INTISARI

Robot memerlukan kemampuan navigasi untuk dapat bergerak secara otonom. Salah satu komponen navigasi yang dinilai penting untuk dimiliki sebuah robot adalah perancangan jalur (*path planning*). Algoritma *path planning* yang baik dinilai dapat menurunkan investasi waktu dan finansial. Salah satu algoritma yang dinilai andal dan masih digunakan sampai saat ini adalah *Artificial Potential Field* (APF). Meskipun andal, kelemahan algoritma APF adalah robot dapat terjebak pada kondisi lokal minimum dan mengalami *deadlock*. Lokal minimum dapat berbentuk *symmetrically aligned robot-obstacle-goal* (SAROG), *symmetrical static object distribution* (SSOD), dan *goal non-reachable due to obstacle nearby* (GNRON). Salah satu penyelesaian lokal minimum yang dinilai efektif adalah dengan memodifikasi algoritma *path planning* berbasis APF.

Modifikasi algoritma *path planning* berbasis APF, yang disebut sebagai *Improved Artificial Potential Field* (IAPF), dilakukan dengan mengubah bentuk medan potensial yang dihasilkan menjadi bentuk kerucut. Penyelesaian masalah SAROG dilakukan dengan menghasilkan fungsi berbasis eksponensial (ψ) yang melibatkan posisi robot dengan posisi halangan. Medan potensial tambahan dibangkitkan untuk menyelesaikan permasalahan SSOD. Selain itu jarak robot terhadap target (S_{rg}) digunakan untuk mengurangi besarnya medan potensial di sekitar target agar robot mampu mencapai target. Algoritma IAPF diimplementasikan pada model kinematika *differential drive mobile robot* (DDMR). Efektivitas algoritma IAPF pada model kinematika DDMR dilihat berdasarkan ketercapaian robot ke target (E_{rg}) dan kemampuan robot menghasilkan lintasan bebas tabrakan baik secara simulasi maupun implementasi riil.

Keberhasilan kinerja algoritma IAPF dilihat dengan pendekatan empiris melalui pengujian simulasi dan implementasi riil. Pada pengujian simulasi, IAPF dibandingkan dua metode lain, *Traditional* APF (TAPF) dan *Optimized* APF (OAPF), untuk melihat efektivitasnya dalam menyelesaikan permasalahan lokal minimum kompleks. Selain itu, pengujian implementasi riil pada tipe *differential drive mobile robot* (DDMR) juga dilakukan untuk melihat efektivitas IAPF dalam menghadapi masalah lokal minimum. Berdasarkan hasil pengujian, algoritma IAPF mampu menghasilkan lintasan bebas tabrakan dan membawa robot mencapai target pada seluruh lingkungan pengujian. Halangan tambahan berhasil dibangkitkan untuk menghindari permasalahan SSOD. Fungsi ψ berhasil membuat robot menghindari halangan sebelum robot mencapai jarak aman terhadap halangan (r). Dari seluruh hasil pengujian, robot mampu mencapai target dengan nilai E_{rg} kurang dari 10%.

Kata kunci – navigasi, robot, perancangan jalur, lokal minimum, SAROG, SSOD, GNRON, medan potensial.

ABSTRACT

Robots need navigation capabilities to be able to move autonomously. One of the navigation components that is considered important for a robot to have is path planning. A good path planning algorithm is considered to reduce time and financial investment. One of the algorithms considered reliable and still used today is the Artificial Potential Field (APF). However, this algorithm has drawbacks where the robot can get stuck in a local minimum condition and experience deadlocks. The local minimum can be in the form of symmetrically aligned robot-obstacle-goal (SAROG), symmetrical static object distribution (SSOD), and goal non-reachable due to nearby obstacle (GNRON). One of the minimum local solutions considered effective is modifying the APF-based path planning algorithm.

Modifying the APF-based path planning algorithm, known as Improved Artificial Potential Field (IAPF), has been done by changing the shape of the potential field generated into a cone shape. Solving the SAROG problem has been done by generating an exponential-based function (ψ) involving the robot's position with the obstacle's position. Additional potential fields were generated to solve the SSOD problem. In addition, the robot's distance to the Srg target was used to reduce the magnitude of the potential field around the target so that the robot could reach the target. The IAPF algorithm has been implemented in the differential drive mobile robot (DDMR) kinematics model. The effectiveness of the IAPF algorithm on the DDMR kinematics model was seen based on the robot's achievement of the target (E_{rg}) and the robot's ability to produce a collision-free trajectory both in simulation and in real implementation.

The performance of the IAPF algorithm is seen with an empirical approach through simulation testing and real implementation. In the simulation test, IAPF was compared to two other methods, Traditional APF (TAPF) and Optimized APF (OAPF), to see their effectiveness in solving local minimum complex problems. In addition, testing the real implementation of the differential drive mobile robot (DDMR) type was also conducted to see the effectiveness of the IAPF in dealing with minimum local problems. Based on the test results, the IAPF algorithm is able to produce a collision-free trajectory and bring the robot to the target in the entire test environment. An additional hitch was raised to avoid the SSOD problem. The function ψ makes the robot avoid obstacles before reaching a safe distance from the obstacle (r). From all test results, the robot is able to reach the target with an E_{rg} value of less than 10%.

***Keywords** :navigation, robotics, path planning, local minimum, SAROG, SSOD, GNRON, potential field.*