An approach to Facilitate the TO of a vehicle in the space 3D

Bonyuet Lee, David.

Polytechnical University of Catalonia (U.P.C.).
Pau Gargallo, #5, 08028. Barcelona. Spain.
Phone (++34-3) 401.69.92 FAX: 401.70.40 E-mail: **bonyuet@esaii.upc.es**

1. Abstract

Teleoperation (TO) is an important step in the new technologies that able robots to operate with human control and supervision. TO provides a highly safe robot operation in certain activities. Actually, the main problem is the skill required to operate these systems: The user requires both, a high knowledge about the teleoperated system "TS" (commands, controls, interpretation of multiple information source, and so on) and a high level of experience in the specific task (nuclear maintenance, underwater searches, space exploration, etc). The aim of this work is the development of a friendly user interface (UI) to a teleoperated vehicle (TOV) in the space 3D. The base requirement is that this interface may enable the system to any user with a certain level of skill in the specific task with a low level of knowledge of TS. Finally, an UI for an Underwater Robot (UR) is presented.

Keyword: Ergonomic interface, TS, Visualization of information, Dialogue Design Methodologies and approaches.

2. Introduction

In spite of all its advantages TO is a hard task (not all the signals from the vehicle may be understandable by all users) [AMAT 95 a, b] and is associated to advanced operators with large experience and high skill[1]. The cost of this special user are very high and limits the use of the system by another user. Task visualization is a key problem in TO since most of the user's control decisions are based on visual information. All data that the TOV sends to the user's computer is very important [HIRAI 92]. The UI plays an important role in the data representation.A single user may not understand all the (unformated) information at a time.

The user interface development for any TOV is very hard. Each work team will have different needs (Table 1) during the time the robot will take to be fully assembled and operative.

Initial State	Each card status must be observed in detail. The response of each card to the detected excitation must be also observed. The main problem of this stage is the operativity of the different boards.
Devel oping state	The interconnected operation of all boards must be observed. Also the flow of information through the connections, and how this flow affects the operation of any board In this stage the gain, offset, sensors, and so on, are adjusted. This stage requires high visualization of all conditions to facilitate calibration. The main problem of this stage is the interconnectivity and the adjustments of individual parts.
Using time	We only need the "essential" information to operate. Other information can create both distraction or confusion. The main problem is the use of the system.

Table.- 1 Requirement in each stage of Robot design

2.1 Alternative Solutions in T. S.

The Figure 1 [FIORINI 93] JPLATOP: Jet Propulsion Laboratory Advanced TO presents a complete user interaction for advanced TO of two static robot arms, the user needs to handle 6 different monitors!.

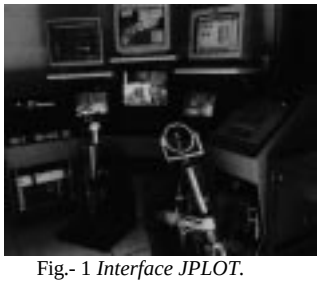

Fig.- 1 *Interface JPLOT.*

3. Enhance the Information Efficiency in TOVs

As it has been said, TO is a hard task and requires a high mental effort. To reduce this mental effort we may use:

- Mimic diagrams (system's virtual representation) to enable the fast magnification of system details.
- Color codification with realistic representation. For instance, the most common color assignation to the water is the blue, and it is accepted world wide, see [JOVI´C 92] to find other common colors interpretation.
- Space representation of vehicle displacement. In order to reference the user in the TOV mobilization is very important to present a coherent reference system. In this way, the user can build the environment of displacement.

[1] The use of a TOV in the space 3D demands a high sensory perception, selection of signals, memory, and delivery of conclusions and decisions, from the displays available to this purpose, without seeing directly the environment of the vehicle.

