Research on Muti-Agent Simulation and Emulation in battlefield Based on NETLOGO

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***Abstract*—Netlogo is a simulation tool based on Complex Adapt System, now it is used for lots of areas. This thesis uses the modeling thought from bottom to top, and discusses several key techniques based on Netlogo, then points out the real meaning for the army operation simulation, hopes to research a new idea for Muti-Agent modeling of battlefield.[1]**

Keywords- Netlogo; Muti-Agent;Simulation

I. INTRODUCTION

As the development of the technology, it is possible to use network of information and computers to create troops which can make up the complex emulational system to demonstrate training of command and constituting of campaign scheme, it is also very important to do research on joint operation theories of army， navy， air force and stratagem artillery and training method and technique support. This thesis search a new simulation tool to research the method of command and control and deployment of military force and structure of network, as the wish to exploit a simple emulational system to explore characteristic and disciplinarian of military active.

NetLogo is a programmable modeling environment of Agent-Based Modeling for simulating natural and social phenomena, it is also a useful tool for research Complex system. It was authored Uri Wilensky in 1999, and continued to develop by Center for Connected Learning and Computer-Based Modeling, Northwestern University in America. Netlogo is the next-generated language of Muti-Agent modeling, it adds some new characteristic, and redesign language and user interface based on Starlogo. Netlogo was made by the java language, so it can run at all of main operating system (such as Mac,Windows,Linux and so on), the model can run at browser as java applets as well.

NetLogo can also offer a classroom participatory-simulation tool called HubNet， Through the use of networked computers or handheld devices , each user can control a number of agents in a simulation to achieve the purpose of distributing simulate. NetLogo is particularly well suited for modeling complex systems developing over time, the dummy world of this model is made of agents, these agents can accept the order to move, all of these agents act at same time, there are three kinds of agents including moving agent， static agent and observational agent. Moving agents mostly simulate actor who do the thing, static agents mostly simulate the background, and the observational agents observe the world which is made of moving and static agents, they also execute the order to catch the estate of whole or partial world, they can control the world even. The agents in the models can run independently, we can increase the number of agents to the model at will so far as the lever of hardware can meet the need, the characteristic of the agents is very active, researchers can define the agent as they need. The alternant rules of the agents are defined by the researcher as practice. The researcher can give the order to thousands of independent agents, so it is possible to research the relation of microcosmic agent and the macroscopical system.

Netlogo is a simulate software that can combine the complex adaptive System theoretics, the idea of object oriented and the technology of distribute artificial intelligence. We can use the powerful function of Netlogo to simulate the model which abstract from the battlefield, then observe the estate and the trend of running process, so this course can give advice to the commander who make the decision. This thesis discusses the method and technique which can describe the action in the battlefield , now the newest 4.1 edition of Netlogo is issued in 2009.7, the simulate technique in this thesis is basis on this edition.

II. THE SIMULATION AND REALIZATION OF BATTLEFIELD BASED ON NETLOGO

The model include view-part and procedure, these two part contact seriously, we can establish the view-part in interface, then make the functional code in procedure, we can combine this two parts by setting the characteristic.

There are three parts in interface:

Running controller: initialization, running, pause, stop;

Parameter controller: switch, scroll bars, selector, input of the parameter;

Simulate vision: monitor, drawing board, annotation;

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There are two parts in procedure: Command and Reporter

There are apperceive models, reactive models, study models, the stock of behavior rule，communicate models and so on in the agent models, the behavior method include the method called “stimulation- reaction” and the adapt study mechanism basis on the intensify study theoretics.

A. The design of battlefield environment

The battlefield is the external environment of war except the persons and weapons. The battlefield environment also can measure off geography environment， weather environment， electromagnetism environment and nuclear environment by the external factor. Network environment is also an important part of battlefield environment as long as the development of information network war. This experimental model uses 2D plane angle of view, centre of the map is on the coordinate (0,0) , the ground floor is made of square tile of the same standard, tiles are static agents in netlogo, every tile has its own characteristic, we can set the characteristic of tiles to realize the true landform, the tiles are used like the point of picture. The size of this model is 243*161, every tile is 1*1 in square, it means whole battlefield is made of 39123 tiles. It comes to realize by adjust the size of tiles to control the proportionment of the size of real battlefield and model battlefield.

B. The action of agent and setup of its characteristic[3]

The action of agent in the simulate system is set like figure 1, they represent different forces in the real battle. A single agent has many characteristic parameter, it represent different forces by setup of characteristic parameter.

