REMOT project

Experimental Setting for the Demonstration of the Teleoperation System

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D6.2: EXPERIMENTAL SETTING FOR THE DEMONSTRATION OF THE TELEOPERATION SYSTEM

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1. INTRODUCTION

In this document we aim to describe the operational tests for the Teleoperation System within the Astronomical framework, **provided a Local Control System (LCS) is given**. These tests are strictly related to the functionality of the LCS: we have made a cross-check of these two terms in order to allow a fast recognition of the hierarchical complexity of the operations. We want to stress the fact that the remote user should use the LCS as he/she were at the observatory console, i.e. he/she needs not to know how the Teleoperation System works. In addition, **the Remote User Interface described in this document, will be considered as a part of the Teleoperation System, and should be provided by the Teleoperation System builders.**

2. FUNCTIONALITY AND OPERATIONAL TESTS CROSS CHECK

In order to propose an Experimental Setting for the Demonstration of the Teleoperation System, we should be able to use all the functionality needed to perform the foreseen operational tests. We wish to underline the fact that, at the foreseen date for the Demo in the Astronomical Domain,

all the functionality described below should be working. In any case the operational tests that we will describe can be thought as a hierarchical stepwise list in which any element needs more functionality than the preceding ones. The results of this cross-check are shown in Table 1[1]: each row corresponds to one operative test and shows the functionality necessary to perform it; each column corresponds to one functionality and shows the list of tests in which it is needed.

	Functionality / Operation	Status Monitoring (Telescope + Dome	Movements Control (Telescope + Dome)	Pointing (Telescope + Dome)	Instrument Monitoring	Instrument Control	Calibration (Telescope + Instrument)	Tracking (Telescope + Autoguiding)	Scientific Data Transfer + Archiving
2	System Access Administration	X							
6	Element Monitoring	X							
13	Element Setup	X	X						
9	Environment Setup	X	X						
7	Dome Movements	X	X	X					
8	Telescope Movements	X	X	X					
4	Instrument Access & Control				X	X			
5	Internal Calibration				X	X			X
11	External Calibration (Telescope + Instrument)	X	X	X	X	X	X		X
12	Observation (without autoguiding)	X	X	X	X	X	X		X
10	Tracking (autoguiding)	X	X	X	X	X	X	X	
12	Observation (with autogiuding)	X	X	X	X	X	X	X	X

Table 1: Operative tests cross-check

[1] Note that the small numbers in the leftmost column refer to the blocks we use to identify the components of the object model for the tests to be performed and that we'll describe in the next section.

3. OBJECT MODEL FOR THE PILOT TEST

In this section we provide a scheme (presented as an object model) for the pilot tests that we are going to design and that we hope to be able to perform as a demonstration of the Teleoperation System Integration within the Astronomical Domain.

It should be noted that, in order to be allowed to perform the whole tests, we need the complete availability of the related functionality (see Table 1), and that all the single tests themselves are strictly necessary one to each other in the hierarchical order described in section 2.

As another feature, we want to stress the fact that the Object Model for the Tests reflects a complete description of the operational behaviour that an Astronomical System should offer, while the tests that we'll perform follow a more closed correspondence, like the one we can build between the numbered boxes presented in figure 2 and the operations described in table 1.

This can be seen in the following diagram, where we briefly sketch what we expect to be performed within the test, and which elements of the Object Model for the Tests it couples to:

Test to be performed	Blocks needed by the test
System Access	[1], [2], [3]
Element Setup	[1], [2], [3], [6]
Element Monitoring	Receives information from the blocks related to the system components that the user wants to monitor and sends it back to him under the control of the LCS
Dome Movements	[1], [2], [3], [6], [7]
Telescope Movements	[1], [2], [3], [6], [8]
Environment Setup	[1], [2], [3], [6], [9]
Instrument Access & Control	[1], [2], [3], [4]
Internal Calibration	[1], [2], [3], [4], [5]
External Calibration	[1], [2], [3], [4], [6], [7], [8], [11]
Autoguiding	[1], [2], [3], [4], [6], [7], [8], [10]
Observation without autoguiding	[1], [2], [3], [4], [6], [7], [8], [12]
Observation with autoguiding	[1], [2], [3], [4], [6], [7], [8], [10], [12]

Figure 1: Diagram for the correspondences between the Tests and the Operative Blocks of the Object Model for the Tests

