Scaling-up MATLAB® Application in Desktop Grid for High-Performance Distributed Computing — Example of Image and Video Processing

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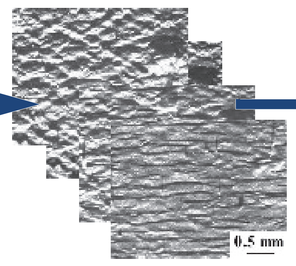
Introduction: Recently, the distributed computing model becomes very popular due to feasibility to use donated computing resources of idle PCs by means of the BOINC software platform [1] and availability of simple and intuitive Distributed Computing Application Programming Interface (DC-API) [2]. Usually, a sequential application by slight modifications in its code could be ported to the parallel version for worker nodes of a distributed Desktop Grid (DG). It is possible for an application with independent processing of big volume of data in a client-server model, for example, for batch image and video processing.

The main aim of the work was to develop an example and test the applicability of integration of MATLAB® objects and codes in a DG for high-performance distributed computing on the example of image and video processing in solid state physics [3].

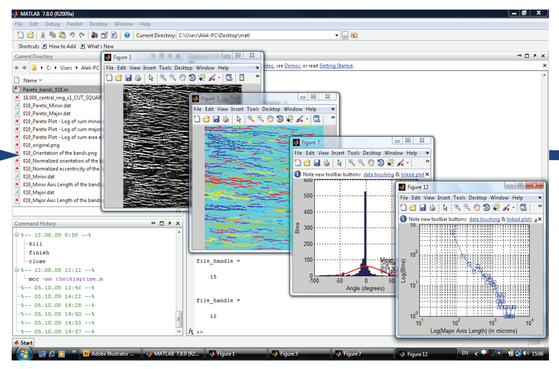
1. Typical Experimental Workflow

Experimental machine for mechanical test of metals

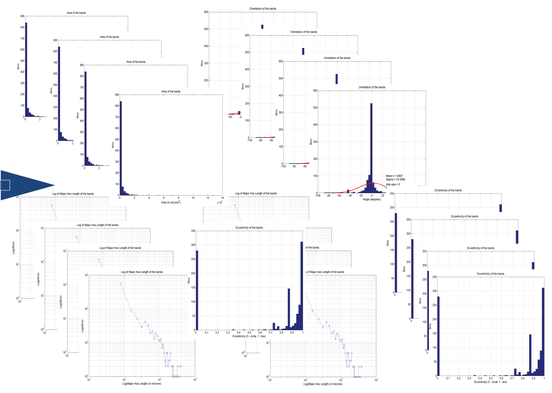
High-Speed Video Camera captures metal surface evolution



Output is Video File (>10^5 frames, >1 Mpixels)



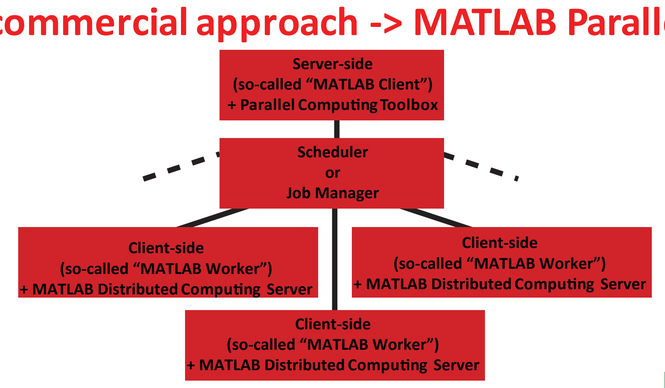
Slow sequential processing of video file (>10^5 frames) in MATLAB® IDE



Scientific results (plots, datasheets)

2. Possible Ways to Increase Video Processing Perfomance by Parallel Computing with...

... standard commercial approach -> MATLAB Parallel Computing Tools



This approach requires **commercial** software:

- Parallel Computing Toolbox™ (**in package**);
- **Distributed Computing Server™ (MDCS) (commercial);**
- **+ MATLAB MDCS™ license for the cluster (!).**

Typical obligatory procedures:

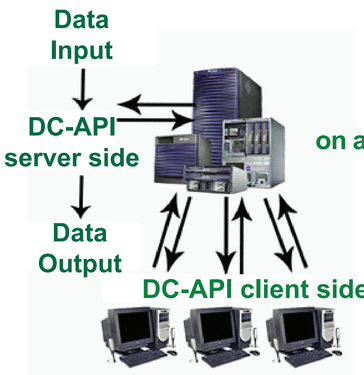
1.Install a server (so-called "MATLAB Client"):
- obtain a license file, install MDCS, start the License Manager on a server;
- test licenses of workers (**log in to all workers**).

2.Develop your parallel MATLAB application

3.Configuring worker nodes ("MATLAB Workers"):
- install the "mdce" services (**on all workers**);
- start the Job Manager and **manually list all workers**.

