Grid-Enabled SEE++

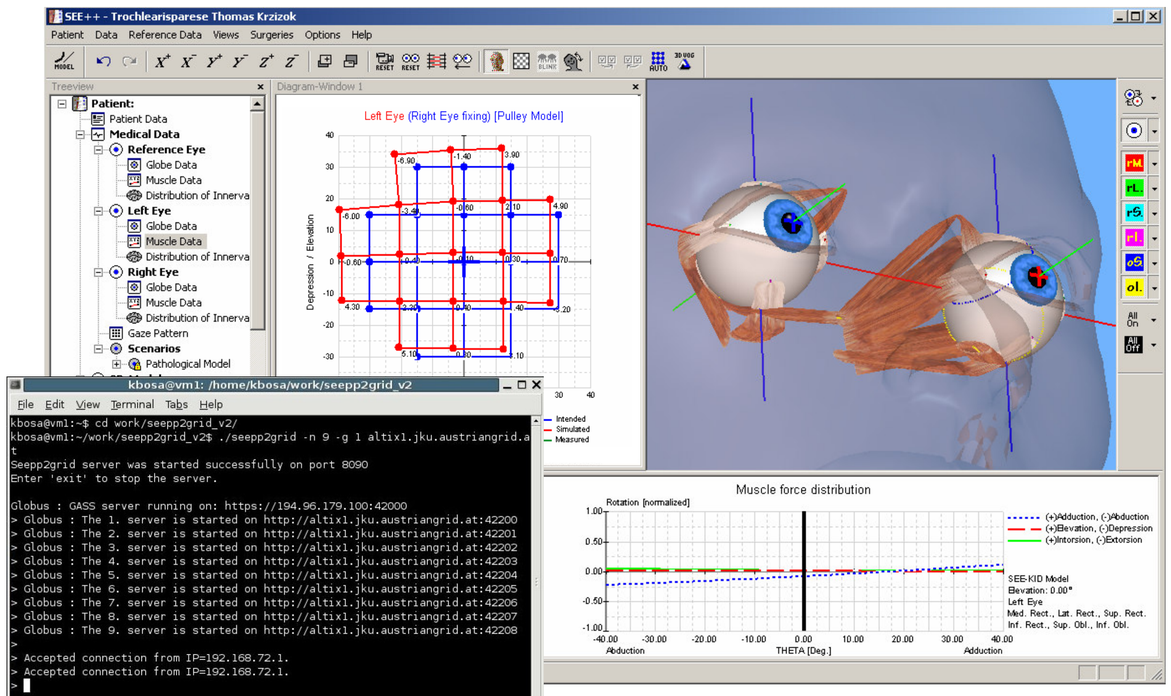
A Grid Software for Virtual Eye Surgery Based on Globus 4 and gLite

Abstract

"Grid-Enabled SEE++" is a software system that deals with the support of diagnosis and treatment of strabismus. Its goal is to adapt and to extend the original SEE++ in several steps and to develop an efficient grid-based tool for "Evidence Based Medicine", which supports the surgeons to choose the optimal surgery techniques in case of the treatments of certain eye motility disorders. Originally, we have designed and developed a grid-enabled version of the SEE++ based on Globus Toolkit 4. Since we met with some limitations of Globus 4, we also designed a version of "Grid-Enabled SEE++" compatible with gLite.