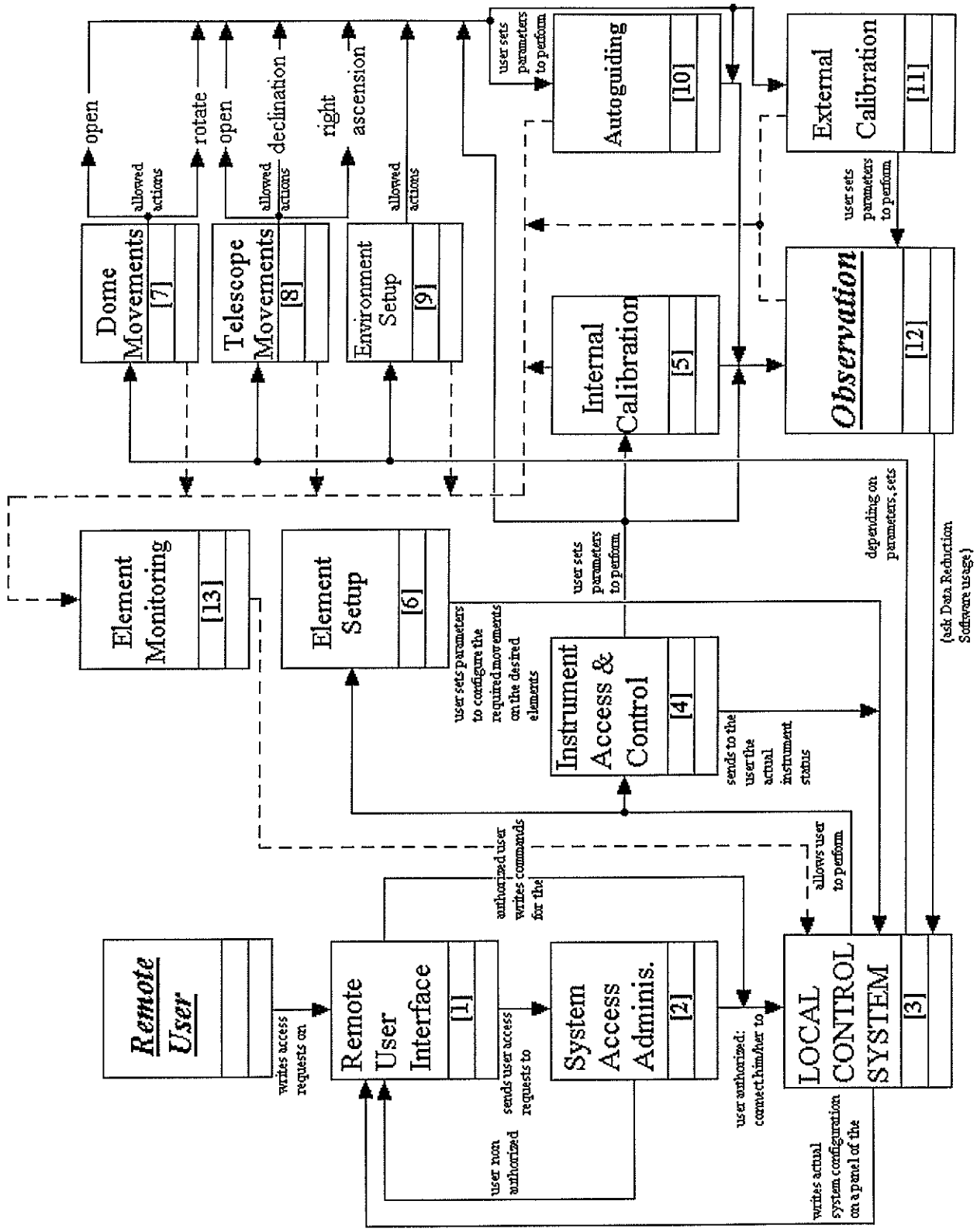

Figure 2: Object Model for the Tests

4. OBJECT MODEL DESCRIPTION

In the following paragraphs we will describe in more detail each element of the Object Model for the Tests and its interdependencies with the others. As already mentioned the list of elementary tests we want to perform is written in hierarchical form. The only tests that we can perform without checking the previous ones are the "Instrument Access & Control" and "Internal Calibration". In any case they are needed by the steps following them[2].

4.1 System Access Administration

With this operation the user should be able to connect to the LCS and perform a monitoring of the observatory status. By "observatory status" we mean a set of parameters which describe the actual Dome and Telescope configurations.

The requested functionality should give access to these parameters by reading out some local sensors. It is a low level one and it's obviously the starting step for the whole other tests. The values of the different parameters are normally summarized in a "status panel", whose design is given by the LCS. This step does not need a local human presence since no dangerous action is involved with it.

Inputs:	Outputs:
login	status panel

4.2 Element Setup

Once the remote user knows the actual observatory status he/she should be able to change it. This means that he/she should control some basic movements such as Dome opening, Telescope opening, Dome rotation, Flaps positioning, Telescope elevation and azimuth movements. At this point "setup" means that we send a set of commands that must be checked by the LCS with the supervision of a local operator, whose assistance is necessary hereafter. The commands relative to these basic movements should be summarised in a menu, in which the user should choose the desired field i.e.: Dome Opening ON/OFF etc.

