CAN Application in Modular Systems

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This paper describes CAN application in a modular robot system. RobMAT is made up of modules that form a new structure called molecule when they are joined together. Every molecule has a master module, which is in charge of receiving external message and retransmitting to the rest of the modules by CAN bus. The message contains all related information about movement control references, sensor data and module synchronization. CAN features allow faster transmission of up to 1Mbit/s. It is also flexible to connecting another CAN device. Such features make CAN appropriate for this application. Task performance using modular robots requires flawless communication among modules; therefore, synchronization is a key factor to take into account where in CAN plays an important role. The importance of synchronization requires a dedicated mailbox to manage it among the modules. Each module comes with a clock in order to process information by itself and correspondingly synchronize. Among the modules, one module has the master clock pulse that has to be transmitted to the rest of the modules of the molecule for readjustment of time. The experiments highlight the excellent performance of synchronization in crucial task.

In recent years there has been an increasing interest in modular robotic systems. These systems aim to carry out a number of tasks by teams of collaborating robots instead of being completed for one simple robot. Modular robotic systems are less task-specialized than industrial robots; nevertheless a greater quantity of them is necessary in order to deal with tasks which one specifically designed robot could not do. Actually, the challenge of these robots lies in coordinating several robots to obtain a common objective with a cooperative behavior.

A good example of team robots are modular and reconfigurable robots, as they form metamorphic structures that are made up of modules, generally identical, which have to work in a coordinated fashion giving uniform behavior to the colony. Their ability of rearranging their modules to adapt to different configurations allows them to cope with many tasks, and consequently increase their performance. The main objective of modularity is that functionality of the whole is greater than the sum of the functionality of each component. The concept of modularity applied in robotics allows making a wide variety of specialized kinematic configuration from a reduced set of standard components. However, the development of modular robots has specific features that have to be solved in order to obtain the desired performance. Most of them are related to control architecture, modular mechanical design and reconfiguration processes.

In modular robotics, control architecture takes on special functions like communication and synchronization among modules, or when and how modules have to change their configuration. Therefore, modular robot architectures can be proposed in several ways, for example, when coupling among modules is done mechanically, hierarchical or centralized architectures are normally implemented such as PolyBot (Yim et al., 2002) or M-TRAN (Kurokawa et al., 2002) systems. On the other hand, when module coupling is not mechanical, like networked robots (McKee and

Schenker, 2000), distributed and decentralized architectures are used. Examples of them are robot systems based on colonies (Navarro-Serment et al., 2002) and (Caprari et al., 2002).

In the RobMAT project CAN plays a key role in the synchronization among modules. Its use is innovative because its application is not really common in other projects with same features. Just in PolyBot (Yim et al., 2002) has been used before, but its assignment is to transfer information, so nothing to do with the synchronization.

This paper has been organized as follows. Section 1 describes the RobMAT control architecture, which explains communication and synchronization among modules. Section 2 is focused on the role that the standard CAN plays in the synchronization among modules and section 3 refers to the rest of tasks where Can is involved in. Section 4 details a real test done with the prototype and section 5 is about the current situation of CAN's development inside the project. Finally, main conclusions from this work about the influence and the application of the CAN bus are summarized in the last section.

1. Control Architecture of the RobMAT System

RobMAT architecture is based on modular and molecular components being all of them one colony. Module is the simplest part which has movement and communication facilities. A molecule is an autonomous robot which is made up of modules. Therefore molecules can have different configurations. Each molecule has a master module and the rest of the modules have a slave role. Later on, master and slave roles will be described. Finally, the colony is remotely commanded by a human operator by means of teleoperation interface. Figure 1 shows the main components of the RobMAT architecture.

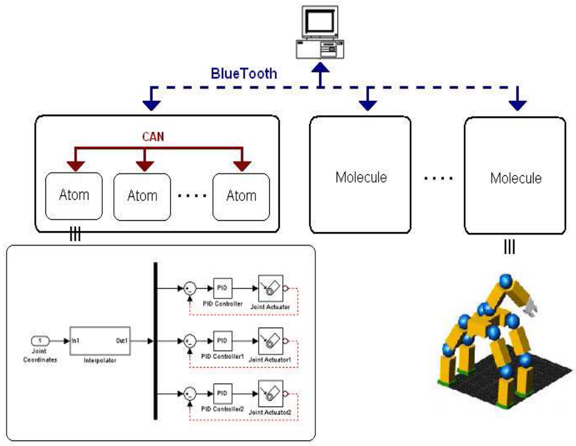

Figure 1: Main components of RobMAT architecture

The module designed for the RobMAT system attempts to reach a balance between complexity of design and performance. The goal is to obtain a very functional module able to execute different kind of tasks. However, it is always kept in mind that the module must be simple in comparison with the complexity of the molecule. With these criterias a module is developed which can form very functional molecules comprised of only a few modules. Figure 2 shows the module designed.

Figure 2: Module of RobMAT

The molecule is a robot formed by various modules which are joined together, as is shown in figure 4. The molecule with the fewest modules which has sufficient autonomy is called base molecule; two modules form this molecule, as is shown in figure 3. Adding suitable tools to a base molecule allows itself to meet several of the demands for a robot.