Terminology

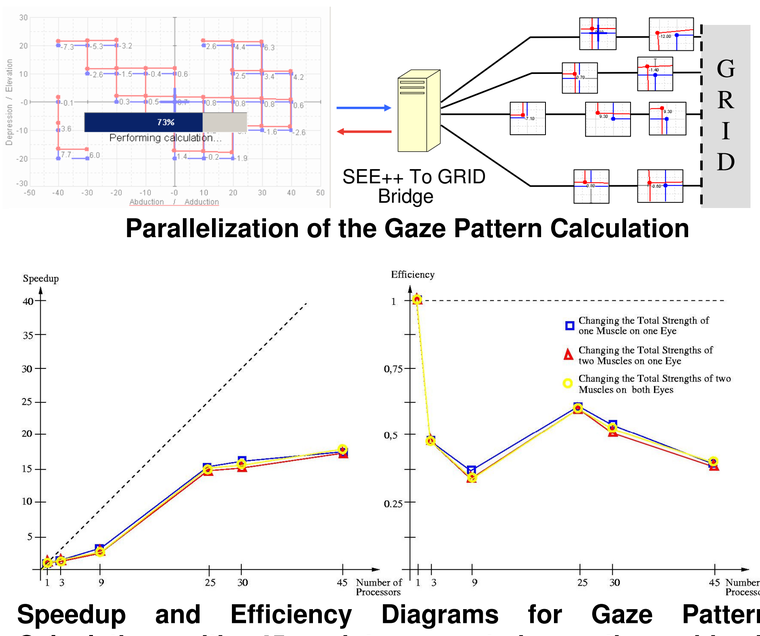
- ***Strabismus*** is the common name given to usually persistent or regularly occurring misalignment of the eyes where eyes point in different directions such that a person may see double images.
- SEE++ is able to simulate a typical medical examination called ***Hess-Lancaster test***, from which the reason for the pathological situation of the patient can be estimated.
- The outcome of the Hess-Lancaster test consists of two ***Gaze Patterns*** of blue points and of red points respectively (see the diagram in the middle of the GUI of SEE++ on Figure 1) . The blue points represent the image seen by one eye and the red points the image seen by the simulated other eye; in a pathological situation there is a deviation between the blue and the red points.
- ***Pathology Fitting:*** It is possible to give the measured gaze pattern of a patient as input. In this case, SEE++ takes some default or estimated eye data and modifies a subset of them until the calculated gaze pattern of the simulated eye (red points) matches the measured gaze pattern (green points).



The User Interface of the "SEE++ to Grid Bridge" (in front) and the GUI of the SEE++

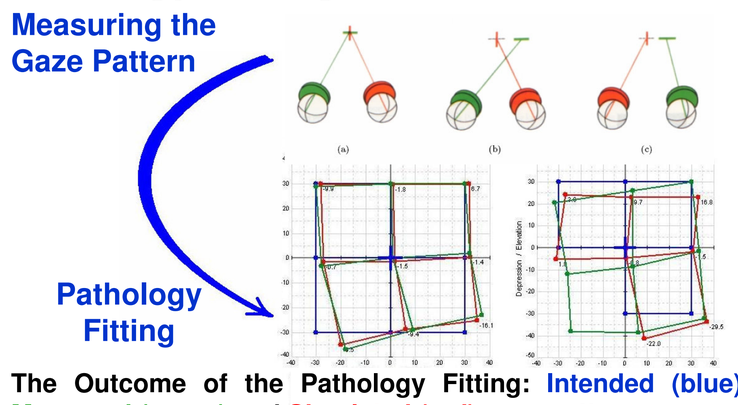
I. Former Results with Globus 4

I.a Grid-Enabled *Hess-Lancaster* Test. The Speedup is a factor of 14-17.



Speedup and Efficiency Diagrams for Gaze Patterns Calculation with 45 points executed on the grid site *altix1.jku.austriangrid.at* (64 Intel Itanium processors 1.4GHz)