Inputs:	Outputs:

[2] Attention has to be paid to the fact that these features refer to what we mean by an Astronomical Observation, to distinguish it from the instruments calibration phase.

Dome Opening ON/OFF	Dome Open confirmation
Telescope Open ON/OFF	Telescope Open confirmation
...	...

4.3 Element Monitoring

With this operation, the user should be informed about the actual status of the elements he/she is working on. This has to be done by the LCS, which sends messages and data describing the configurations that can help to understand the real time behaviour of the interactions with the system. A graphical panel of the Remote User Interface will be used to display this information.

4.4 Dome and Telescope Movements

The action of pointing the telescope and Dome ensemble is performed in different substeps: fast movement to a prefixed point (low accuracy with respect to the given co-ordinates), fine pointing (slow micrometric movements with high accuracy). Even if the control loop is still longer than 1 second the telescope position data transfer should be fast, in order to allow a real time control. For a fast movement the specific procedure syntax generally consists in typing a desired set of co-ordinates: Right Ascension=12h 30' 44", declination=45°, in the relative fields of the "pointing panel", and therefore send it to the LCS. The actual position of the telescope is read in the running co-ordinates fields of the "status panel". The fine pointing should be run with the feedback of the guiding camera that gives approximately the actual field of view and by use of a simple "arrows" panel. The tracking facility (i.e. the auto guiding of the telescope that must follow the guide star) is not necessary if the target is the Dome flat screen or the twilight sky.

Inputs:	Outputs:
R.A., Dec.	running co-ordinates
Dome lamp position	position confirmation

4.5 Instrument Access & Control

As already explained, this operational test (and the following one) can be carried on independently from the previous ones. The instrument control software is completely integrated into the LCS, but independent from the telescope and Dome status. The simple "access" means the monitoring of the actual instrument status, by reading a set of parameters

specific for the different instrumentation available. As happens for the telescope dome ensemble, also the instrument parameters should be represented in a "instrument status panel". Local human presence isn't requested at this step.

Inputs:	Outputs:
instrument login	instrument control panel

4.6 Internal Calibration

Once the remote user knows the actual instrument status he should be able to change it. This is necessary in the instrument set-up phase, which could also be performed during daytime. The actions requested depend upon the particular instrument. At this point we can also perform a so called internal calibration: this could be the case of dark current estimate, flat fielding (for CCD detectors), filters setting, ... Even if human presence is not strictly necessary at the local site, it could be requested in some cases like for the mounting of particular devices. The specific syntax of such a setting procedure depends strictly upon the instrument characteristics but it should always follow the general scheme of pressing field buttons or typing specific data in selected screen fields, i.e. for a CCD camera the user must choose the exposure type among prefixed opportunities offered in a "instrument control panel", and the exposure time by typing it in second units.
A functionality that could be requested to the teleoperation system is the "scientific data transfer" (i.e. lossless compression).

Inputs:	Outputs:
Exposure type: Flat	Flat ready (internal lamp on)
exp.time=3000sec	exp.time=3000sec
go exposure	exposure running/performed
...	...

4.7 External Calibration

This step is used to calibrate the telescope plus instrument ensemble on actions as the Dome flat fielding, sky flat fielding or the auto-check of active optics (if any). All the previous functionality shall be effective and local human supervision is needed. In addition to the previous procedures, these external calibrations should offer the control on some external accessories as Dome lamps (ON/OFF), or special devices (normally not used in the scientific observations), as reference

artificial laser stars. The control of these tools should be offered as specific panels called by selecting the related fields in the already cited "telescope Dome control panel".

Inputs:	Outputs:
Dome lamps ON	Dome lamps control panel
(as in the previous section)	

4.8 Autoguiding

The remote astronomer has the responsibility of identifying the scientific target. This means that he/she should be able to get a preliminary field of view once the telescope has been pointed. In order to achieve it, the tracking or autoguiding facility (i.e. the telescope follows the guide star) must run and the field of view camera must be switched on. In addition of what described in the 3.3 section, the user should only select the "tracking ON" button.

At this step a lossy compression, to be selected from the teleoperation system services, could be acceptable. Human presence is needed at local site.

Inputs:	Outputs:
Target OK? Yes	Target confirmed
Tracking ON	Tracking ON

4.9 Astronomical Observation (<u>with</u> autoguiding)

At this point all the functionality must be effective. In addition we can expect that during a long exposure the remote astronomer could ask to perform some preliminary data reductions using the local Data Reduction Software. This means that the remote astronomer should be able to access to the DRS independently from the LCS control facility. Human presence is needed at local site.

Inputs:	Outputs:
DRS options	DRS control panel
abort exposure	**exposure aborted**
stop exposure	**exposure stopped**
continue exposure	exp. time to go
	exposure terminated
...	...

