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Parallel Processing Concept Based Road Traffic Model

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Abstract

In this paper, we propose a modified version of road traffic model based on parallel processing concept for single lane traffic simulation and the parallel processing concept based on cellular automata. In this road traffic model the road are divided into cells that can be either occupied by a vehicle or empty. The vehicle movement based on cellular automata rules. The parallel processing based road traffic model is very simple and regular massive parallel model which is able to make a real time computation.

Keywords: Road Traffic Model, CA,Cell,Real Time Computation.

1. Introduction

The developing IT world, everything is so improving time by time. Transportation is very important for every country. Advances in transport technology have brought benefits, but growing vehicle fleets and escalating furl use have also created problems. If transportation is clear, traffic jam and air pollution will be less. Moreover, by controlling car traffic, car accidents case will be reduced in every country. Traffic congestion is one of the main roles in every country. A relatively new research area called Intelligent Transportation System (ITS) which is basically concerned with the application of information and communication technologies (ICT) to the planning and operation of transportation system.

The concept of Cellular Automata(CA)[1,11] based traffic models have been used to study many traffic phenomena[1,2,3,4,5,6,7,8,9].Among these one CA model is rule 184 CA(R184) model based on elementary CA proposed by Wolfram[2]. Using CA for traffic simulation was conducted Nagel and Schreckenberg[3].Nagel and Schreckenberg(NS model) developed a simple stochastic CA model to single lane highway traffic. Another CA model developed by Benjamin, Johnson, and Hui(BJH model)[4] is similar to the NS model with a slow-to-start rule. The main advantages of parallel processing concept are efficient and fast performance when used in computer simulation. In the recent years, due to the

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parallel processing concept, parallel computation algorithm and flexible design model is more successful in road traffic network. The road traffic model based on parallel processing concept has been utilized to study many traffic models.

In 1983, S. Wolfram's[2] proposed first one dimensional Cellular Automata model with binary state. Here rule 184 is used for traffic flow so, it is called Wolfram's rule 184.For the CA-184 model[2] , we have the two rules. In **1992**, NS model[3] based on 4 rules in the CA. In **1996,** another model developed by Benjamin, Johnson, and Hui (BJH model) [4] is similar to the NS model, but with 'slow-to-start' rule. The slow-to-start rule allows a stopped vehicle to move again with this slow-to-start probability 1-ps. If the vehicle didn't move, then it tries to move again but this time with the probability ps. In 1996 , Fukui and Ishibashi[5] constructed a generalization of prototypical CA-184 CA model. This model has two different categories: 1). Stochastic Fukui--Ishibashi 2). Deterministic Fukui—Ishibashi. The New Time Oriented Cellular Automata (TOCA) model[6] is based on the threshold of changing speed is equal to the minimum time headway t. Thus the time headway between two vehicle can never be smaller than the threshold of changing speed. A modified cellular automata model for traffic flow was proposed by GE Hong xia, DONG Li-yun , LEI Li and DAI Si-qiang (2003)[7].In this model a changeable security gap is introduced. This model is modification version of NS model. In **2004,** M. Namekawa, F. Ueda, Y.Hioki, Y. Ueda and A.Satoh[8] proposed the model that is improving a NS model. They Show the speed and cells relationship in Table 1. In 2009, Clarridge and Salomaa[9] proposed a Modified version of **BJH model.**In this model, the cars' velocities are adjusted at each time step according to the following rules. Recall that d is the distance to the next car, v is the velocity of the current car, vnext is the velocity of the next car, pslow is the probability that the slow-to-start rule is applied, and pfault is the probability that the car lows down randomly.

2. Cellular Automata

A Cellular Automaton (CA) [5] is a decentralized computing model providing an excellent platform for performing complex computation with the help of only local information. Researchers, scientists and practitioners from different fields have exploited the CA paradigm of local information, decentralized control and universal computation for modelling different applications.

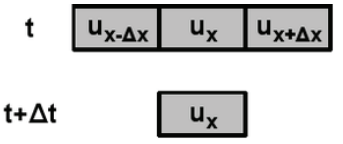

Figure 1. One dimentional Cellular Automata

The basic one-dimensional Cellular Automata (shown in Figure 1) model for highway traffic flow is based on the Cellular Automata rules. The highway is divided into number of cells. Each cell can either be empty or occupied by one car. If cell occupied by car then it is denoted by 1 or otherwise 0.All cars have the same length of cell.

3. Proposed Road Traffic Model Based on Cellular Automata

Proposed model on Cellular Automata , the road is divide into number of cells each cell occupied by a car and each cell assign by a speed. One car with two different speed shown in Table 1.