I.b Preliminary Studies with the Pathology Fitting



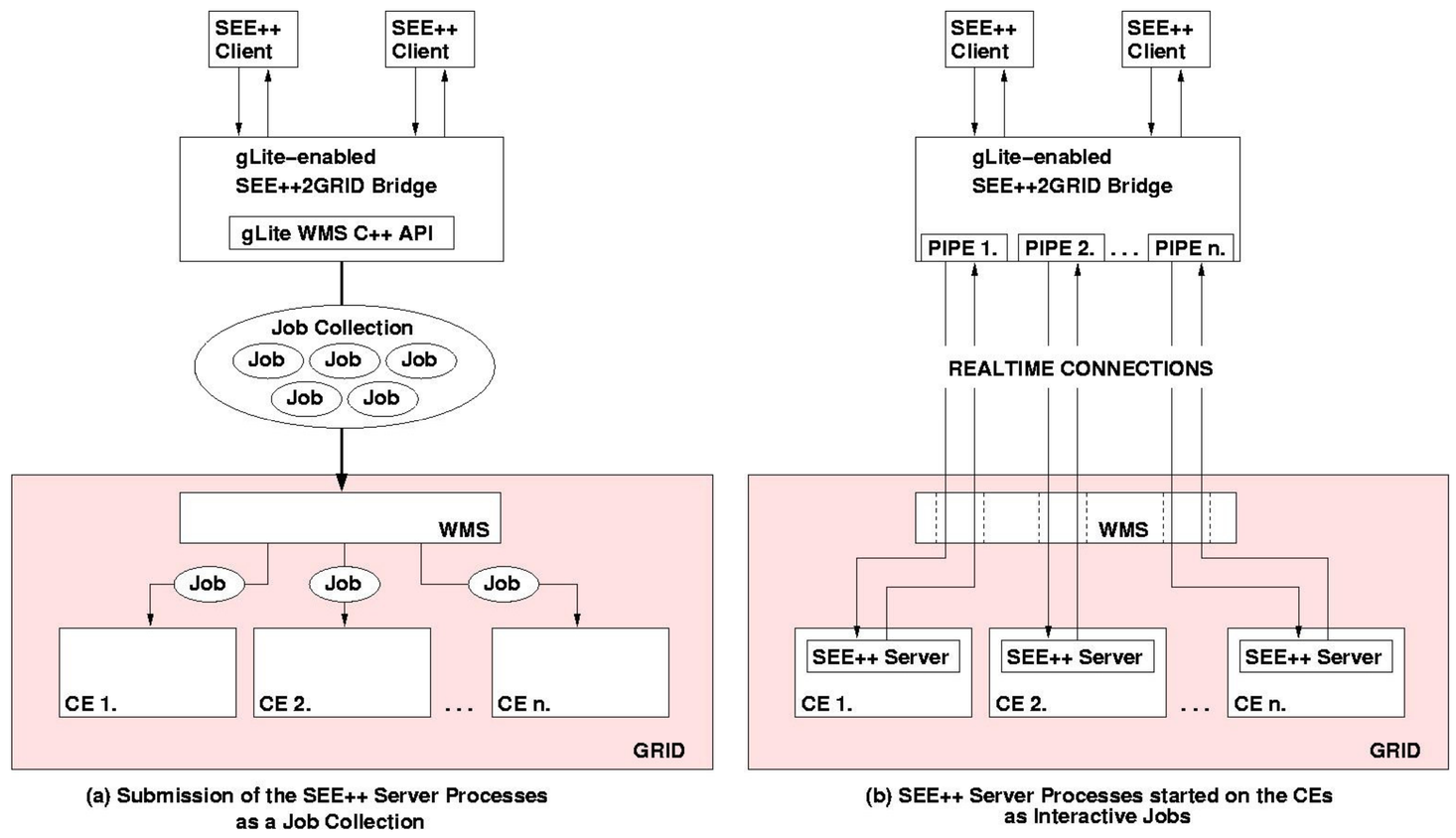
The Outcome of the Pathology Fitting: Intended (blue), Measured (green) and Simulated (red) gaze patterns.

```
/*
Eye : Initial Eye Model
M   : Measured Gaze Pattern
H   : Heuristic
*/
pathologyFitting(Eye, M, H)
  E1 := Eye
  C1 := gazePattern(E1)
  if C1 matches M return E1

  loop
    p := nextParameterVariation(H)
    if p is equal to NULL return E1
    E2 := optimization(p, E1, M)
    C2 := gazePattern(E2)
    if C2 fits M better than C1
      E1 := E2
      C1 := C2
      if C1 matches M return E1
```

```
/*
p  : a Type of Eye Model Parameter
E1 : Eye Model
M  : Measured Gaze Pattern
*/
optimization(p, E1, M)
  v = vector of the p parameter values
        on the six eye muscles in E1

  loop
    C2 := gazePattern(E1, v)
    if |M−C2| < ε return E1
    v2:= OptimizationStep(v, |M−C2|) /* with Jakobian
         and Hessian matrix calculations */
    Update parameter p in E1 by v2
    v := v2
```