Referring to the Astronomical Observation without autoguiding, the only difference with the operation just described consists on the fact that the tracking facility is put OFF.

5. PERFORMING THE TEST

As already stated, the global pilot Test, that we are designing to verify the behaviour of the integration of the generic Teleoperation System with the Astronomical Domain Applications, will be split into a set of smaller tests, each one devoted to add a more complex feature to the whole system or to run a deeper operation in the hierarchy.

Our aim, while performing the complete set of elementary tests, will be to show how an Astronomical Observation has to be handled.

In the following paragraphs we'll describe all the steps that a user has to follow in order to perform the Astronomical Observation[3]. It should be noted that any step of the test can be considered as an additional verification of the behaviour of the Teleoperation System usage.

In the following figures, the pushable buttons have a label on them and a grey colour, the writable fields are filled with a darker grey colour, the selectable menus are represented as pushable buttons and the hidable buttons are drawn in a darker grey colour.

5.1 System Access [1], [2], [3]

The remote user is sitting at his/her own desk, where a computer environment, supplying a remote access control facility, is provided.

When the user asks the computer system to run this facility, he/she will be provided with a graphical window where his/her login name and password should be written and the user type has to be chosen from a predefined menu (figure 3).

[3] For the sake of completeness, we associate every test we are going to describe with the blocks of the Object Model for the Tests of figure 2.

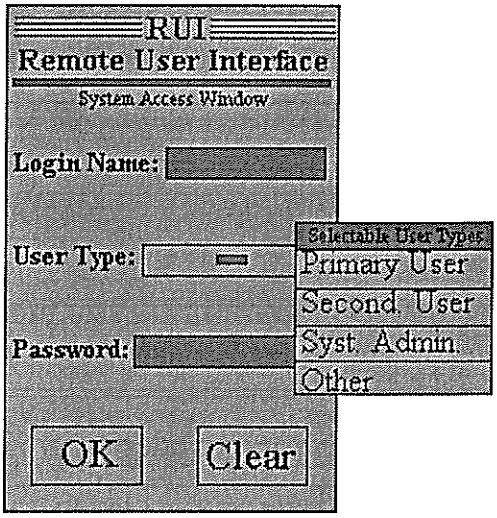

Figure 3: The System Access Window

If authorized, the Session Identification Window (figure 4) and then the Remote User Interface Main Window (figure 5) are visualized, by opening graphical windows which respectively show information about the session opening and the actual observatory status. Contemporarily the environment for that user type is set. At this point he/she will have to choose the actions to take on by consulting some predefined menus, containing all the operations he/she is allowed to ask (Dome Movements, Telescope Movements, Instrument Access & Control, ...).

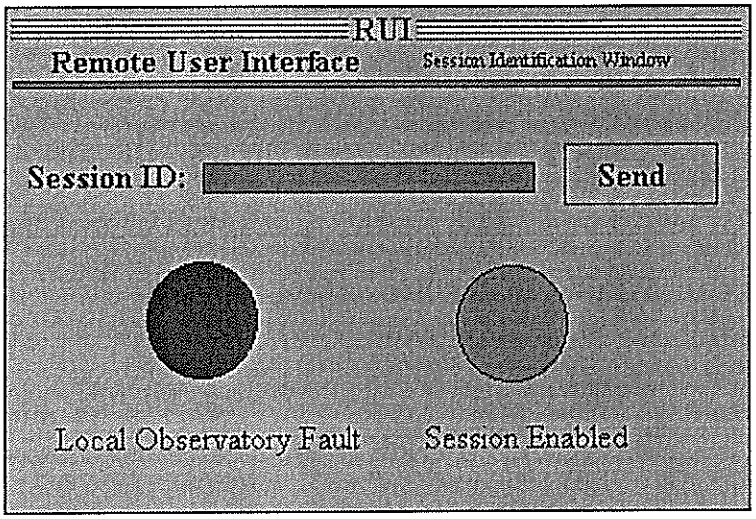

Figure 4: Session Identification Window

5.3 Element Monitoring Receives information from the blocks related to the system components that the user wants to monitor and sends it back to him under the control of the LCS

This functionality will help the user to know the real time status of the elements he/she is using.

This is obtained by sending back to the Remote User Interface any information about the actual element usage (see figure 7).

