ON AN AUTOMATION TOOL FOR COMPLEX MEASUREMENTS

Dorel Aiordachioaie[*♦]**, Herbert Peremans**[**]**, Gabriel Sirbu**[***] **and Viorel Nicolau**[+]

[*]*"Dunarea de Jos" Galati University, Electronics and Telecommunications Dept.,*
Domneasca – 47, Galati – 800008, Romania, Email: Dorel.Aiordachioaie@ugal.ro

[**]*University of Antwerp, TEW-MTT Department, Active Perception Lab*
Prinsstraat – 13, Antwerp 2000, Belgium. Email: Herbert.Peremans@ua.ac.be

[***]*"Dunarea de Jos" Galati University, Electronics and Telecommunications Dept.,*
Domneasca – 47, Galati – 800008, Romania, Email: Gabriel.Sirbu@ugal.ro

[+]*"Dunarea de Jos" Galati University, Electronics and Telecommunications Dept.,*
Domneasca – 47, Galati – 800008, Romania, Email: Viorel.Nicolau@ugal.ro

Abstract: The paper describes some results in developing an automated software tool for complex measurements, concerning the number of values, timing and distributed sources. The process, which generates the values, is defined by an application where a mobile robot is involved with navigation based on SONAR. The software tool is composed from a number of software agents, part running on a desktop computer, part running on mobile robot. The sequence and the values of measurements are stored in a database. The software tool is developed under Linux and written in C. The first version is acceptable, by properly working in some simple scenarios.

Keywords: Software tools, automated measurements, SONAR, mobile robots.

1. INTRODUCTION

The generation framework of the paper is coming from a EU research project, called CIRCE, [1]. The measurements experiments were developed at Antwerp University labs.

The process, which generates data, is composed of a mobile robot, able to navigate inside of the lab using a standard SONAR system. In the stage of the tuning of the navigation algorithms and for evaluation purposes of different navigation strategies, a database is necessary in order to store a complex set of parameters, like number of measurements, structure and dependencies, e.g. position, orientation, parameters of the emitted pulses, parameters of the received echoes, parameters of ultrasound transducers, time moments of the measurements, etc.

The difficulty of the problem is coming from the fact that a history of the measurements is necessary to have and from the structure of the experiments, which

---

[♦] Corresponding author

suppose coordination between the movements of the robot and the parameters of the signals. The design and the use of non-automated tool was verified to be not reliable, not flexible and a time consuming task.

The paper describes a software tool used in automation of these measurements. The primary structure of the software tool was developed by prof. Rolf Muller of Tuebingen University, Germany, for an arm-based robot. Our effort were to adapt the primary source code and data structures for an application where the robot is mobile and the communication between robot and remote computer is wireless.

The software tool is basically an automaton written in C under Linux. The communication mechanism is based on sockets under the client-server architecture. The names *client* and *server* are relative to the reference level, so a client could be – in the same time – a server for other modules. Roughly, the following modules are working: *Postgresql*, for the management of database; *batui*, for the management of the user interface and for input-outputs; CEN, a module to coordinate the protocol of communication; *robot-server*, to manage all the clients at the level of the robot.

The context and the framework of the project are described in section 2. The structure of the measurements and the constraints are described in section 3. The structure of the tool is presented and discussed in section 4. Some results of the tool are presented in section 5, i.e. a screen shot with some explanations of the results and possible directions to improve the flexibility of the tool.

2. DESCRIPTION OF THE PROJECT

At this moment the greatest obstacle to the widespread use of autonomous mobile robots both in an industrial setting, e.g. autonomous AGV's, and in the home, e.g. service robots, is the lack of reliable and efficient environment perception. One major goal of the CIRCE project is to study such perception systems. In particular, we concentrate our research on ultrasonic perception systems that would enable a mobile robot/wheel chair to navigate autonomously through a natural (unstructured) environment, [1]. A major problem is the difficulty to store and to manage the experimental values coming from SONAR ranges and different environments.

The problem to solve is regarded to an experiment where a mobile robot, [2], is involved. The robot uses the SONAR principle in navigation. Under the project, a new SONAR head is developing based on biological similarity with bats. In order to understand better the perceptual mechanism of bats, like animals, and to define the features of the SONAR head, a set o measurements are necessary to do, with different emitted pulses and environments. The measurements involve the receptions of the echoes from environment and the storage of the range values for each point from the exploration environment.

3. THE STRUCTURE OF THE MEASUREMENTS

A measurement has the following primary objects, each one with a set of parameters: the emitted pulse, the received echoes, the position of the robot, the position of the SONAR head and the environment.

The emitted pulse has the following parameters: the pulse width, the start frequency, the stop frequency, and the pulse period. Each of these must be changed in some pre-defined ranges.