A Draft of the Pathology Fitting Algorithm

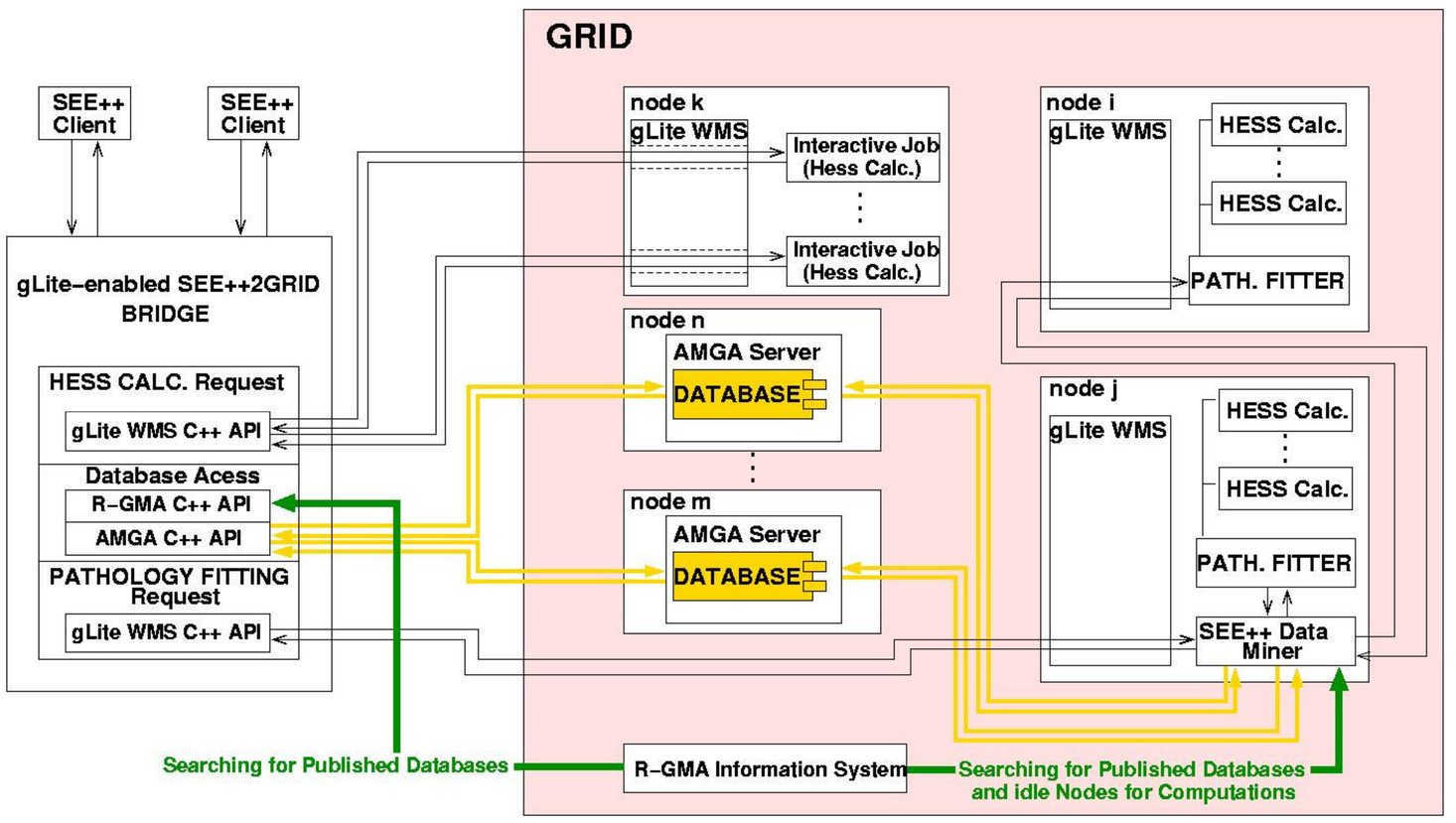
II. The Initial Architecture of SEE++ based on gLite



(a) Submission of the SEE++ Server Processes as a Job Collection

(b) SEE++ Server Processes started on the CEs as Interactive Jobs

III. The Entire Design of the gLite Compatibe SEE++



Upper Austrian Research GmbH
http://www.uar.at
http://www.see-kid.at

Research Institute for Symbolic Computation (RISC),
Johannes Kepler University,
Linz, Austria
http://www.risc.uni-linz.ac.at

www.austriangrid.at

Austrian Grid is a project funded by the *bm:bwk (Federal Ministry for Education, Science and Culture)* after recommendation by the Austrian Council for Research and Technology Development.

EGEE-II INFSO-RI-031688