Collective Cube Clustering using a specially designed hardware add-on

D. Böndel, M. Grünewald, T. Hanna and F. Sandmeier

System and Circuit Technology, Heinz Nixdorf Institute,
Paderborn University, Fürstenallee 11, D-33102 Paderborn

E-mail: klahold@hni.uni-paderborn.de

1 Problem description

Several robots shall explore an unknown environment with small cubes inside. This task consists in locating the cubes, collecting them and building clusters with them. The environment contains also walls that should be avoided.

2 Approach

The robots are equipped with a specially designed hardware add-on module allowing them to pick up the cubes and to transport them to any location. All the robots use the same algorithm to explore the environment, to recognize the cubes and to transport them to the cluster

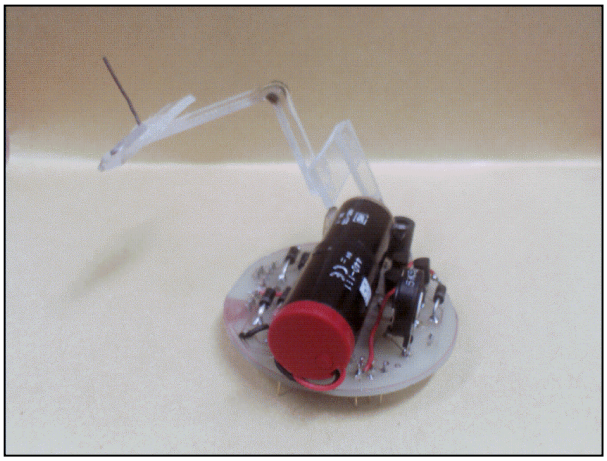

Figure 1. The hardware add-on module designed for the transport of the cubes. It consists of a simple dc motor with a lifting shaft for picking up cubes

The unknown environment is explored using decreasing circles. When a robot finds an object it drives around it and measures the radius of it. If the obstacle has a specific radius it will be recognized as a cube. Furthermore walls and already existing clusters can be differentiated because they have different dimensions.

Then the robot transports the cube to his cluster whose position is a fixed coordinate in a relative coordinate system. The navigation control drives the robot to these coordinates while avoiding obstacles.

Cooperation between the robots is implicit: they exchange no information but recognize each other as moving obstacles. The control structure is optimized to reduce destructive interference to a minimum. The developed hardware add-on module consists of a simple dc motor with a lifting shaft for picking up cubes.

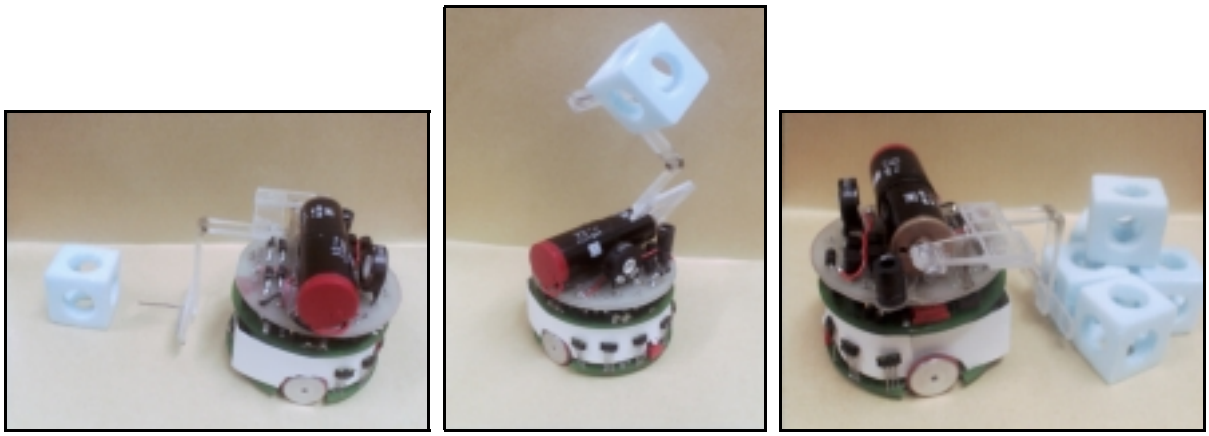

Figure 2. From left to right: a robot before it picks up a cube, the robot on the way to its cluster and finally the unloading of the cube at location of the cluster.

3 Results

Several tests showed that the above described method works. A minor problem produced the navigation back to the cluster. The relative coordinate system used is not very accurate [Kla99] and in some cases, the robot cannot find the exact position of the cluster. The problem could be reduced by searching for the cluster in the area around the coordinate where the robot has expected its cluster.

The implicit cooperation between the robots also functions, but not as well as thought. If you put two robots in a closed area that covers one square meter, the robots hinder each other because the possibility is very high that one robot intersects the path of the other, forcing it to find a new way to his target. Thus, the overall speed of the clustering is reduced if the robots operate too near to each other.

Acknowledgements. This project has been carried out under supervision of Prof. U. Rückert, System and Circuit Technology, and with the assistance of A. Löffler and J. Klahold who helped us a lot to implement our ideas.

4 References

[BMTF99] **Dirk Böndel, Matthias Grünewald, Thomas Hanna and Frank Sandmeier.** *Kooperatives Verhalten Autonomer Systeme am Beispiel eines Cluster-algorithmus.* Projektabschlußbericht, Universität Paderborn, Fachgebiet Schaltungstechnik, 1999

[Kla99] **Jürgen Klahold**. *Navigation und Neuronale Sensorkalibrierung auf dem Mini-Roboter Khepera*. Studienarbeit (S38), Universität Paderborn, Fachgebiet Schaltungstechnik, 1999