Table 1: One car with two different speed (S1=1, S2=2)

Speed/ Time	1	1	1	2	2	1	2	1	1	1	1
T=0		c									
T=1			c								
T=2				c							
T=3							c				
T=4									c		
T=5										c	
T=6											c

If we consider the speed of car then the modified CA rule is:

$\mathbf{a_{i-1+sp}(t+1)= a_{i-1}(t).a_i(t)^{/}.a_{i+1}(t)^{/}}$

sp means speed of a car.

Table 2: Rule updating table:

111	110	101	100	011	010	001	000
0	0	0	1	0	0	0	0

Two cars with two different speed shown in Table 3.

Table3: Two cars with two different speeds (S1=1,S2=2)

Speed/ Time	**1**	**2**	**1**	**2**	**2**	**1**	**1**	**2**	**1**	**1**	**2**
T=0		**c**	**c**								
T=1											
T=2											
T=3											
T=4											
T=5											
T=6											

For two car with multiple Speed Sign. Applying the rule 64.

Rule 64: $a_{i-1+sp}(t+1)= a_{i-1}(t).a_i(t).a_{i+1}(t)^{/}$

i is space , t is Instance of time and sp speed of the car.

Accident will occur at the instance of time T=1.

If we consider two cars and the cars follow the speed signs then accident may occur.

Table 4: Rule updating table:

111	110	101	100	011	010	001	000
0	1	0	0	0	0	0	0

Algorithm for Traffic Flow Based on CA Rule

Step1 : Based on Cellular Automata rule

1) for single car with Multiple Speed sign. Applying the Rule 16.

Rule 16: $a_{i-1+sp}(t+1)= a_{i-1}(t).a_i(t)^{/}.a_{i+1}(t)^{/}$

i is space , t is Instance of time and sp speed of the car.

2) for two car with multiple Speed Sign. Applying the rule 64.

Rule 64: $a_{i-1+sp}(t+1)= a_{i-1}(t).a_i(t).a_{i+1}(t)^{/}$

i is space , t is Instance of time and sp speed of the car.

Step 2: If we consider two cars and the cars follow the speed signs then accident may occur. Condition for accident :-

If (car1(speed) >car2 (speed)) then

Accident may occur.

Else

No Accident occur .

Step3: If we consider two cars and the cars follow the speed signs then accident may occur then we follow the following conditions for avoid the accident:

i) If car1 with speed 2 then change the speed for car1 . Vnew= Vold*1/2

ii) If car2 with speed 1 then change the speed for car2 . Vnew= 2*Vold.

Step 4: Present position of car based on the rule.

4 . Experiments

Our proposed JAVA applet simulates traffic flow based on CA rules. The CA rules are specify as follows (1) The freeway is modelled as a sequence of grid points or cells. (2) Every car occupies one grid point or cell.(3)A car can have a speed of 0 - Vmax grid points per time interval. (4) A car with speed of less than Vmax increases its speed by one unit in each time interval, until it reaches the maximum speed. (5)If a car's distance to the car in front is d grid points, its speed is reduced to d-1 or change the speed if necessary to avoids collisions into it. (6) With a certain probability, in each time interval some cars slow down one unit for no good reason whatsoever. (7) Each colour represents different speed (Red for Speed =0, Blue for Speed=1, Orange for Speed=2, Cyan for Speed=3, Green for Speed=4, Yellow for Speed=5) , if a grid point is empty, it's colour is the default background colour.

In Figure 2 , we show the traffic flow simulation result of Cay Horstmann Model[10] based on Space and Time. In Figure 3 , we show the traffic flow simulation result of Proposed Model based on Space and Time.

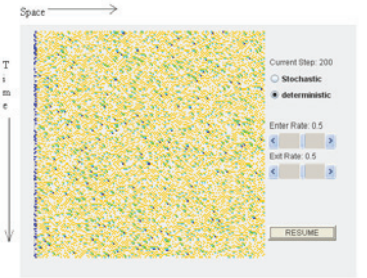

Figure 2: Simulation Result of Cay Horstmann model after 200 Steps.

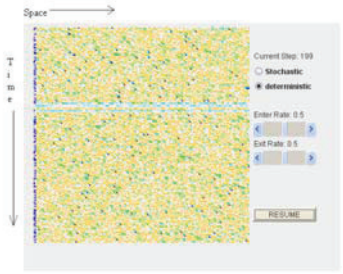

Figure 3: Simulation result of proposed model after 199 steps.

5. Conclusion

This paper presents a road traffic flow problem based on cellular automata theory as cellular automata achieves highly parallelism.Cellular Automata rules can be updated in parallel for any vehicle. CA can be implemented very efficiently and CA based model is suited to simulating large road network.In this paper ,we are trying to solve the road traffic problem with respect to the increase of the vehicles travelling and reduce the number of accident based on cellular automata simple rules. With the above knowledge and proposed model can be taken in planning and controlling the Traffic Flow problem.

6. Future Work

Future we need to incorporate lane changing rules into the applet and Intersection problem using applet.

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