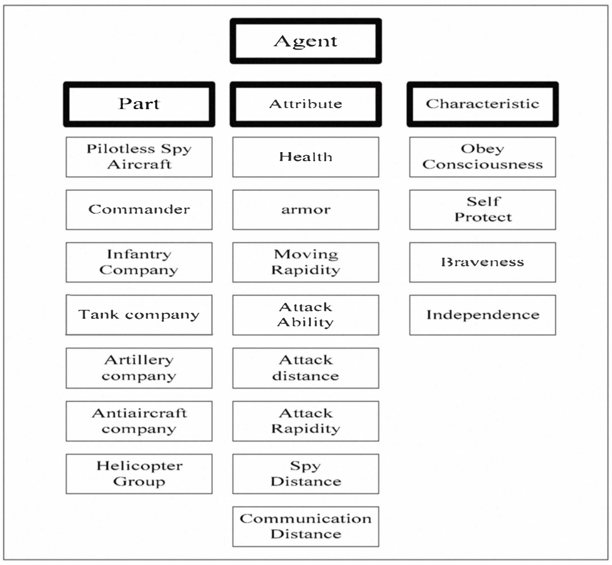

Figure 1. The Attribute and Characteristic of Agent

We analyze the fight to decision-making level and action level basis on different mission, so the agent can be describe as command agent，spy agent，attack agent and target agent, like figure 2 below.

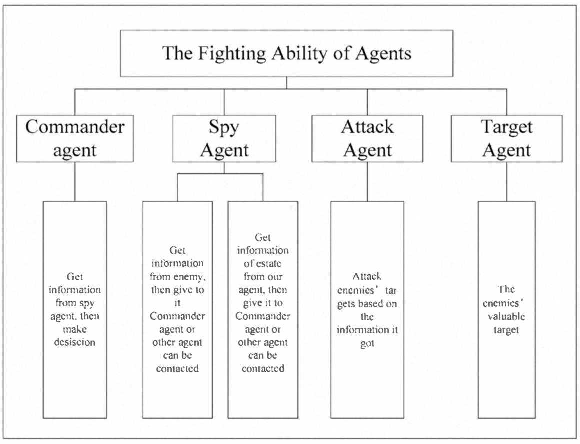
The Fighting Ability of Agents
Commander agent
Spy Agent
Attack Agent
Target Agent
Get information from spy agent, then make desiscion
Get information from enemy, then give to it Commander agent or other agent can be contacted
Get information of estate from our agent, then give it to Commander agent or other agent can be contacted
Attack enemies' tar gets based on the information it got
The enemies' valuable target

Figure 2. Graph of ability analyses of our and enemiers’ agent

Command agent is the command cell, its characteristic is faster speed of moving， longer distance of communication，more powerful ability of decision-making, but it can’t attack others, command agent also can control the moving mode，the location and the attack method of the action agent, they are the controller in the battlefield. Spy agent is information supporter in the model, but they don’t attack the enemy agent face to face currently. Attack agent is the action cell in this simulate system, its characteristic is shorter distance of reconnaissance and weak ability of sense, but they are the actors of attack, they find the enemy and fire by their reconnaissance and the order of commander. Target agent is the value cell of enemy, including of attack agent， spy agent and command agent of enemy, the parameter is set below in the program.

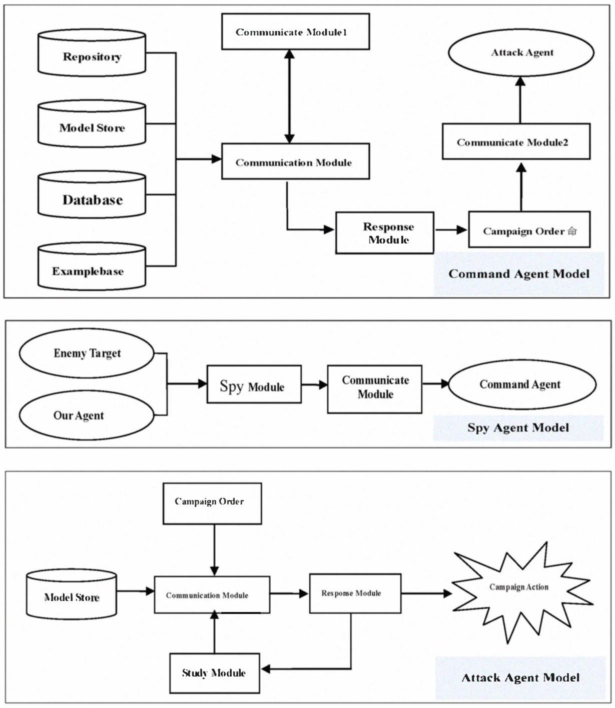

Figure 3. Kinds of agents

Every moving agent has these attributes. Bases on different kinds of agent, at initialization of process, we set relevant value to every attribute variable. At this time, the value of this variable expresses the individuality of every agent. So the rationality of the value of the agent is the index to scale whether the model is distorted or not.

