September 2004

FEA Information Inc.

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FEA Information Inc.
Trent Eggleston & Marsha Victory

September 2004 – Announcements

New Participant:

We welcome as a participant Quing Zhou, PhD. - Professor - Department of Automotive Engineering - Beijing, 100084, China. Additionally to our site www.ls-dyna.cn

Contact us to contribute to the FEA News or the FEA Websites.

Sincerely,

Trent Eggleston & Marsha Victory

Top Crunch
New Submission Guidelines
www.topcrunch.org

The TopCrunch project was initiated to track the aggregate performance trends of high performance computer systems and engineering software. Instead of using a synthetic benchmark, actual engineering software applications are used with real data and are run on high performance computer systems. The data are available for download in the form of data files for our current software suite. With time, we expect to track the evolution of delivered performance as a function of enhnacements in both software algorithms and hardware. The results of the benchmarks are available as submitted, and may be searched by data, code name, and year. Summaries and overall rankings are posted twice per year following the precedent set by TOP500.

Submission Guidelines:

Only results obtained with legal versions of LS-DYNA will be published.

- **A new page has been created listing the authorized LS-DYNA Versions**
- **This page can be viewed on the Top Crunch Site under the link "Result" then "Submit New Results"**
- **This page on the Top Crunch Site will be maintained by Livermore Software Technology Corporation.**

LS-DYNA Released Versions Authorized for Benchmark Results SMP/MPP	
08/03/04	Version ls970.5434
03/24/04	Version ls970.3535
08/31/03	Version ls970.3858

This page is maintained by LSTC for Top Crunch Org.

FEA Information's Featured Interest Article

http://www.fujitsu.com/news/pr/archives/month/2004/20040913-01.html

Fujitsu Develops Service Robot that Offers Human Task Support in Offices and Commercial Establishments

Tokyo, September 13, 2004 —

Fujitsu's Service Robot

Fujitsu Laboratories Ltd. and Fujitsu Frontech Limited today announced their joint development of a service robot that can provide support for various services in offices, commercial facilities, and other public areas in which people work or spend leisure time. The newly developed robot features functions that enable it to provide such services as greeting and escorting guests onto elevators, operating the elevators, moving parcels using a cart, and security patrolling of buildings at night.

Fujitsu Frontech Limited will commercialize the robot, with sales scheduled to begin in June 2005.

Details of the robot are to be presented at the 22nd Annual Conference of the Robotics Society of Japan scheduled to be held from September 15 at Gifu University in Japan. There will also be a demonstration of the robot at the Combined Exhibition of Advanced Technologies Providing Image, Information and Communications (CEATEC) Japan 2004, opening on October 5 at Makuhari Messe in Japan

Background

There is great anticipation for the application of robots for a wide range of fields such as in medical services, social services, housework, and so on. According to Japan's Ministry of Economy, Trade and Industry (METI), societal expectations are high for robots to contribute to the realization of an enriched

society. Fujitsu Laboratories has been conducting ongoing R&D on robots for practical use, in the quest for robots to support people in their daily lives and make their lives more convenient.

Fujitsu's past robot offerings include the bipedal robots HOAP-1, that was developed in September 2001, and HOAP-2 developed in March 2003, both of which were designed for a broad range of applications for R&D of robot technologies and which are commercially available from Fujitsu Automation Limited. Fujitsu also developed MARON-1 in October 2002, a home robot that can be controlled from a mobile phone and which is being sold by PFU Limited on a limited basis. Building on its past expertise in developing robots for R&D and home-use applications, Fujitsu went further to the next level by developing a robot that can co-exist with people and provide services in a variety of places such as offices and public facilities.

Newly Developed Robot System

The new service robot is comprised of a head capable of moving up, down, left, and right, arms with four degrees of freedom(1), left and right motor-driven wheels that can rotate independently, a CPU that controls the entire robot, and a 3D visual processing system comprised of a digital signal processor (DSP)(2) and custom hardware.

Key features of the robot are as follows:

1. Ability to autonomously move to a designated location according to a pre-programmed map while carefully avoiding obstacles

The robot is capable of quickly perceiving people or things in its surrounding areas while simultaneously measuring their location, through the use of two cameras which can be quickly self-selected from its eight available cameras as necessary, using the newly developed 3-D visual processing system. Visual processing enables the robot to detect and avoid obstacles so that it can move safely to a designated location, thereby making it capable of completing tasks alongside people.

2. Ability to perceive, take hold of, and hand objects to people

By utilizing visual processing the robot can hold things and press buttons, such as elevator buttons. The arms can move naturally and smoothly through the use of the central pattern generator (CPG)/ numerical perturbation (NP) method[3] developed by Fujitsu, which simulates the nervous system of vertebrates.

