Mobile Robot Based Online Chinese Chess game

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Abstract

We present the game tree search techniques based on Chinese chess game, and use mobile robots to present the scenario. We design a mobile robot to be applied in many fields, such as entertainment, education and security. The mobile robot has the shape of cylinder and its diameter, height and weight is 8cm, 15cm and 1.5kg. The power of the mobile robot is three Li batteries, and connects with parallel arrangement. It has three IR sensors to detect obstacle. The controller of the mobile robot is MCS-51 chip, and can acquire the detection signal from sensors through I/O pins, and receives the command from the supervised computer and the remote controller via wireless RF interface. The controller of the mobile robot can transmits the detection result to the supervised computer via wireless RF interface. The mobile robot can speak Chinese language using voice driver module. We develop the user interface of mobile robots according to the basic rules of Chinese chess game, and program the motion trajectories for the mobile robot to play the Chinese chess game. In the experimental results, mobile robots can receive the command from the supervised computer, and move the next position according to the attribute of the chess piece.

Keywords: *Chinese chess, smart robot, MCS-5 chip, wireless RF interface, motion planning algorithm*

1. Introduction

Chinese chess [1] game is one of the most popular games. A two-player game with a complexity level is similar to Western chess. In the recent, the Chinese chess game has gradually attracted many researches's attention. The most researchers of the fields is belong to expert knowledge and artificial intelligent. There are many evolutionary algorithms to be proposed. Darwen and Yao proposed the co-evolutionary algorithm to solve problems where an object measure to guide the search process is extremely difficult to device [2]. Yong proposed multiagent systems to share the rewards and penalties of successes and failures [3]. Almost all the chess game can be described by game tree. Game tree presents the possible movements and lists all situations for the chess. In the paper, we want to use the game tree to program the motion trajectories of the Chinese chess piece, and use the multi-robot to present the scenario of the movement for the Chinese chess game.

Many researchers have been studying the problem of multi-robot task allocation for some time. In general, the task allocation problem divides a task into many subtasks, and assigns some robots to each subtask. Gerkey addresses the multiple robot –multiple task problem (MR-MT) [4] where the object is to assign a robot team to multiple task. So that the systems' efficiency is maximize. This problem is also called the coalition formation. Gerkey and Mataric [5] indicate that despite the existence of various multi-agent coalition algorithms. These algorithms have not been demonstrated in the multi-robot domain. Vig and Julie show that, with certain modifications, coalition formation algorithms provided in the multi-agent domain can be applied to the multi-robot domain [6]. Chen and Li have been proposed a power-efficient path planning protocol named collaborative path planning algorithm (CPPA) for a multi-robot system without global positioning system (GPS) [7].

The paper is organized as follows: Section II describes the system structure of the multiple robot based Chinese chess game system. Section III presents the function of the mobile robot. Section IV explains the evaluation method of the Chinese chess game using multiple mobile robots, and the experimental results are implemented in section V. Section VI presents brief concluding comments.

2. System Architecture

The system architecture of the multiple robot based Chinese chess game system is shown in Fig 1. The system contains a supervised computer, a monitor, a wireless RF interface and thirty-two mobile robots. Mobile robots are classified red side and black side.

The supervised computer can receive the status of the mobile robot via wireless RF interface. They contain the orientation and displacement of mobile robots. Each robot is arranged an ID code. Users move the chess piece on the monitor. The supervised computer can transmits the ID code to the mobile robot, and transmits the orientation and position command to the mobile robot. The mobile robot can move the next position according to the command from the supervised computer.

