ICD ?.?/?.? “The NICI to Adaptive Optics Interface”

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February 26, 2002
Ver 1.0

Issued By: MKIR

Revision Control

1.0 Initial ICD

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1 Description

1.1 Purpose

This Interface Design Description describes the interface between NICI and the Adaptive Optics (AO) subsystem This specific interface is governed by the design specifications of the Adaptive Optics system. This system is developed as part of the (Hey Doug!? Who is the actual developer of this?)

NICI communicates with the AO system to sharpen the images focussed on the imaging array and to control the position of the image on the array. Status of the AO system relayed through the instrument Controller and Instrument Sequencer will affect the TCS and the movement of the entire telescope system.

1.2 Scope

This document describes the interactions between the AO and NICI . The two main modes of operation are for normal user control or for engineering control.

1.3 Stylistic Conventions

Text within angle brackets like this < > is used to indicate a range of possible values. Discrete choices are separated by a vertical bar like '|', while a range of choices are separated by a pair of periods like '..'. Units or data type are presented in square brackets like this [ ].

2 Related Documents, glossary and acronyms

2.1 References

[1] *OCDD for NICI, Doug Toomey*
[2] The Command Set for the IRTF AO Sysytem *"AO IC Command Dictionary":* http://irtf.ifa.hawaii.edu/~ao/software/htdoc/ic_commands/index.html.

2.2 Abbreviations and Acronyms

AO Adaptive Optics System
EPICS Experimental Physics and Industrial Control System
IC Instrument Controller
IOC Input-Output Controller

MKIR Mauna Kea Infrared
NICI Near Infrared Coronagraphic Instrument
N/A Not applicable here
NGS Natural Guide Star

TCP/IP ethernet protocol used for information transfer
Tcl/Tk Portable scripting language developed by John Osterhout
TBD To Be Determined
TCS Telescope Control System

2.3 Glossary

IS Instrument Sequencer One of the data processing elements of NICI dedicated to converting control information from Gemini's epics system into discrete commands for the NICI instrument to perform. The IS will report back to epics on actions taken by NICI.
IC Instrument Controller – One of the data processing elements of NICI dedicated to processing specific commands intended for NICI. This is the primary interface into NICI for the instrument sequencer or for stand-alone (engineering) mode.

2.4 Related Interface Control Drawings

Not applicable

3 Physical System Interfaces

This interface will be implemented between the NICI instrument control CPU (IC), and the AO hardware.

3.1 Mechanical Interface

Not applicable

3.2 Optical Interface

Not applicable

3.3 Electronic Interface

This interface will be implemented between the NICI instrument control CPU (IC), and the AO hardware. This is intended to be an Ethernet interface connecting the various subsystems that make up the NICI instrument.

3.4 Mass/Balance

Not applicable

3.5 Thermal Interface

Not applicable

4 Software/Control Function Interface

4.1 Communication Infrastructure

The communication of information is achieved by using the TCP/IP socket connections inherent available in the operating system support of both the Adaptive Optics and the Instrument Controller processors. Both machines will be running sockets communicating with Tcl/Tk engines. This provides the functionality required to format and exchange control information between these two subsystems.
The IC will be a “client” of the AO “server” and will initiate all transactions.

5 Behavior

The two main interactions with the AO system are during initialization and during normal running.

5.1 Initialization

During initialization, as well as engineering mode, the commands will be to reset, initialize, set low-level parameters, and read low-level state. Command sequencing for initialization will consist of from the IC to the AO system and require only that the responses fall within a narrow range of acceptable values. Otherwise the initialization sequence fails and diagnostic (human) interaction is needed. Diagnosis during engineering mode will consist of commands sent by way of a glass teletype command-line interface to the AO system. In this manner, any AO system command can be typed directly with the AO's output coming back for immediate display.

5.2 Normal Use

During normal use, the AO system will be asked to control the image quality, to report telescope re-positioning information and report on the raw photon counts of the AO detector array. Only a few commands will be used and these correspond directly to the high level AO commands detailed in ICD's for IS2IC and OCD2NICI.

6 Scenarios

This section describes the interactions for operation of the AO system. Initialization is not detailed here.

