Gait planning and research of hexapod bionic robot based on bipedal injury

Fenghui Xu, Yongxing Jia*, Zequan Zhou, Xiaoqi Liu, Lei Wang
Communication Engineering College, Army Engineering University, Nanjing, Jiangsu, 210007, China
*Corresponding author’s e-mail: 269216046@qq.com

Abstract. Hexapod bionic robot plays an important role in battlefield reconnaissance and battlefield rescue. However, due to the complex battlefield situation, the robot's legs are often damaged due to attacks, electromagnetic interference and other reasons, so it cannot work normally according to the original gait planning. In this paper, the damage situation of the hexapod bionic robot gait planning study, establish a foot injury cases six-legged robot model, USES the existing six-legged robot, combined with Matlab simulation model, build six-legged robot for foot injury under the condition of six-legged robot, simulation analysis is carried out under the different gait, planning out the suitable gait of robot movement. According to the analysis, the suitable gait under the condition of different injuries was obtained. This study can be used to improve the adaptability of hexapod robot in battlefield conditions and extend the working life of hexapod robot.

1.Bipedal injury model
Under the condition of bipedal injury, the hexapod robot has different damage models, as shown in figure 1.

![Figure 1. Hexapod robot under the condition of bipedal injury](image)

2.Stability assessment and parameter setting
In this paper, the stability margin is selected as the index to measure whether the damaged hexapod robot can work stably. The stability margin refers to the shortest distance between the center of gravity of the multi-legged robot in the support plane and the support polygon formed by the contact point
between the support foot and the support plane. The larger the stability margin, the higher the stability of the robot.

The hexapod robot parameters adopted in this paper are: the length of the robot body is 220mm, and the width is 120mm. The three-degree-of-freedom leg structure is adopted. Starting from the body, the length of each leg segment is set as the first leg segment is 25mm for the basal segment, the second leg segment is 140mm for the femoral segment, and the third leg segment is 130mm for the tibia segment.

3. Gait analysis of hexapod robot under double fully injured condition

In the hexapod robot under the condition of bipedal injury shown in figure 1-2-1, according to the stability margin theory, only robots (4) and (5) may walk with a certain gait. In this type (4) and II type (5) respectively were analyzed.

3.1 Tripod gait under the condition of bipedal injury

Three-legged gait three legs in the support state, one leg in the swing motion. Gait planning is divided into specific type I six-legged robot three-legged gait planning and II six-legged robot three-legged gait planning, each type of six-legged robot three-legged gait is divided into a three-legged gait and cross three-legged gait sequence.

3.1.1 I six-legged robot three-legged gait planning

(1) Sequential three-foot gait

Under the condition of bipedal injury, the stable margin polygon and the position of the center of mass are shown in figure 2 when the hexapod robot moves in a tripod gait.

![Figure 2. Stable margin polygon and the center of mass position of hexapod robot during tripod gait movement under the condition of bipedal injury](image)

(2) Alternating three-legged gait
The stable margin polygon and the position of the center of mass during the alternating tripod gait of hexapod robot, as shown in figure 3.

The figure 3 shows that under the condition of foot injury type I six-legged robot movement, on the basis of three-legged gait if robot alternately, in turn, to perform an action, also placed in the L3 is dynamic, the robot's center of mass will not fall within the stability margin polygon, stability margin value is negative, robot is easy to happen in this condition. So in I machine work, the L3 should be considered as a set of dynamic, easy to happen like robots, need time to shorten this state.

3.1.2 Type II six-legged robot three-legged gait planning

(1) Sequential three-foot gait

Figure 4. Under the condition of bipedal injury, The stable margin polygon and the position of the center of mass during the alternating tripod gait of typeIIhexapod robot
The stable margin polygon and the position of the center of mass during the alternating tripod gait of type II hexapod robot, as shown in Figure 4.

According to figure 3-1-6, When moving in a sequential three-legged gait, the type II six-legged robot movement Under the condition of bipedal injury, The overall stability margin of the robot is not high, and R1 and L3 are negative values, but the absolute values are close to 0.

2) Alternate three-legged gait

![Figure 5](image)

Figure 5. Under the condition of bipedal injury, The stable margin polygon and the position of the center of mass during the alternating tripod gait of type II hexapod robot

3.2 Bipedal gait under the condition of bipedal injury
Among the hexapod robots under the condition of bipedal injury as shown in figure 1-2-1, according to the stability margin theory, only robot (5) may move with a bipedal gait.

It is analyzed separately here.

When (5) the hexapod robot moves in a bipedal gait, the stability margin polygon is a line segment because the bipedal is located in the pendulum dynamics. According to the concept of stability margin, the center of mass of the robot should be located on this line segment if the robot wants to keep stable as far as possible.
As can be seen from figure 6, when the robot moves in a bipedal gait, the stability margin polygon is a line segment, and the center of mass of the robot always lies on this line segment. Therefore, the robot can advance normally under the gait planning, but the stability is not high.

4. Conclusions and prospects

4.1 Conclusion

For the hexapod robot under the condition of bipedal injury, when the three-legged gait is adopted, the stability of the alternating three-legged gait is greater than that of the sequential gait, and the hexapod robot can continue to work. With bipedal gait, the hexapod robot can continue to work, but its stability is not very high.

4.2 Prospects

In this paper, gait planning of hexapod bionic robot under the condition of bipedal injury is studied, mainly by means of Matlab simulation.

However, this method is only a theoretical study, which needs to be combined with other engineering software for engineering simulation to determine the actual validity of the conclusion.

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Figure 6. Under the condition of bipedal injury, The stable margin polygon and the position of the center of mass during the alternating tripod gait of hexapod robot
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