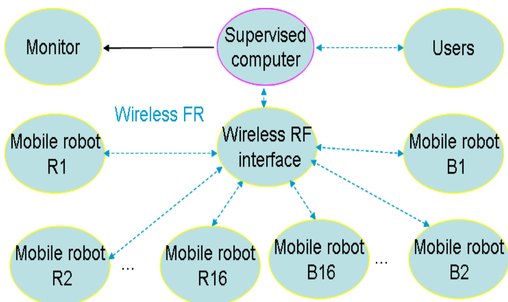
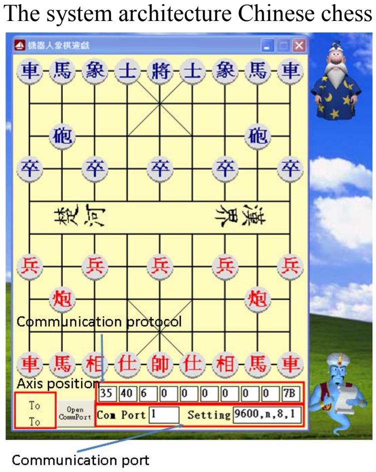
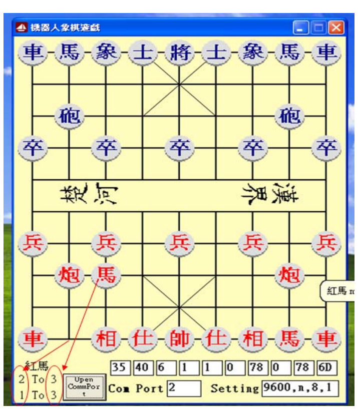


Fig. 1 The system architecture Chinese chess system



(a) The board state



(b) Move the chess piece “red horse”

Fig. 2 The user interface of the Chinese chess game

The user interface of the multiple robot based Chinese chess game system is shown in Fig. 2(a). There are two regions in the supervised interface. The chess board state of the Chinese chess is the main monitor of the user interface. The user can move the chess piece using the mouse according to the rules of the Chinese chess game. Mobile robots receive the status from the supervised computer via wireless RF interface. There are two sides of the system. One is the red side; the other is black side. Each side has sixteen chess pieces. There are one “king” chess piece, two “advisor” chess pieces, two “elephant” chess pieces, two “horse” chess pieces, two “rook” chess pieces, two “cannon” chess pieces and five “pawn” chess pieces. It can displays “communication port”, “communication protocol” and “axis position” on the bottom of the interface.

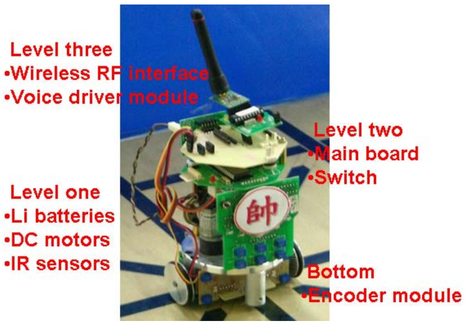
In the axis position function, we make two experimental results to explain the Chinese chess game interface. We can move the “red horse” from the position (2,1) to the next position (3,3) using the mouse. The supervised computer control “red horse” mobile robot move to the next position (3,3) via wireless RF interface. The scenario of the interface is shown in Fig. 2 (b). The bottom of the interface can display the original position (2,1) and the next position (3,3), and communication port is 2, and setting is 9600(Baud rate).

3. Mobile robots

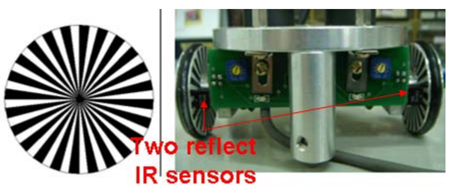
The mobile robot has the shape of cylinder, and it’s equipped with a microchip (MCS-51) as the main controller, two DC motors, some sensor circuits, a voice driver module, a encoder module, and a wireless RF interface. Meanwhile, the mobile robot has four wheels to provide the capability of autonomous mobility, and is shown in Fig. 3.

The structure of the mobile robot is shown in Fig. 3. It has four levels in the smart robot. The shape of each level is circle. Each level is embedded some circuits. The power of the slave robot is three Li batteries to be embedded in level one, and connects with parallel arrangement. The level has three obstacle avoidance circuits using IR sensors, and contains two DC motors to drive the mobile robot.

The level two of the mobile robot has main board. The controller of the mobile robot can acquires the detection signal from sensors through I/O pins, and receives the wireless RF signal via wireless RF interface. The controller of the mobile robot can transmits the detection results to the supervised computer via wireless RF interface. The switch input can turn on the power of the mobile robot, and selects power input to be Li batteries or adapter. The level three is wireless RF interface and voice driver module. The bottom of the mobile robot is encoder module. The module can calculate the moving distance for the mobile robot. We use two reflect IR sensors to calculate the pulse signals from the two wheels of the mobile robot.