C. The Design and Realization of Agent Rule

The rules of agents are the core of model, the macroscopical result comes true only if the microcosmic agent can be described clearly. After finding the target in process, the agent estimate if the enemy are in the ascendant first, if the answer is yes, the agent begin to defend, then execute the series of rules of defence, if the answer is no, the agent begin to attack(if our agent can't attack, it begin to reconnoitre) , then execute the right rules. After that, the model starts to circle this process, the agent as well, until the model finish the process or the agent die.

1) The moving rule

The moving rule sets that the blue agent defends at the beginning of model's process when the red agent attacks, the direction of attacking is confirmed at the beginning, we give different values to the flexibility characteristic of different agents basis on practical ability, if there isn't blue target or the information of reconnaissance or the order of commander, the agent move based on its direction in the beginning and step of model, every step is(((flexibility / 100) + random-float (flexibility / 100)) / 4) tiles long. The whole battlefield is divided to thousands of titles, the moving agent estimates the distance by comparing the number of titles.

In the model, the moving condition is the estimate sentence that "if condition [commands] or if else reporter [commands1] [commands2]， the program is set below.

```
    to march;;  the moving action
    jump 1 ; ;    the agent moving a tile distance along
with the direction.
    end
```

2) Evadable rule

The evadable rule of the agent is also estimate by the sentence "if condition [commands] or if else reporter [commands1] [commands2]". First the agent must estimate if there is more threatening targets towards us, if the answer is yes ,the agent evades, if the answer is no, the agent must estimate what kind of target it is, if the target is like itself, then estimate the number, if the number of us is in the ascendant, then attack, if not ,then evade. Otherwise if the blue target is what we must attack first ,then attack， the program is set below.

```
    to evade ; ;     the evadable rule
    rt 180 + plus-or-minus 90 march ; ;      turn left or
right 90 degree basis on the direction.
    end
    to-report  plus-or-minus [ #angle ]
    report #angle - random-float ( 2 * #angle )
    end ; ;
```

3) Alternate rule

The alternate rule is used for the attack agent, when the attack agents shoot enemies, this alternate action will be used. Attacking by different agent will use different rule, this model design three kinds of rules: ground to ground, air to ground, ground to air. The program is below:

```
    to attack-enemy [ enemy ]; ;   attack acton
    if else [my random luck] > [enemy random
luck ]; ;  compare the luck random value of us and
enemy
    [set health heath - *** ; ;    decrease of our health
    set luck luck * .99; ;  decrease of our luck value
    ask enemy [ set luck luck * 1.01 ] ]; ; ascend of
enemies' luck value
     [ ask enemy
    [ set health health -  ***; ; decrease of enemies'
health
    set luck luck * .99]; ; decrease of enemies' luck
value
    set luck luck * 1.01; ; ascend of our luck value ]
     rt 90; ;  the agent turn right 90 degree
    end;;
```

4) Reconnoiter rule

The reconnoiter rule mostly use for spy agent, its spy action mainly estimate the threaten towards to the reconnaissance, if the threaten isn't urgency, the agent continue to reconnoiter in the battlefield, if the threaten is urgency ,the spy agent should leave away, the program is set below:

```
    to reconnoiter ; ;    reconnoiter action
    set    heading  goal-head  +  plus-or-minus  45
march  ; ;  turn left or right 45 degree basis on the
direction.
    end; ;
```