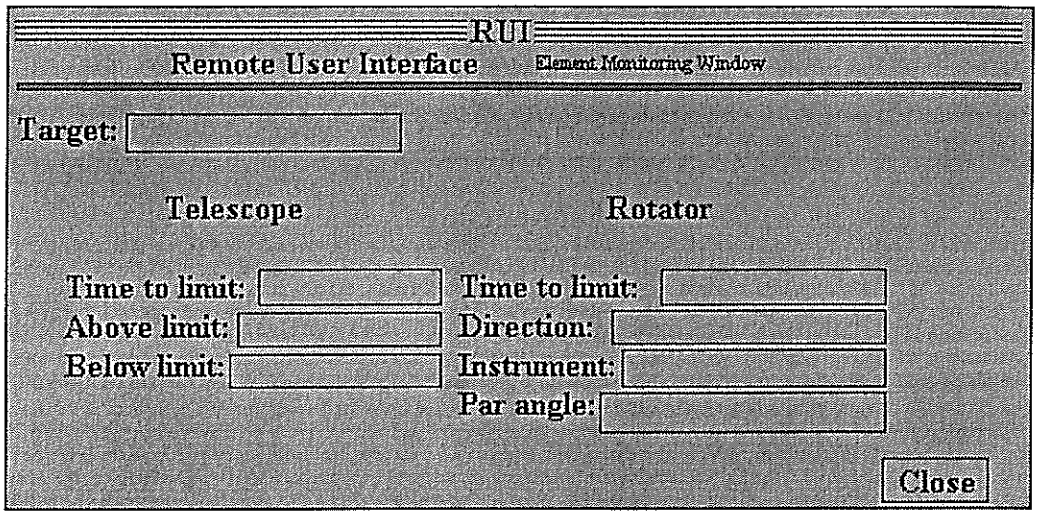

Figure 7: Element Monitoring Window

5.4 Dome Movements [1], [2], [3], [6], [7]

At this level the Dome Movements are not directly controlled by the remote user, but automatically managed by the **Go To** functionality of the Remote User Interface Main Window.

This feature, related also with the Telescope Movements, is shown in a single graphical window, as described in next paragraph.

5.5 Telescope Movements [1], [2], [3], [6], [8]

The remote user selects a target from the Remote User Interface Main Window by selecting one item in the target fields. The targets can be seen and inserted by means of the New Next button, which will show a window like the one displayed in figure 8.

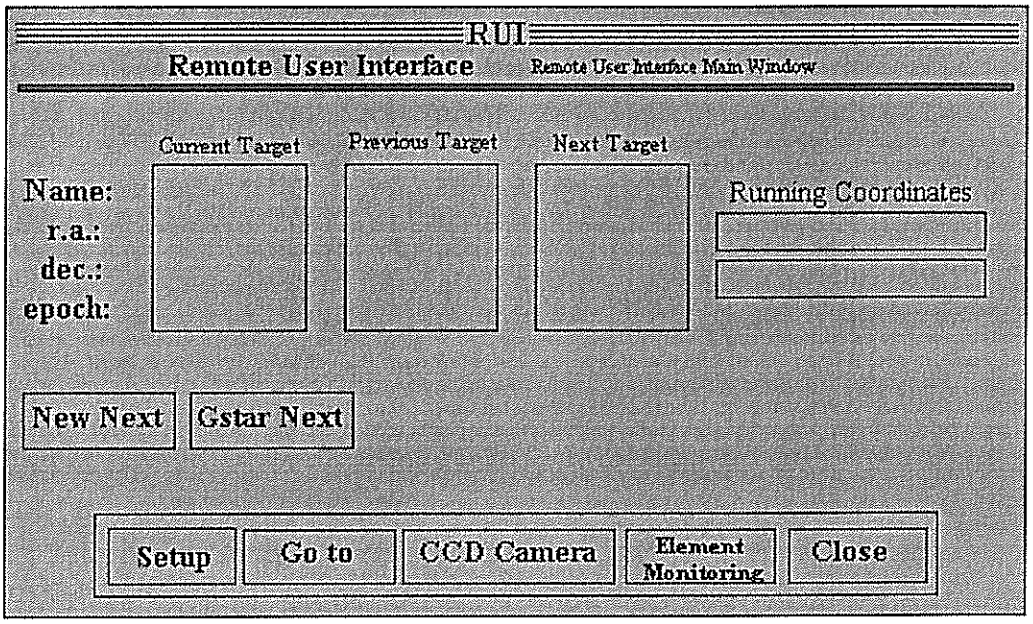

Figure 5: Remote User Interface Main Window

5.2 Element Setup [1], [2], [3], [6]

The remote user chooses the telescope element he/she wants to interact with and the actions he/she wants to perform on it or the characteristic parameters he/she needs to go on with the experiment.

This could be the case of Dome opening and Telescope opening.

All this information will be sent to the LCS, which, in turn, will take the corresponding actions on the appropriate element (see figure 6).