(a) Prototype of the mobile robot



(b) Encoder module

Fig. 3 The structure of the mobile robot

4. Evaluation method

The basic rules of the Chinese chess are found easily on the Internet. Before we want to control the multiple mobile robots based chess. A Chinese chess engine needs to be designed and tested to ensure that all chess piece movements and game rules are strictly adhered. We proposed the engine to be a simple program implementing basic rules of the games. The boardstate, denoted a axis position (x, y) from (0,0) to (8,9).

The definition of the boardstate is shown in Fig. 4. Then we define the initial position all chess pieces to be shown in Fig. 5. Such as the position of “red king” is (4,0), and “black king” is (4,9)…etc. We plot the possible motion trajectory for the chess piece on the boardstate. Then we define the game tree, and move the chess piece to the possible position. Such as the chess piece “red horse” can move to the position (0,2) or (2,2). But the chess piece can’t move to the position (3,1) according to the rules of the Chinese chess game.

We can define the rules of the chess piece. The initial position of the chess piece is (x, y), and defines the movement rules of some chess pieces as following

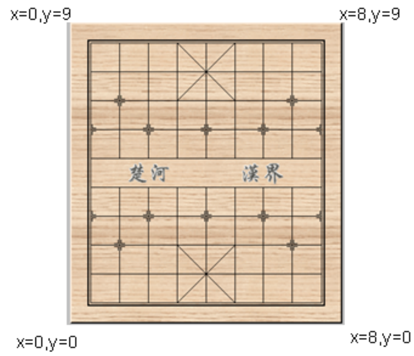


Fig. 4 The definition of the boardstate

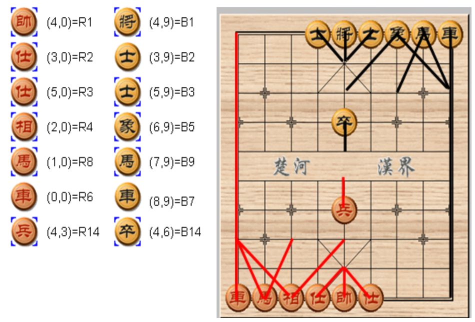


Fig. 5 The position of the chess piece

(x+1,y) or (x,y+1) or (x-1,y) or (x,y-1) or (x+1,y+1) or (x-1,y-1) or (x-1,y+1) or (x+1,y-1)
x<=2,y<=2,IF R1’s (y)= B1’s (y) ,(x,y+n),n<=9

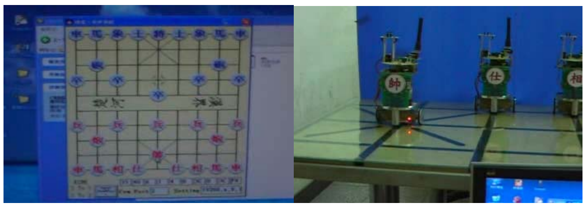
(x+1,y+1) or (x-1,y-1) or (x-1,y+1)or (x+1,y-1)
x<=2,y<=2

(x+2,y+2) or (x-2,y-2) or (x-2,y+2)or (x+2,y-2)
x<=4,y<=9,
sum(x+1,y+1)<>1
sum(x-1,y+1)<>1
sum(x+1,y-1)<>1
sum(x-1,y-1)<>1

5. Experimental results

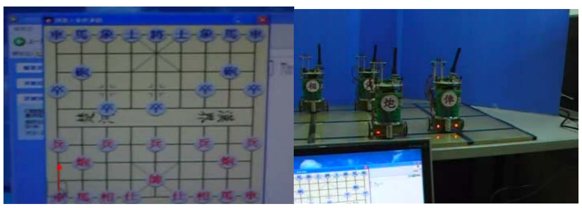
We execute some experimental scenarios for the Chinese chess game system. The two players is located by two side. One is red chess piece; the other is black chess piece. The first experimental scenario is “red king”. The user moves forward the chess piece “red king” using the mouse to be shown in Fig. 6 (a). The supervised computer must order the command to the mobile robot “red king” to move forward via wireless RF interface. The mobile robot can calculate the displacement using the encoder module, and speak the movement status of the mobile robot using voice module. The experimental result is shown in Fig. 6 (b).

