FORMATION ALGORITHM IN SWARM ROBOTICS SOFTWARE

Yazdani Hasan, Dr. M. Deepamalar
[1]Research Scholar, SSSUTMS, Sehore
[2]Research Guide, SSSUTMS, Sehore

ABSTRACT: Swarm behavior is interesting for humans for multiple reasons. A huge number of related papers was studied by a reading group to gain knowledge in the field of Swarm Robotics. The main reason is that in a swarm, many simple homogeneous individuals can meet greater capability when working together, than the individuals themselves are able to achieve. The aim of this investigation was to build the focal point of the task to arrangement of swarm robots which is communicated in the advancement of a development calculation. An expansive Simulink display was produced ready to recreate the conduct of 10 robots in a swarm. An arrangement calculation utilizing potential field powers was actualized ready to make an alluring power from correspondence and an awful power from the estimating of light force.

Keywords: Swarm Robotics, Formation Algorithm, Homogeneous system

INTRODUCTION

A swarm is both flexible and robust in the sense that it is possible to add or remove a member of the swarm, without any major faults such as deadlocks or lack of capabilities. Hence there is no leader or specialists in the swarm, and thereby no single point of failure. Big complex industrial robots can be very expensive, it is very interesting to see whether the swarm collaborative methods can be applied to applications as an alternative to these. The advantages are the same as from the biology, and smaller simple robots are cheaper to produce and thereby easier and cheaper to scale the production up and down, as the task demands it. Furthermore the swarm is able to replace a broken member by another automatically, since the robots are homogeneous.

The main reason is that in a swarm, many simple homogeneous individuals can meet greater capability when working together, than the individuals themselves are able to achieve. Furthermore a swarm is both flexible and robust in the sense that it is possible to add or remove a member of the swarm, without any major faults such as deadlocks or lack of capabilities. Hence there is no leader or specialists in the swarm, and thereby no single point of failure. Parallels can be drawn from the biology behavior to robots. Big complex industrial robots can be very expensive, it is very interesting to see whether the swarm collaborative methods can be applied to applications as an alternative to these. The advantages are the same as from the biology, and smaller simple robots are cheaper to produce and thereby easier and cheaper to scale the production up and down, as the task demands it. Furthermore the swarm is able to replace a broken member by another automatically, since the robots are homogeneous. Hence it has no single point of failure, resulting in savings in a breakdown. An example of an application for the swarm method could be in hazardous environments like a rescue recovery or in warzones etc. When a building has crashed or is in any way too dangerous to enter for humans, a set of swarm robots could search for surviving people using formation. By use of small simple robots, the loss of a faulty member would not be cost full and since there is no leader it will not affect the overall mission, because all other robots can continue. The use of swarm collaborative methods is a fairly new subject in robotics and has not really met the market yet. The testing of these methods are mainly done in simulations, since testing on real world robots is very time consuming and costly. We will start our development by looking into which project is already presented to learn what have been done. This will help us to solve problems and improve the solution.

This study was to increase the focus of the project to formation of swarm robots which is expressed in the developmentof a formation algorithm. A large Simulink model was developed able to simulate the behaviour of 10 robots in aswarm. A formation algorithm using potential field forces was implemented able to create an attractive force from communication and a repulsive force from the measuring of light intensity. From using both communication and light intensity it was possible to control both the distance between the robots and a common phase alignment. The development of 10 lightweight swarm robots was represented. A simple implementation of the algorithm from simulation, proved the concept by controlling the robots to the expected behaviour.

FORMATION ALGORITHM

This paper proposes a new methodology for developing and testing swarming and formation algorithms. This methodology incorporates many of the good features from the methodologies mentioned in Related Work. It is focused on bridging the gaps between simulation and real the world as well as increasing understanding of swarms by combining the different approaches and streamlining analysis.