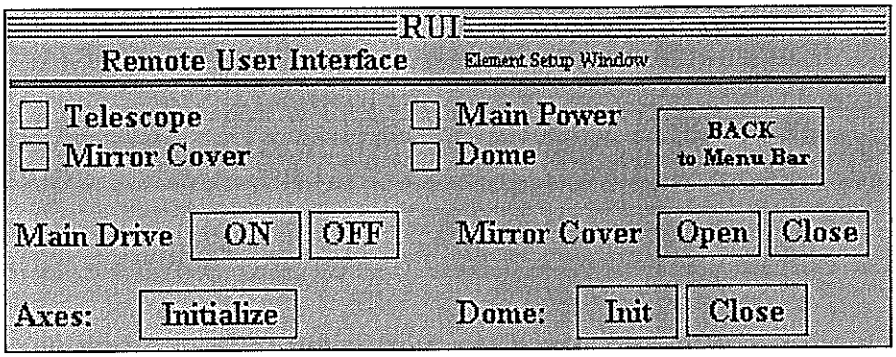

Figure 6: Element Setup Window

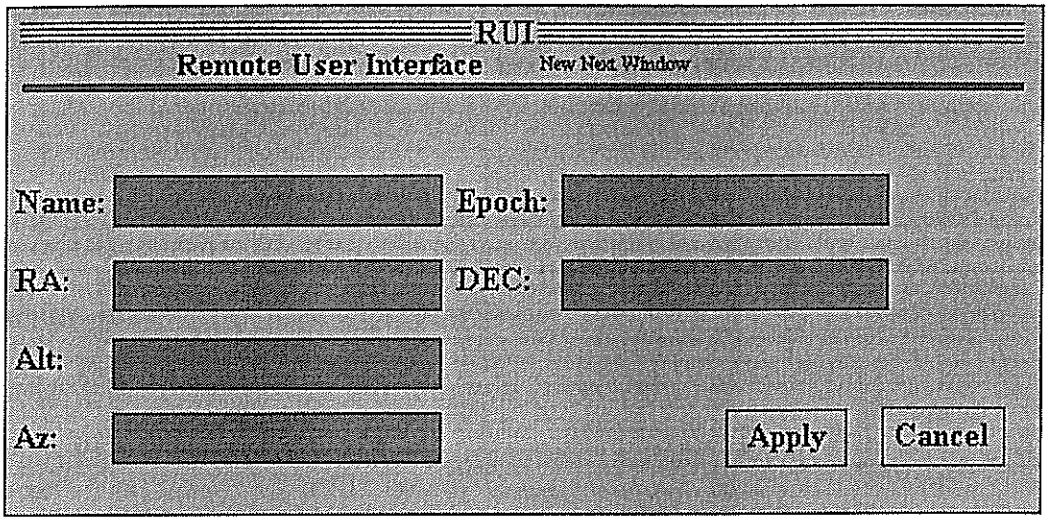

Figure 8: New Next Window

After the target has been selected, the user pushes the **Go To** button (figure 9). The Dome-Telescope ensemble will move to the desired coordinates.

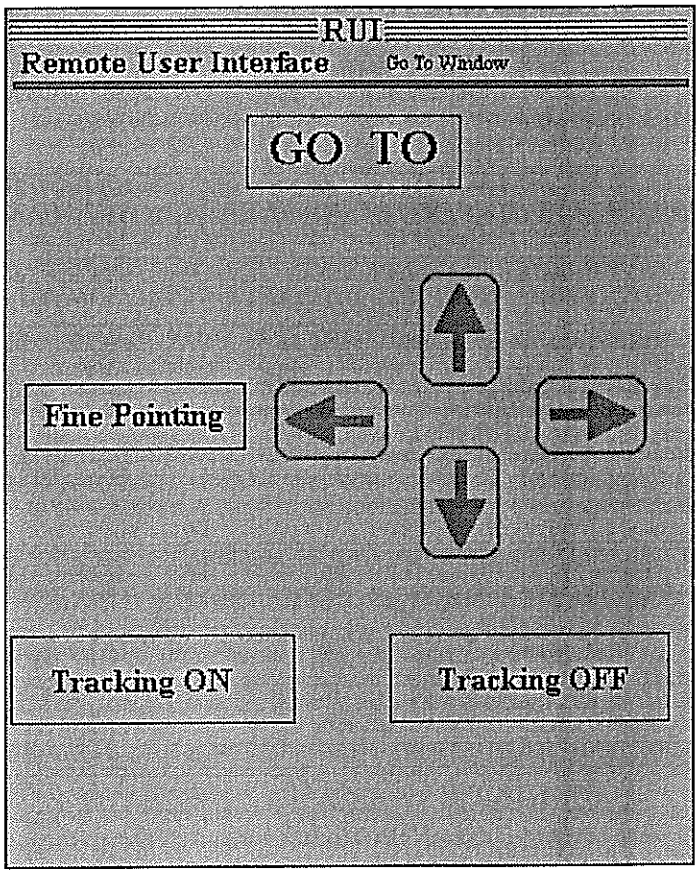

Figure 9: Go To Window

5.6 Environment Setup [1], [2], [3], [6], [9]

This feature is not provided within the Pilot Test.