4.Run application with **manual** housekeeping.

...our original approach -> MATLAB Compiler + DC-API + BOINC DG



This approach requires **free** software:

- BOINC software (**freeware**);
- DC-API libraries for DG by SZTAKI (**freeware**);

+ MATLAB Compiler + MATLAB Compiler Runtime(MCR)
(in package, if you have MATLAB, then you already have them)

All you need to do is:

1.Install Desktop Grid (DG) with a BOINC DG-server

2.Develop your parallel MATLAB application

3.Wrap MATLAB-functions to DLL-library by MATLAB Compiler.

4.Port an application with the DLL-library to BOINC environment with DC-API calls.

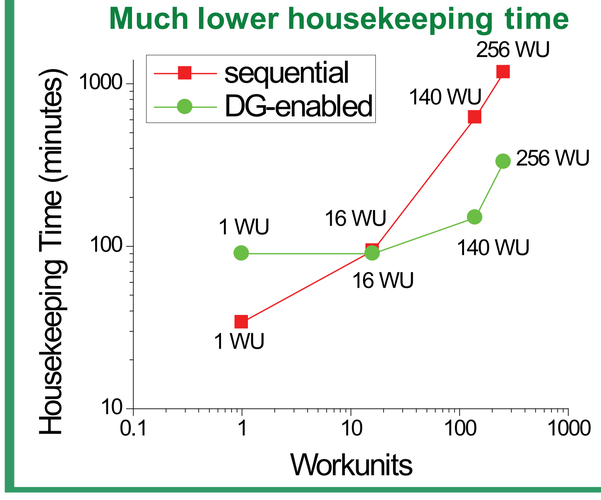
5.Deploy an application on the DG-server.

6.All BOINC-clients **themselves** connect to the DG-server

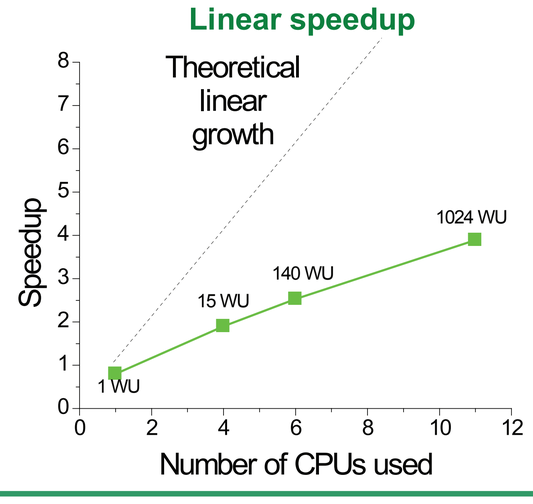
7.Run an application with **automatic** housekeeping.

3. Performance Analysis of Desktop Grid Enabled Solution

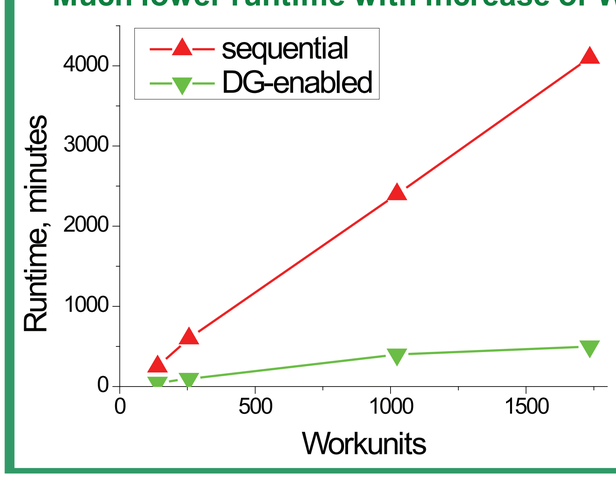
Much lower housekeeping time



Linear speedup



Much lower runtime with increase of WU



4. Drawbacks

- **need** to install **MATLAB Compiler Runtime** on workers;
- **unpredictable "black box" behavior** of wrapped MATLAB functions;
- **not all MATLAB** functions and toolboxes **are portable.**

5. Advantages

- **NO necessity** in **MATLAB DCS license,** only incorporated MCompiler and MCRuntime,
- **unlimited scaling-up** by volunteer PCs,
- **automatic setup** of workers and more flexible management of idle/busy workers.

6. Acknowledgements

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[1] BOINC — Berkeley Open Infrastructure for Network Computing (http://boinc.berkeley.edu).
[2] SZTAKI Desktop Grid, Computer and Automation Research Institute (SZTAKI) of the Hungarian Academy of Sciences (MTA) (www.desktopgrid.hu).
[3] Y.Gordienko, E.Zasimchuk, R.Gontareva: Heterogeneous Pattern Formation at Aluminum Surface — Fourier, Morphology and Fractal Analysis; Materials Science Forum, vol 567-568, pp.169-172, 2007.