the article « Trajectory Planning and Tracking for Autonomous Vehicle Based on State Lattice and Model Predictive Control » [2], we assume also that now the odometric model is well done and that the simulation of the model can be correctly done.

II. Odometric model

We will compute here the following equations :
Dx/Dt = v *cos (phi),
Dy/Dt = v *sin(phi),
Dphi/Dt = tan(delta)/l,
Where l is the length of the vehicle.

A. Variation of the heading angle

We have simulated the datas for the variations of the heading angle of one vehicle. With the speed of the vehicle, the variations of the heading angle remains the most important parameter of such a simulation.

B. Distance of travelling

The distance of travelling of the vehicle is also one important parameter of such a simulation, indeed in the Cartesian frame we can access to the datas in X and in Y.

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We want here to thank all the pas members of the automation of the vehicles at Rocquencourt; actually the vehicles are called the Cybercars and are under the development at the Inria of Paris with the project team of RITS.

The affiliation was the IMARA which was one project leaded by Michel Parent at Rocquencourt.

Edern Yves Ollivier was with the Inria of Rocquencourt. He is now at home (e-mail: edern.ollivier@orange.fr).

III. Results for the variations of the heading angle

First, we will deploy the odometric model by simulation under Scilab for plotting the trajectories of one vehicle. We do the incrément of time and of the distance and of the heading angle automatically and that to be shaped by the parametrization of the odometric model.

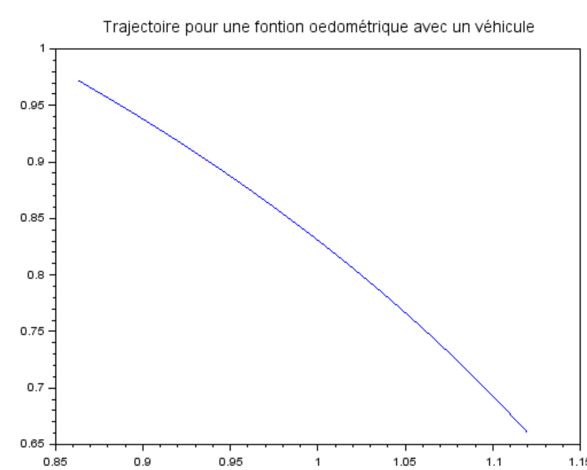

Figure 1 : Simulated datas of one portion of the odometric model in meters (X, Y) for one vehicle

Here we have the results that are improving the understanding of the model which is to be shaped for the oedometric model. Here again, we see that the linéarisation of the model is correctlu done ans that the continuity of the curves are ensured.

We should simulate more deeply in the next weeks for the datas to be presented in the conférence named ICARCV or ICARA. Maybe that IROS is not so much appropriated for such an évaluation of the datas of the odometric model.

```
phi(1,1) = 3.14/6;

// initialisation de l'orientation du v√©hicule



for i=1:20

   for j=1:1

      delta(i,j) = 0.05*i;          // rad

      v(i,j) = 1.3;                 // m/s

      phi(i,j) = phi(1,j) + tan(delta(i,j))/5; // rad

      x(i,j) = v(i,j) *cos(phi(i,j));      // m

      y(i,j) = v(i,j) *sin(phi(i,j));      // m

   end

end

// en r√©ponse au plagiat de l'√©quipe chinoise



plot(x, y)

// graphe de la trajectoire dite oedom√©trique



title("Trajectoire pour une fontion oedom√©trique
avec un v√©hicule", "fontsize", 3)

// Ajout d'une d√©finition du graphe
```

IV. Results for the distance

Secondly, we want to make a guidance with the équations of the automation of the intelligent vehicle, with the linéarisation of the oedometric model and feeded with the commands of the automation.

Figure 2 : Simulation completed with the delta of 0.02 rad

Here we have seen that the simulation is well completed for one vehicle.

```
clear all
// attention aux multiples dérivées qui
s'introduisent dans le DL de rang 2 ou 3

dt = 1;
phi(1,1) = 3.14/4;
delta(1,1) = 0.02;
x(1,1) = 0;
y(1,1) = 0;
v(1,1) = 0;
// initialisation de l'orientation du véhicule

for i=1:2000
for j=1:1
if i > 1
delta(i,j) = /*delta(i-1,j) + */0.02; // rad
end
v(i,j) = 1.3; // m/s
if i > 1
phi(i,j) = phi(i-1,j) + dt *tan(delta(i,j))/5; // rad
```

```
x(i,j) = x(i-1,j) + v(i,j) *dt *cos(phi(i,j));//*1/(5*cos(delta(i,j))^2); // m
y(i,j) = y(i-1,j) + v(i,j) *dt *sin(phi(i,j));//*1/(5*cos(delta(i,j))^2); // m
end
end
end
// en réponse au plagiat de l'équipe chinoise

plot(x, y)
// graphe de la trajectoire dite oedométrique

title("Trajectoire pour une fontion oedométrique avec un véhicule", "fontsize", 3)
// Ajout d'une définition du graphe
```

V. CONCLUSION

As one conclusion, I could say that the odometric model is well known now and that everything is shaped for the commands of a model of automation to be included with the odometric model.

APPENDIX

As we better know the odometric model, here is the view of such a trajectory for it.

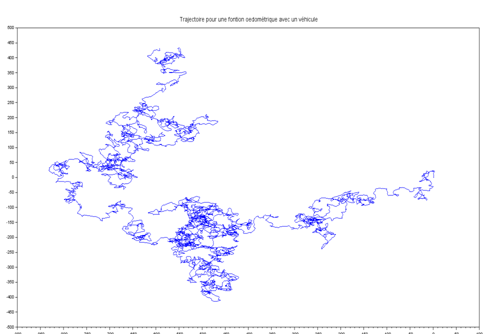

Figure 3 : Simulation of the odometric model completed

ACKNOWLEDGMENT

The computer where the simulation has been provided has got the Scilab suite for the simulation to be executed.

I would like to thank Mister Serge Steer who was an important participant of the development of such a software at the Inria of Rocquencourt.

REFERENCES

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[2] Trajectory)Planning)and)Tracking)for)Autonomous)Vehicl e)Based)on)State)Lattice) and)Model)Predictive)Control,)IEEE)Intelligent)Transporta tion)Systems) Magazine (Volume:)11 , Issue:)2 ,)Summer)2019) ;

Edern Ollivier was born in Paris XI, Paris, France in 1977. He received M.S. degrees in automation from the ENSMM, Besançon, in 2001 and the M.S. degrees in computer engineering from the FH of Karlsruhe, Karlsruhe, Germany, in 2001.

From 2001 to 2004, he was an Expert Engineer with the Inria of Rocquencourt. His research interests include the developpment of the Cybercars, SLAM and EKF.