5.7 Instrument Access & Control [1], [2], [3], [4]

For the Pilot Test, the only instrument foreseen as available is the CCD Camera. The "Instrument Access & Control" operation is made operative by pushing the related button of the Remote User Interface Main Window.

According to this action, the window sketched in figure 10 will appear.

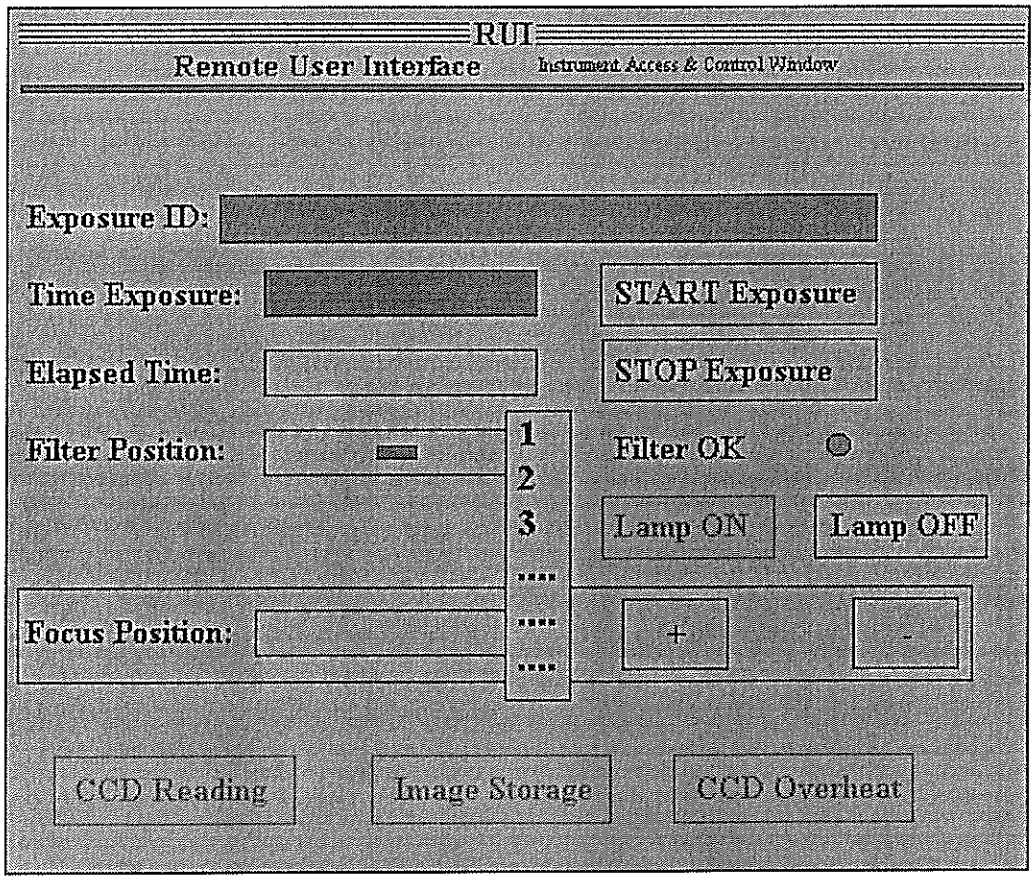

Figure 10: Instrument Access & Control Window

5.8 Internal Calibration [1], [2], [3], [4], [5]

This is an action performed by setting some parameters of the "Instrument Access & Control" window. Essentially two internal calibrations are foreseen:

- Bias (a 0 seconds exposure in which the electronic bias is read from the CCD);
- Flat Field (a lamp exposure used to record the pixel-to-pixel variations of the CCD).

5.9 External Calibration [1], [2], [3], [4], [6], [7], [8], [11]

This is a calibration which uses a source external to the instrument such as a Dome lamp or the twilight in order to perform a Flat Field Observation. In this classification the fine tuning of focus is included too.

5.10 Autoguiding [1], [2], [3], [4], [6], [7], [8], [10]

In order to use the autoguiding facility the user must specify a guide star by means of the Gstar button of the Remote User Interface Main Window.

This can be shown in figure 11.