D. The modeling and realization of adaptive learning mechanism for behavior based on reinforcement learning

Reinforcement learning is a kind of tactic learning in artificial intelligence, is a method that have ability of adapting dynamic environment and use the environment feedback as input, it also called encouraged learning or estimated learning which develop from the theoretics of animal learning, self adapted controlling. As the reinforcement learning describes, the characteristic of the agent in this model add a intelligent parameter called luck that is understand as experience of battlefield, the value of luck is set 1, after every fight of us and enemy , the value of luck will be changed as feedback . The program is set below.

```
    to attack-enemy [ enemy ]
    ifelse random-float luck <= [ random-float luck]
of enemy
       [ set health health  - ***
         set luck luck * .99
         ask enemy [ set luck luck * 1.01 ]  ]
       [ ask enemy [ set health health - ***
    set luck luck * .99 ]
         set luck luck * 1.01    ]
      end
```

After every fight of us and enemy , there will be a estimation of random shoot. The large the luck of us is, the probability that we shoot on the enemy, and vice versa. If we shoot enemy first , the luck of us *1.01, the luck of the enemy *0.99. so the battle experience of agent can see through this method.

E. the design and realization of select module of the agent

The select function of agent is main function in this experiment, through this function the researcher can adjust organizing of troops. The realization of select function of agent need that all the agents is not beginning to run, in this model we use two button to realize this function , go1:the function of organizing of troops, go2: the function of running of agents. The program is set below.

```
     to go1; ;
      if greeting? = true [ clear-greeting ]; ;
      if mouse-down? ; ;
     [let candidate min-one-of turtles [distancexy mouse-
xcor mouse-ycor]; ;
      if [distancexy mouse-xcor mouse-ycor] of candidate
< 1 ; ;
     [ watch candidate ; ;
          while [mouse-down?] ; ;
     [ display
     ask subject [ setxy mouse-xcor mouse-ycor ]  ]; ;
     reset-perspective ]]
       End; ;
      ;;Agent
      to go2
     if greeting? = true [ clear-greeting ]
```

III. DATA COLLECTION AND MODEL RUNNING

A. Initialization of Model

After the rules of the model are established, we can simulate the campaign in this environment, we can see the model vision like figure 3 below: there is force setting button on the top left corner, there is data collection button on the bottom left corner and there is window of model process on the top right corner.

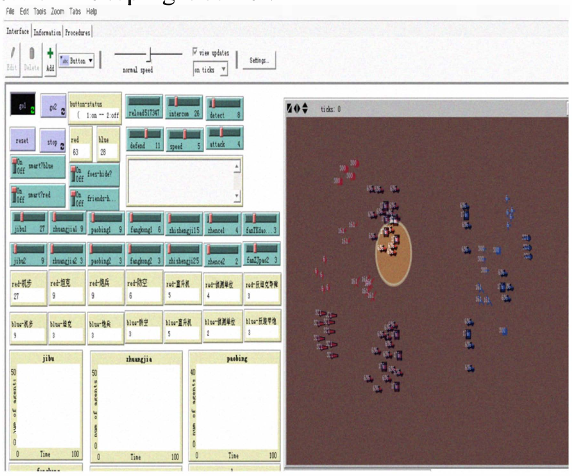
File Edit Tools Zoom Tabs Help
Interface Information Procedures
Settings...
reset
stop
red
blue
jibu
changjia
paobing
Time
ticks: 0

Figure 4.   The Window of Running Program

B. The data collection of model

There are expert data collections in Netlogo, we can watch the change of number of agents by writing some programs. The model has seven window to register the change of kinds of forces, through this graph, we can see different change of forces of us and enemy in different moment.

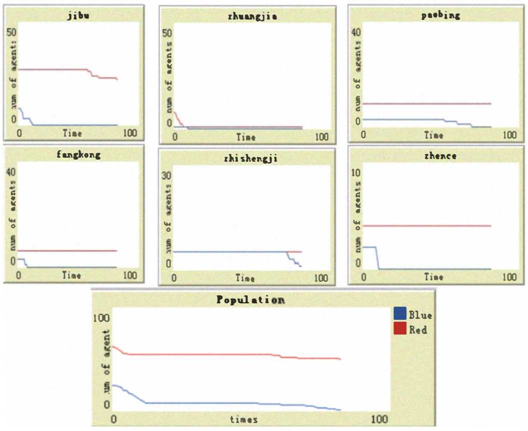

Figure 5. Data Collection of the experiment

IV. CONCLUSION

Nowadays, there is few simulate tools in our army to research the complexness in the battlefield, this thesis attempts to use Netlogo to simulate fighting in the battlefield, its simple program language, intuitionistic operate environment, abundant model store and the characteristic that can be operated distributingly in long distance are very valuable and useful for our army to research the deraign, building of network, analyzing of operation efficiency.

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