The second experimental scenario is “red rook”. The user moves forward chess piece “red rook” using the mouse to be shown in Fig. 7 (a). The supervised computer orders the command to the mobile robot "red rook". The chess piece move to the position and stop. The mobile robot can calculate the displacement using the encoder module, and speak the movement status of the mobile robot using voice module. The experimental result is shown in Fig. 7 (b).



(a) (b)

Fig. 6 The experimental result for "red king"

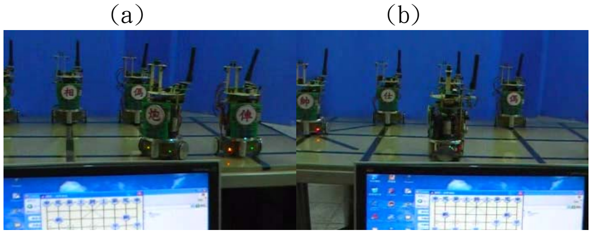


(a) (b)

Fig. 7 The experimental result for "red rook"

The third experimental scenario is "red cannon". The user moves the chess piece "red cannon" to right side using the mouse to be shown in Fig. 8 (a) and (b). The supervised computer orders the command to the mobile robot "red cannon" to move. The chess piece turns right and move to the position. Then it can turn left and face to the black chess. The mobile robot can calculate the displacement and the orientation using the encoder module, and speak the movement status of the mobile robot using voice module. The experimental result is shown in Fig. 8 (c) and (d).

(a) (b)



(c) (d)

Fig. 8 The experimental result for "red cannon"

6. Conclusion

We have presented a Chinese chess game system using multiple mobile robots. The system contains a supervised computer, a monitor, a wireless RF interface and thirty-two mobile robots. Mobile robots are classified red side and black side. The mobile robot executes the chess attribute using two interfaces. One is wireless RF interface, and the other is voice interface. We develop the user interface on the supervised computer for the Chinese chess game system. The supervised computer can control mobile robots, and receive the status of mobile robots via wireless RF interface. Users can move the chess piece using the mouse on the supervised computer. The supervised computer can control the mobile robot to move to the next position. It can speak Chinese language for the movement status. In the future, we want to develop the artificial intelligent technologies in the supervised computer. Users can play the Chinese chess with the supervised computer.

Acknowledgement

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References

[1] S. J. Yen, J. C. Chen, T. N. Yang and S. C. Hsu, "Computer Chinese Chess," ICGA Journal, Vol.27, No. 1, pp.3-18, Mar, 2004.

[2] P. Darwen and X. Yao, "Coevolution in Iterated Prisoner's Dilemma with Intermediate Levels of Cooperation: Application to Missile Defense," International Journal of Computational Intelligence Applications, Vol. 2, No. 1, pp.83-107, 2002.

[3] C. H. Yong and R. Miikkulainen, "Cooperative Coevolution of Multi-agent Systems," University of Texas, Austin, USA, Tech. Rep. AI01-287,2001.

[4] B. P. Gerkey and M. J. Mataric, "A formal analysis and taxonomy of task allocation in multi-robot systems," Int. J. Robot, Res. Vol.23, NO.9, pp.939-954, 2004.

[5] B. Gerkey and M. J. Mataric, "A framework for studying multi-robot task allocation," in Proc. Multi-Robot System, From Swarms to Intell. Automata, 2003, Vol.2, pp15-26.

[6] L. Vig and J. A. Adams, "Multi-robot coalition formation," IEEE Trasactions on Robotics, Vol.22, NO.4, 2006.

[7] J. Chen and L. R. Li, "Path planning protocol for collaborative multi-robot systems," IEEE International Symposium on Computational Intelligence in Robotics and Automation, Espoo, Finland, 2005, pp.721-726.