- Clear reference and a suitable versatility in the change of perspective.
- At least two levels of zoom, that allow the user to have a better perspective.
- Of a large monitor with high color resolution so it may simplify the tele-visualization of the vehicle.
- The displaying of different information using the same graphic (icons, etc), to reduce the space occupied in screen.

4. An Example of an UR Interface

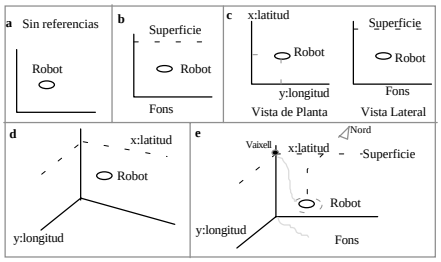

Fig.- 2 Different perspectives of a TOV in the space

Above, we saw some rules to design a user interface to operate a TOV in the space 3D. Now, we will define the interface to teleoperate an UR. If the TS designer does not present a coherent reference system to the user of a TOV, s/he may not follow the vehicle displacement. In Fig. 2, it may be seen different perspective to represent a single underwater vehicle. Figure 2e shows in a single interface all the information the user may need to understand the system. In an UR a coherent reference system is: the mother boat (where the UR goes out!), bottom of the sea, surface, north indication, etc. This information should have different colors to differentiate each of the different conditions.

Based on the recommendation explained in this article, we define the interface shown in Fig.- 3. There are three general columns of data, the first column defines the displacement in the three possible directions, and also the orientation and inclination of the robot. In the same column, a window shows the recommendation of the system, and the bottom down window lets the information command to control the robot. The main window (second column) is to visualize a perspective representation of the used placement and location of the robot, the reference system, the task point, and other information that may help the user's job. The last column is composed of a series of commands that enable the different controls available to manipulate the interface.

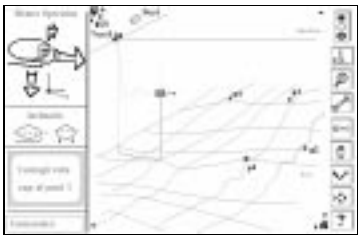
Fig.- 3 Interface for an underwater vehicle

5. Conclusion

This paper describes the characteristic design that some designers may consider in his/her TS. and the interface between such TS and a vehicle in the space. Also an example of a teleoperated underwater vehicle is described. The improvement of efficiency is obtained by reducing the number of variables shown, selecting the representative variables, and representing different variables in the same figure in a graphical way. In a TOV it is very important to represents a coherent reference system that can be followed by the user; in such a way the s/he requires a minimum information about the system behavior (energy, etc), and it constitutes a single function that may be easily tracked by an appropriated algorithm, while providing correct advise to the user.

6. Acknowledgment

We would like to acknowledge the contribution of Dr. Josep Amat and Dra. Alicia Casals for their help in correcting this work. Thanks also to the ESAII Departament for his collaboration and support.

7. References

[AMAT 95a] Amat, J., Batlle, J, Casals, A. & F., J.; "GARBI: The UPC Low Cost Underwater Vehicle", Joint US/Portugal Workshop in Undersea Robotics and Intelligent Control, Lisboa, March 2/3, 95

[AMAT 95b] Amat, J.,Codina, J., Cufy, X., Puigmal, J. "Vision Based Control Underwater Vehicle for Long Duration", ICAR´95,Seventh International Conference on Advanced Robotics, pp 273 - 277.

[FIORINI 93] Fiorini, P.; Bejczy, A. & Schenker, P.; "Integrated Interface for Advanced TO", IEEE CS, Vol. 13, Nº 5, Oct. 1.993, pp 15-19.

[HIRAI 92] Hirai, S.; Sato, T. & Matsui, T.; "Intelligent and Cooperative Control of Telerobot Task", IEEE CS, Vol. 12, Nº 2, Feb. 1.992.

[JOVI´C 92] Jovi´c, F; Process Control Systems, Principles of design, operation and interfacing, Chapman & Hall, London, 1.992