The received echoes define a vector with variable length. The SONAR head has two receivers corresponding to the two ears, so there are two echoes signals.

The position of the robot is a two dimensional vector, which define the position in space, in horizontal plane. There could be x and y in cartesian coordinates or r and θ in polar coordinates. The number of positions depends on the imposed trajectory, and it is a variable value. The SONAR head has an emitter and two receivers, mounted on the same physical object. With reference to a reference coordinates system fixed on mobile robot, the emitter has elevation and azimuth. Each receiver has also an elevation and an azimuth. In the present configuration, the transducers are of POLAROID type, [3].

The environment is described by a set of qualitatively parameters enough to describe: the composition, the organization and the location of the objects around the robot. Each experiment should store all these parameters and the results of the measurements.

4. THE STRUCTURE OF THE TOOL

The structure of the tool at the level of communication among servers and clients is presented in Fig.1. There are two main objects: the remote computer, for running on all agents regarding to experiments, and the mobile robot. The communication between these are wireless, under a range of 100-150 meters, inside the laboratory. The object running on desktop computer has a set of three agents: the main server called CEN, the PostgreSQL server and a client program. The server called CEN, which is an acronym from Central Experiment Node, is responsible with the communication among different agents.
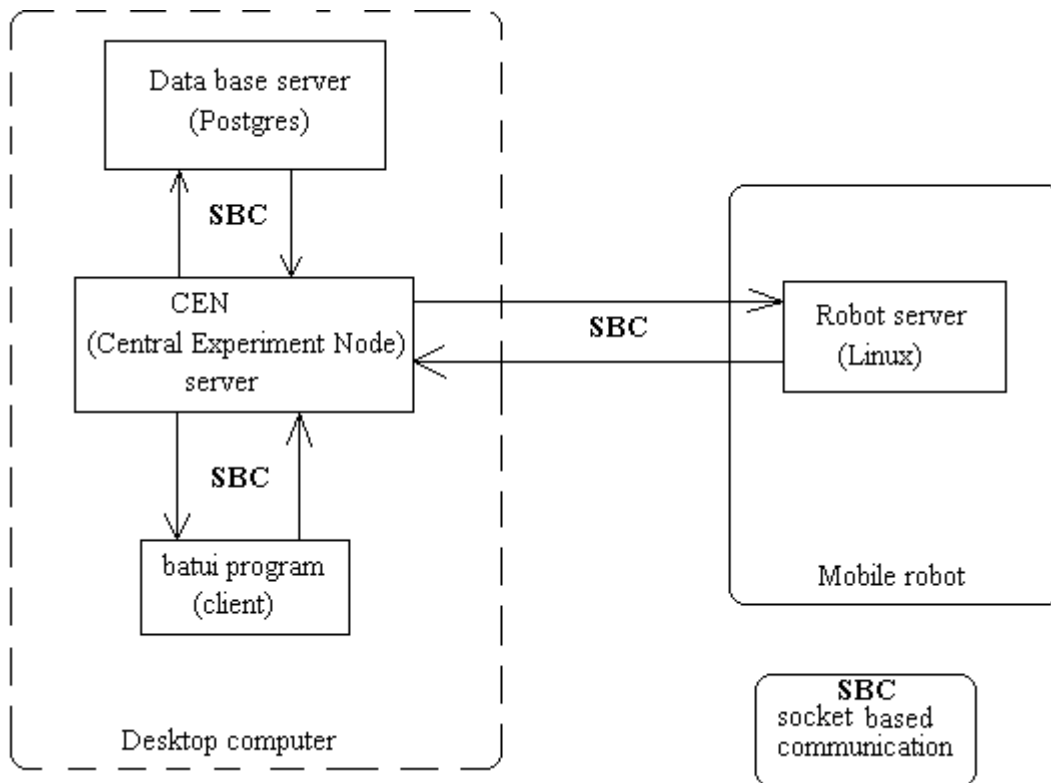

Figure 1. The structure of the tool

The PosgreSQL server, [4], is responsible for managing a database with input and output parameters values of the experiments. The agent for managing the user interface, in order to define commands and the values of the input parameters, is called *batui*. The name is coming from bat user interface. The communication among servers, like agents, is made on socket mechanisms.