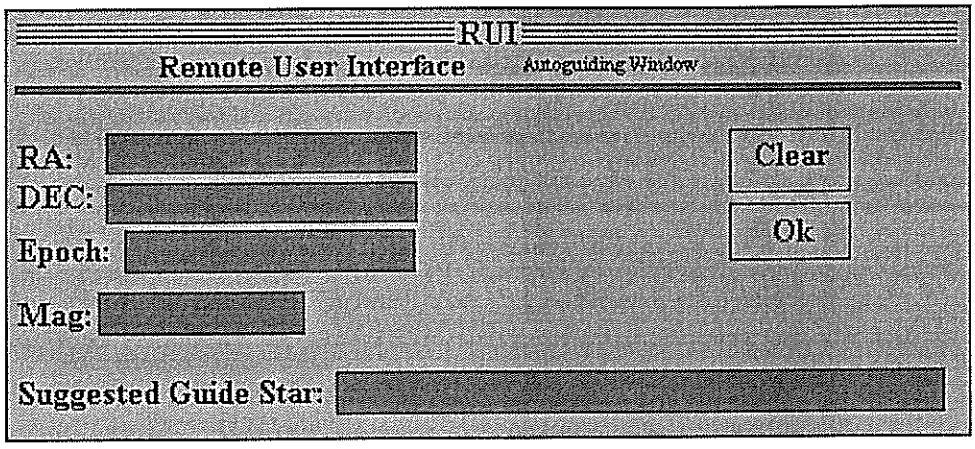

Figure 11: Autoguiding Window

The Guide Star is identified by means of the Autoguiding System, which is independent from the current facility.

5.11 Observation without autoguiding [1], [2], [3], [4], [6], [7], [8], [12]

The user could decide to make an observation without the autoguiding. The tracking facility is always available on request.

5.12 Observation with autoguiding [1], [2], [3], [4], [6], [7], [8], [10], [12]

Once all the previous steps are performed and the scientific target is pointed, the user starts the scientific exposure and waits for the resulting image.

5.13 Graphic Window

When the exposure is over, the remote user can watch at the resulting image by means of the graphic window, already described in document D6.1.

This is why we give a simple layout of it being it software dependent (see figure 12).

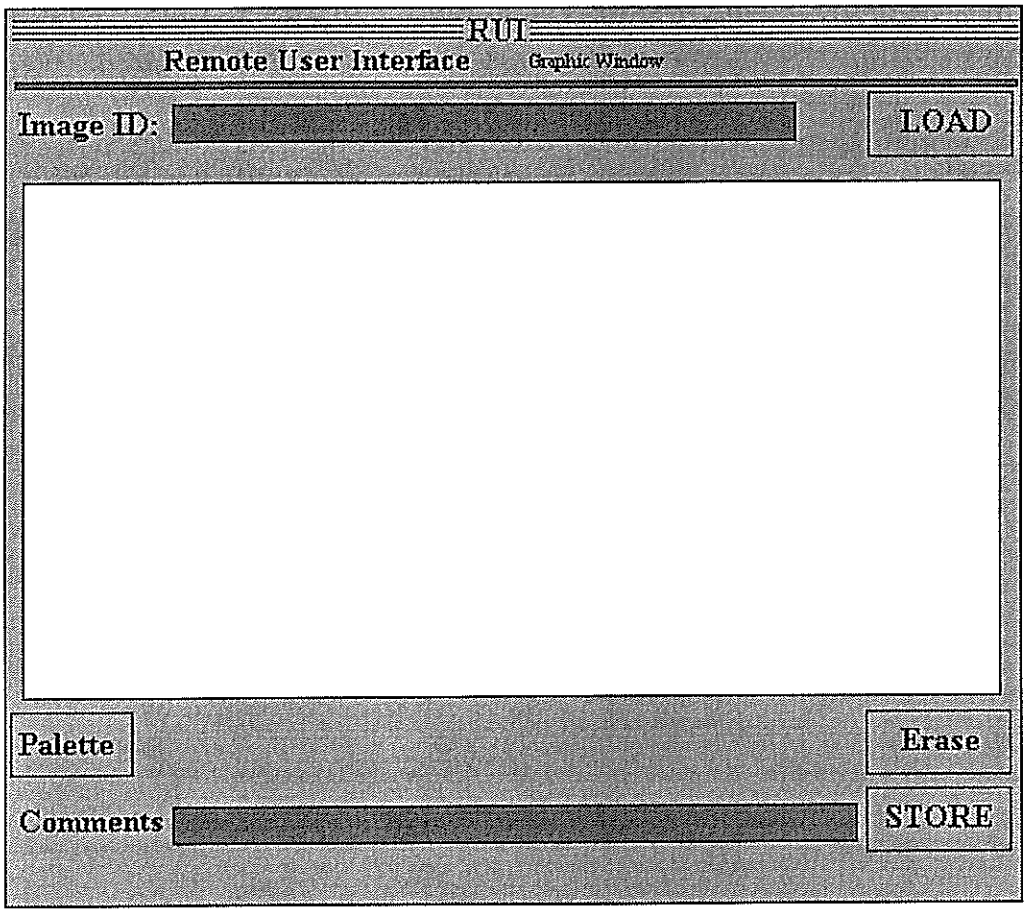

Figure 12: Graphic Window

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