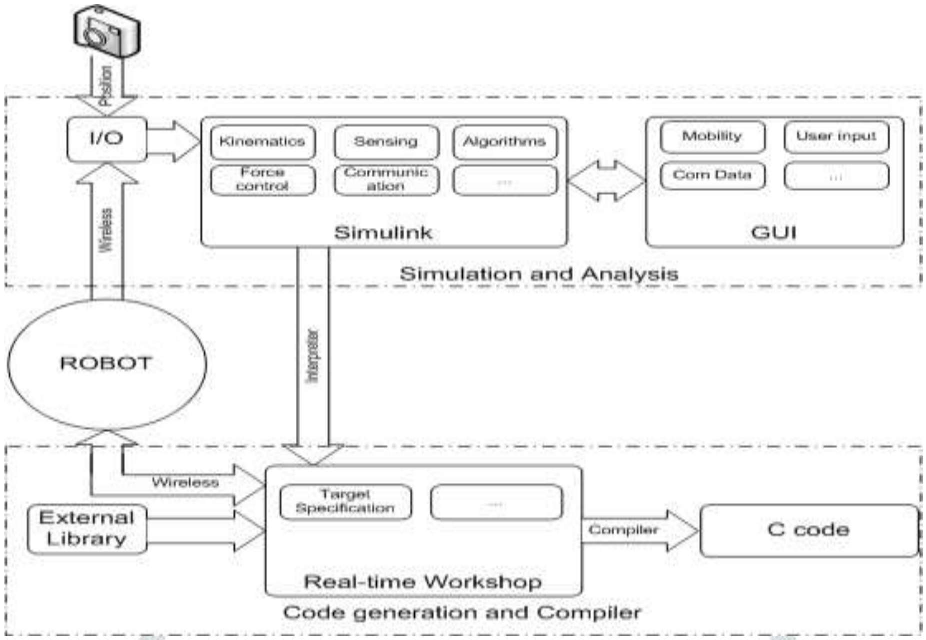

Figure 1: Diagram of the proposed formation methodology

The proposed methodology involves three main function blocks working in a closed loop for development and evolution: Matlab Simulink, GUI, and Real-time Workshop. On one hand, swarm algorithm can be internally simulated through mathematical models built in Simulink, and shown in GUI for pre analysis. On the other hand, the sensory data can be directly imported in the same model for the empirical verification. Analysis of data from experiment and/or simulation are presented in a high level GUI makingit Increasingly easier to compare, and therefore transfer results from mathematical models to the real world through the Real-time Workshop.

The Real timeWorkshop plays a role as an interpreter that translates model-based algorithm and control to C code before compiling to machine code and downloading to the robots. The wireless connections to and from the robots are imperative to the proposed methodology for two reasons. Firstly sensory data is needed in real-time to be imported into the Simulink for processing and analysis. Secondly in order to automate the expensive job of hands-on-coding of robots, the machine code can be remotely downloaded to the robots. To achieve full hands-off coding of robotsand keep focus on the model-based swarm algorithms, the GUI allows to change parameters on the fly. A diagram of the methodology is shown in Figure 1.