In Fig. 2 is presented a partial activity diagram. The main activities and interactions among modules are presented. It is important also the sequence of operations, i.e. the master agent is on the central experiment node.
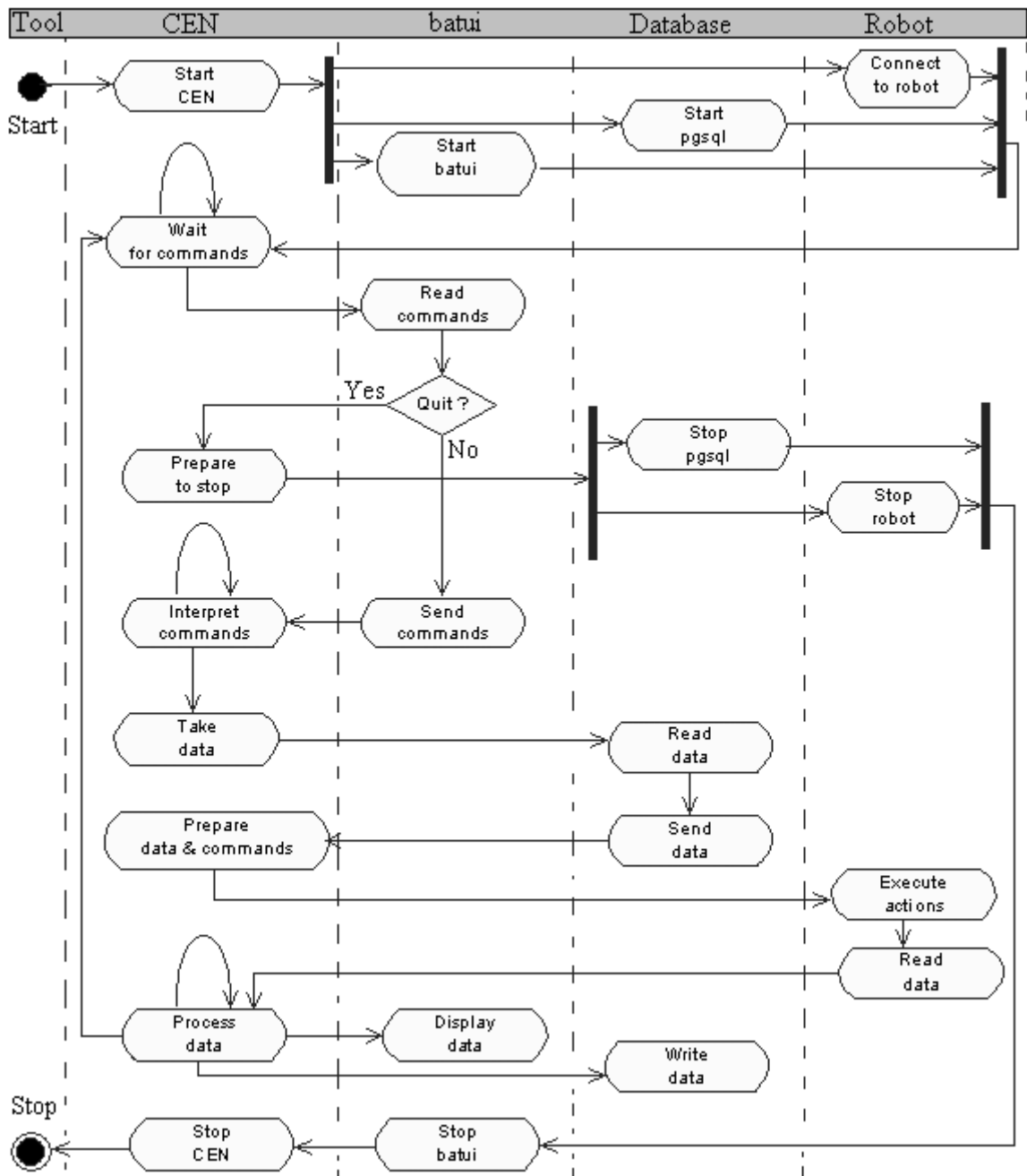

Figure 2. A *partial* activity diagram of the tool

5. RESULTS

The tool is running on computer under Linux, [5] with kernel 4.18 and Red Hat 8.0 distribution, [6]. All programs on desktop computer, including the communication with the database, are developed in C using KDevelop development environment, [7].

In Fig. 3 an example of how the user screen is looking like. On the left-up corner the results of signal processing are presented, e.g. the amplitude spectra of the echo signals, the spectrograms or the output of gamma tone filters.

Next, under the results of the computation, the screen of the *batui* program is presented. There, all the commands and the input parameters values are displayed.

On the left – bottom corner, the window of PostgreSQL is presented. In fact, this is optional, in the sense that the user cannot affect the behaviour of the data base server. The reason of having such a window here, at least in the development stage, is the possibility to have a qualitative measure about the running state of the programs. It is very useful also at the time of the development of the tool to have an indicator of the errors that could appear at the level of database. For example, an error message coming from PostgreSQL server is information that the reading or writing process of data has problems.