6.1 Control of Image Quality and Control of Image Position

When NICI is running with AO corrections it will sharpen the focus of the image as well as position the guide to the center of the image array. The NICI AO system can only handle so much tilt or focus correction. When the limit is reached a command must be sent to the telescope to move the telescope of change the focus position of the secondary. In this manner the AO system will control the telescope fast focus and fast tilt. As such it must communicate with the telescope to take control of these functions from the telescope systems. These will be slow corrections that will happen periodically.
This is typically commanded once at the start of a new object and is based on the seeing conditions and the brightness of the guide star. This is an input to the AO system and will be done typically at the start of an observation and not usually changed until a new object is selected.
As the telescope position drifts the NICI AO system will correct for this wavefront tilt with the DM and the tip/tilt stage behind the DM. When the tilt correction in the AO system exceeds a preset limit a command will be issued from NICI to GEMINI to offset the telescope by a certain amount in a certain direction. How often this happens will be determined by the tracking rate error of the telescope. Corrections should be expected at a rate comparable to what has been seen with the Hokupaa system. It is expected that these corrections will be made ???? times/hour.

The information from the AO to the IC is of the form:
Focus:

`Focus amount`

Where `amount` is the focus shift in mm (positive means focus moves toward the floor)

Tilt:

`Offset ra dec`

Where `ra` is the right ascension and `dec` is the declination.

These messages will be translated into appropriately formatted requests to the IS (and from there to the TCS).

6.2 Enable/disable NICI or Gemini control of tilt and focus

When we energize our AO system we will want to control the focus and telescope position. Normally Gemini controls those using information from a peripheral wavefront sensor(a little guide camera off to the side looking at some other star). Our information is better and we do not want both servos running so we must ask Gemini to stop controlling tilt and focus. This will be a controlled interaction between the IS and IC:

1. The user sends the request to energize the AO system
2. The IC receives that request and tells the AO system to start the loop
3. The IC sends the request up to the IS for Gemini to use AO information for focus and position

6.3 Controlling The Membrane Mirror Stroke

The membrane mirror stroke is like an optical gain. When the stroke is changed a different interaction matrix must be used. When the user requests a certain membrane mirror stroke the AO Command Object in the IC also updates the AO's matched interaction matrix.

The present command to the AO system is:

membrane frequency phase stroke

frequency is in Hz
Phase is in some local units
stroke is in some local units 0-80000

6.4 Commanding The Value Of The Loop Gain

The loop gain is the value multiplied by the calculated correction,which is typically in the range of 0.1 -0.2.
Command to AO:

```
Gain gainValue
```

Where `gainValue` is in the range of 0.0 to 1.0

6.5 Pausing the AO Correction Loop

This allows the AO loop to pause while the telescope goes off to do a sky frame. All control parameters remain frozen.

Command to AO:

```
lp.state  idle
```

The keyword `idle` will pause the loop.

```
Lp.state feedback
```

The keyword parameter `feedback` will complete the feedback loop and re-enable the AO system.

6.6 Raw Detector Counts

The corrections of the AO system depend on an array of photon detectors. The amount of energy received by these detectors must be monitored on a continual basis: If too little energy is received, the corrections become erratic and unstable. If too much energy is received, the detectors may become saturated and even damaged. While hardware interlocks prevent the actual damage to the array, the data from these detectors is made available for monitoring purposes.

The command:

counts `decay`

which returns the 85 counts integrated by the factor `decay`. Where `0 <= decay < 1.0.`

7 Detailed description

This section will describe in detail the interface issues.

7.1 Command Set

The commands of the AO system are supplied by the IFA. These commands are detailed in the URL:
http://irtf.ifa.hawaii.edu/~ao/software/htdoc/ic_commands/index.html

7.2 Command description

All the commands recognized by the AO are passed from the IC by way of the internal NICI TCP/IP communication system.

7.3 Status information

All the status information generated by the AO system is passed to the AO command object by way of the internal NICI TCP/IP communication system.

7.4 Alarm conditions

N/A

7.5 Debugging and Maintenance

This interface will be debugged using the Data Server supplied by the DHS.

7.6 Simulation

This interface will be simulated using the Tcl/Tk simulation of the AO command set.

8 Safety Issues

The photon detector array can be damaged by intense photon energy when powered on. For this reason, hardware interlocks prevent damage. These hardware interlocks do not require any software set-up or control.