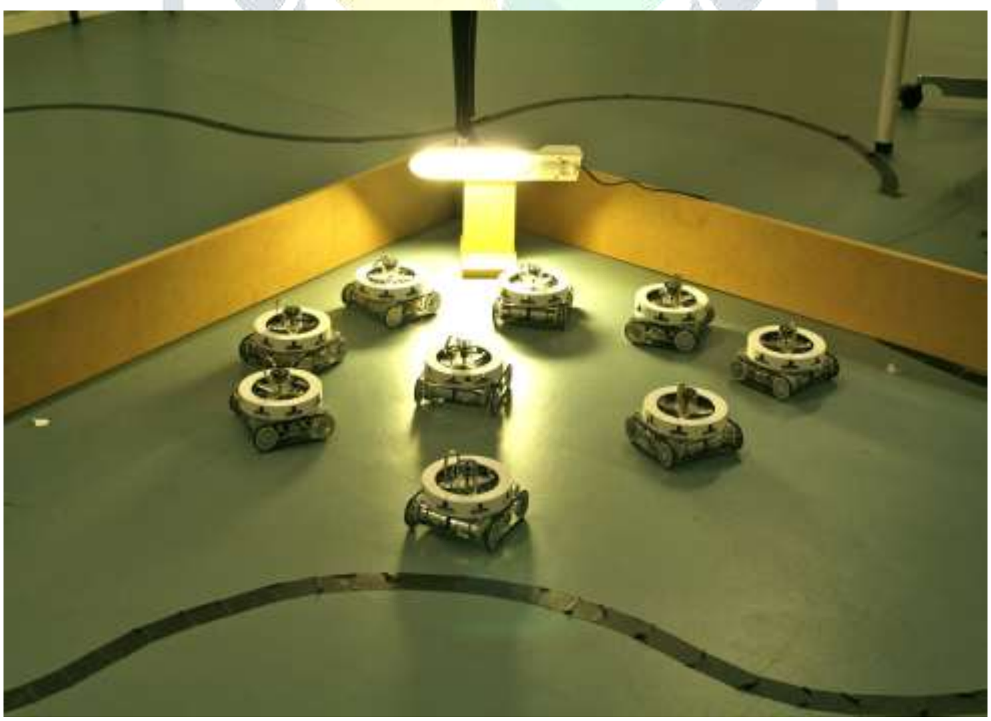

Figure 2: Provided robots in the arena

IMPLEMENTATION

A set of 10-15 small simple robots is provided to us by the university, from a previous project as illustratedon Figure 2. These 13 by 13 cm robots are driven by a tank drive train powered by two smallelectrical motors. The drive train gives the individual robots great moving ability since they are able to turn around on their own center axis. Hence it is able to change position fast with minimal use of movement. Furthermore they are able to change the drive train between the caterpillar tracks and a four wheel drive, depended on how the tracks are attached. This gives advantages in rough terrains.

The main circuit-board of the robots is provided with an ATmega128 microprocessor which is programmed trough an In System Programming port. The microprocessor can however be programmed using any of its communication ports. Furthermore is a set of 8 infrared distance sensors attached around the sides, and one on the top with a rotating mirror, able to scan the surroundings. The robots come with a 300 cmx 270 cm arena with 15 cm high side walls ensuring that no robot can escape. The arena is covered with felt carpet which gives good traction.

The kinematic model of the robots is implemented in the Simulink Model for simulations. In this way the output from simulation and experiments will be directly comparable. Also A communication model is developed for receiving and sending data from the PC's wireless communication port into the Simulink model. Simulation of the swarm will give values and formation to compare to the real world measurements. On top of the Simulink model a GUI is designed to show all sensor data, as well as the formation of the robots. Furthermore it adds ability for a user to change the parameters of the algorithms on the fly for faster tuning of these. By using Real Time Workshop combined with a GCC compiler the code generation from the algorithms input to the GUI is automated. This and the ability to program the robots through a wireless connection, as demanded in the methods, automate many time consuming jobs.

CONCLUSION

This investigation was to expand the focal point of the venture to arrangement of swarm robots which is communicated in the improvement of a development calculation. Approach displayed a bound together procedure for creating swarm robots was exhibited, taking care of the down to earth issues researcher's appearances when working with certifiable robots. An extensive Simulink display was created ready to mimic the conduct of 10 robots in a swarm. An arrangement calculation utilizing potential field powers was executed ready to make an appealing power from correspondence and a terrible power from the estimating of light force. A basic usage of the calculation from reenactment, demonstrated the idea by controlling the robots to the normal conduct.

References

[1] B. B. Werger, M. J. Matari´c, Robotic ”food” chains: Externalization ofstate and program for minimal-agent foraging, in: In (Maes et al, TheMIT Press, 1996, pp. 625–634.

[2] K. Lerman, A. Galstyan, Mathematical model of foraging in a group ofrobots: Effect of interference, Autonomous Robots 13 (2) (2002) 127–141.

[3] M. Wilson, C. Melhuish, A. B. Sendova-Franks, S. Scholes, Algorithmsfor building annular structures with minimalist robots inspired by broodsorting in ant colonies, Autonomous Robots 17 (2-3) (2004) 115–136.

[4] N. R. Hoff, A. Sagoff, R. J. Wood, R. Nagpal, Two foraging algorithmsfor robot swarms using only local communication, in: Robotics andBiomimetics (ROBIO), 2010 IEEE International Conference on, IEEE,2010, pp. 123–130.

[5] T. Wang, H. Zhang, Multi-robot collective sorting with local sensing, in:IEEE intelligent automation conference (IAC), Citeseer, 2003.

[6] V. Hartmann, Evolving agent swarms for clustering and sorting, in: Proceedingsof the 2005 conference on Genetic and evolutionary computation,ACM, 2005, pp. 217–224.