The upper right window presents messages coming from the robot's server side. In the current version, the state messages about the units and communication are presented.
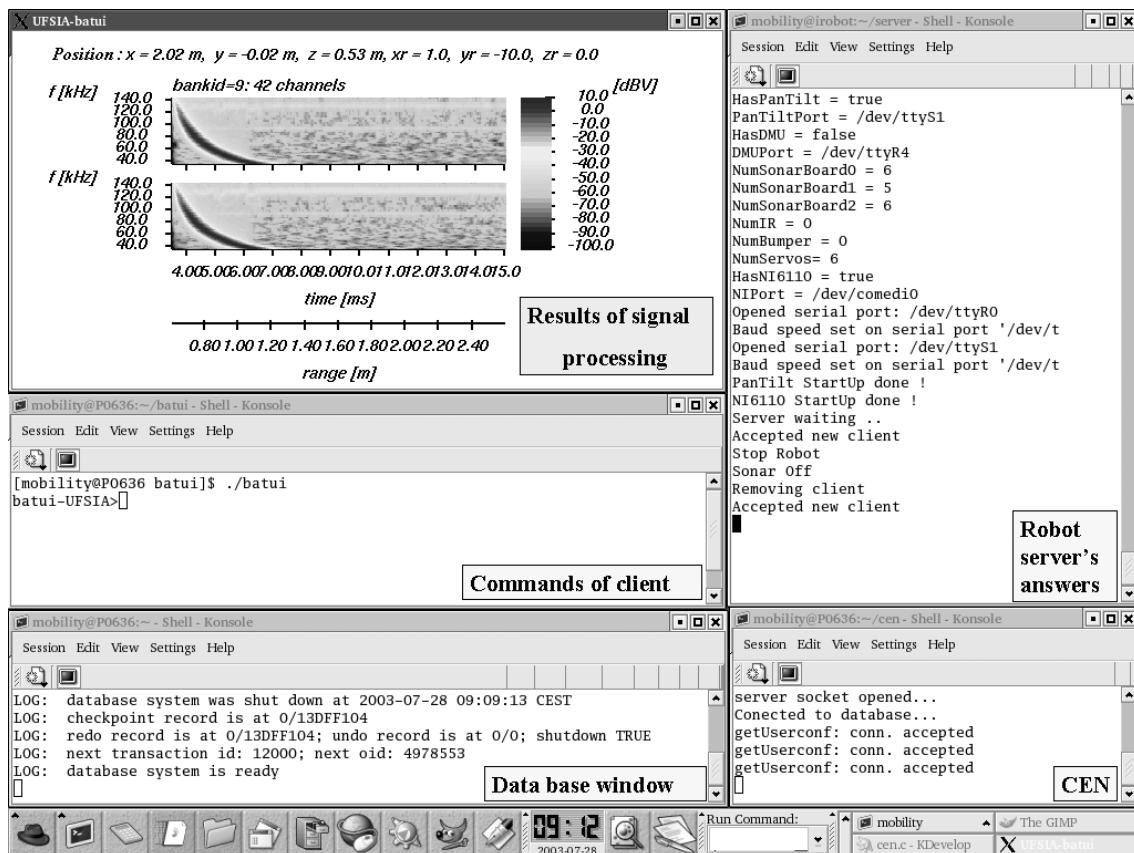

Figure 3. A *partial* screen snapshot of the software tool

Finally, on the bottom right corner messages from central experiment node are displayed. The values of some flags are used in the estimation of the working point and on the running process.

6. CONCLUSIONS

The objective of the paper was to present some aspects from the design of a software tool necessary in the applications where a huge number of parameters and variables are involved. The structure of the tool uses a set of interacting software agents, able to control the measurements and to store data.

From the user interface commands are parsed and interpreted. All values of the input parameters and all values of the variables from the process, which characterize an experiment, are stored into database.

The tool is flexible and stable, in the sense that it is properly responding to the user input commands and by writing all the necessary parameters in database, feature which always is desire when design complex software tools under Linux.

From the experiments running till now, it seems that a new module is necessary to manage some possible faults at the level of agents, e.g. by independently restarting some servers when it is necessary, without affecting the state of other modules.

7. ACKNOWLEDGEMENTS

8. REFERENCES

[1]. Chiroptera-Inspired Robotic Cephaloid-CIRCE: a Novel Tool for Experiments in Synthetic Biology, *http://www.circe-project.org/index.htm*, 2002.
[2]. iROBOT Corporation, *http://www. irobot.com /rwi/p03.asp*, 2002.
[3]. Polaroid Corporation*, http://www.polaroid -oem.com/ultrason.htm*, 2003*.
[4]. PostgreSQL*, http://www.postgresql.org/*, 2004.
[5]. Linux*, http://www.linux.org/*, 2004
[6]. Red Hat *, http://www.redhat.com/*, 2004
[7]. KDevelop*, http://www.kdevelop.org/*, 2004