3. Ability to turn toward voices when called, and accomplish tasks by following voice instructions

The robot is equipped with multiple microphones that enable detection of the direction of a sound source. The robot can also visually detect people, and can understand and complete simple tasks that are instructed verbally.

4. Functions to search for information according to users' needs and present the information using the most appropriate method

The robot can connect to the Internet, search for information according to user request, and present the information in the method that best fits the situation, such as by announcing the information, displaying the information on its own display, pointing to information on a separate source, and so on. Various kinds of Internet services can be provided through the robot by using its network-related functions. Self-equipped with a web server, the robot can be instructed, programmed and remote-controlled from an external devices such as computers, that do not feature specific applications for the robot.

5. Self-charging

When low on power, the robot autonomously moves to a charger to self-charge by using high-density non-contact charging based on an induction charging method to enable safe charging.

6. Ability to flexibly maneuver itself within compact spaces, on slopes, over minor surface gradations, and complete tasks

The robot can pivot on the spot by using two driving wheels that move independently. It also can move flexibly and smoothly over slopes and uneven surfaces, by utilizing a hing that connects its front and back driving wheels.

7. Natural, easy-to-understand human-like voice

Utilizing the natural prosody speech synthesis method[4] developed by Fujitsu Laboratories Ltd., the robot is capable of natural, human-like speech.

Future Developments

Fujitsu plans to develop applications for which this new robot can be used, with Fujitsu Frontech Limited scheduled to commercialize and begin selling the robot in June 2005.

Key Specifications

- Dimensions: 644 mm (width) x 566mm (depth) x 1300 mm (height)
- Weight: 63 kg

- Mobility of operable parts: Head: 2 degrees of freedom, Arms: 4 degrees of freedom, Hands: 1 degree of freedom, Wheels: 2 degrees of freedom
- Speed: 3 km/hr
- Sensors: 8 CMOS cameras, 2 ultrasonic sensors, 2 proximity sensors
- User interface: 10.5" TFT touch panel monitor, 3 microphones, 1 speaker
- Expansion interfaces: Wireless LAN (802.11b equipped)
- OS: Main CPU- WindowsXP ® embedded, DSP: DSP/BIOS
- Battery type: Nickel-Metal Hydride (NiMH, in main unit)
- Charging method: Non-contact self-charging (enables 24-hour continuous operation)

Glossary and Notes

(1) degrees of freedom: A degree expressing freedom of movement equivalent to that of human joints. 4th degree of freedom is equivalent to the degree of freedom enabled by the human shoulder (front, back, up, down, rotation) and the elbow (bending).

(2) digital signal processor (DSP): A microprocessor ideal for processing voices and images.

(3) central pattern generator (CPG)/ numerical perturbation (NP) method: Central pattern generator (CPG) - a neural-oscillator system that combines multiple neural oscillators, similar to features found in earthworms and lampreys; a type of neural network used in engineering. Neural oscillator - a part of the central nervous system that is found in vertebrates and is believed to generate a periodic rhythm. Numerical perturbation method (NP) method - a method of analysis used to approximate nonlinear functions that are difficult to analyze. Long used to calculate satellite orbits, in recent years this technique has been applied to fluid dynamics and quantum dynamics. The numerical perturbation method uses a computer to numerically process perturbations. The CPG/NP method is a method used for generating smooth and natural motion of robots, utilizing CPG networks and the NP method. Fujitsu employed the CPG/NP method for the humanoid robots it developed, HOAP-1 and HOAP-2, to enable speed learning of motion.

(4) natural prosody speech synthesis method: A speech synthesis method developed by Fujitsu Laboratories Ltd. that can synthesize remarkably natural voice in various speech styles, by using the prosody pattern which is extracted from a natural human voice. Prosody refers to the characteristics of speech, such as intonation, rhythm, and volume.

About Fujitsu Laboratories Ltd.

Founded in 1968 as a wholly owned subsidiary of Fujitsu Limited, Fujitsu Laboratories Limited is one of the premier research centers in the world. With a global network of laboratories in Japan, China, the United States and Europe, the organization conducts a wide range of basic and applied research in the areas of Multimedia, Personal Systems, Networks, Peripherals, Advanced Materials and Electronic Devices. For more information, please see: http://www.labs.fujitsu.com/en/

Mummy: Inside Story
Archeology meets Advanced Visualization with SGI Technology
http://www.sgi.com/features/2004/june/mummy/

In a world first, using SGI's visualization technology, British Museum visitors can see for the very first time what lies beneath the wrappings of a 3,000-year-old mummy, while it remains completely intact.

One of the challenges when studying Egyptian civilization is that Egyptian mummies contain a wealth of information about the past, but to un-wrap them is an irreversible and potentially destructive process. This poses a huge problem for Egyptologists, who want to gain access to the data contained in mummies while at the same time preserving them untouched for future investigators.

Visualization technology is used by SGI customers in a wide range of industries, such as in healthcare - for medical diagnosis - and in oil and gas - for the analysis of seismic data. The technology was also used in an innovative project called the 'Visible Human', where for the first time a complete human being was virtually visualized inside and out. SGI came together with the British Museum to see if the same techniques could be applied to an Egyptian mummy.

The British Museum chose the 3,000-year-old priest Nesperennub as the mummy to investigate. Nesperennub was CT-scanned at the National Hospital for Neurology and Neurosurgery in London and underwent 3D laser scanning in Scotland. These scanning sessions produced more than 1,500 images which were reassembled into a single 3D dataset that could be interactively viewed and explored, using a specially developed, real-time visualization application created by SGI Professional Services.

Invaluable archaeological discoveries

A team of SGI and British Museum experts were then able to embark on a process of discovery by subtly adjusting many parameters, such as density and opacity to tease out fine detail buried deep in the body. They have been able to identify features that could never have been accessed if the mummy was unwrapped such as a mysterious cavity inside the skull which experts believe could have been the result of a disease.

Bringing the Virtual Mummy to the public

The British Museum realized the magnitude and impact of these findings and the opportunity to explore the possibility of sharing these discoveries not only with archaeological communities but also through educational outreach to schools and educational institutions. The museum also recognized that applying innovative technology to ancient discoveries in this way could have mass appeal and worked with the SGI Professional Services team to identify the most effective way of recreating the 3D mummy to bring the

discoveries to life for the public. The result was the decision to install an SGI® Reality Center® immersive theater at the British Museum as the centerpiece of a dedicated exhibition.

CT image of the skull of Nesperennub showing cavity above the eye, This view shows that it had almost pierced the frontal bone of the skull

Prof. David Hughes, Manager for Advanced Visualization at SGI, who has worked from the outset in partnership with Dr Taylor to drive the project comments: "This has been a remarkable experience, participating in the project from initial concept, through the scientific discovery phase and here to public outreach. Now the public can share in this too through this immersive experience that recreates these discoveries just as we found them originally."

The 'Mummy: Inside Story' exhibition seats 112 people and has been designed and installed by SGI Professional Services and Fakespace Systems Inc. Powering the Reality Center is an SGI® Onyx® 350 system with three InfiniteReality4™ graphics subsystems, 12 MIPS® R14000™ CPUs, 6 gigabytes of RAM and 1.5TB of disk space.

The British Museum will use this technology in three modes. Playback: where the public will experience a 22 minute narrated show. Playback and Real time: where the show will be paused for 'interactive interludes' where free roaming is possible to explore areas of interest. And finally Real Time - a full interactive mode where the entire model of the mummy is loaded for research, special events and presentation by a museum expert.

Due to open to the general public on July 1st 2004, the exhibition will take visitors on a journey inside the mummy, going under the lid of the coffin, virtually peeling away the bandages and traveling into the body itself, all in 3D stereo. The show is narrated by Sir Ian McKellen and will be shown on a 12-foot tall by 42-foot wide curved screen. Following the show, which will include a facial reconstruction of Nesperennub and a historical reconstruction of how he would have lived, the final area of the exhibition will feature the mummy displayed in its coffin alongside examples of the artifacts featured in the show.

The launch will reinforce the British Museum's reputation as a leading center of research on all aspects of ancient Egypt. It currently houses the most comprehensive collection of Egyptian antiquities outside of Cairo.

Working together, the British Museum and SGI saw a unique opportunity to marry visualization technology used by businesses to explore large datasets, with the non-invasive exploration of ancient Egyptian artifacts. The result is an innovative virtual experience based on SGI's leading edge visualization technology that has been adapted and made accessible to the public in an exhibition that once again shows the British Museum as a world leader in the study of Egyptian civilization and a modern, innovative world heritage institution.

The Need for Speed

LSTC, Intel and SGI

Dramatic new possibilities for design engineers to greatly reduce the time needed for crash analysis, while simulating more complex and longer events.

Increase the speed and accuracy of complex simulations while minimizing your cost.

"Leading-edge Crash Simulation Solutions"

Download the whitepaper:

http://www.sgi.com/products/servers/altix/whitepapers/crash_formhtml

Hardware
&
Computing and Communication Products
(Listed in Alphabetical Order)

www.amd.com

www.fujitsu.com

www.hp.com

www-1.bim.com/servers/deepcomputing

www.intel.com

www.nec.com

www.sgi.com

www.paracel.com

Software Distributors

Alphabetical order by Country

Australia	**Leading Engineering Analysis Providers** **www.leapaust.au**
Canada	**Metal Forming Analysis Corporation** **www.mfac.com**
China	**ANSYS China** **www.ansys.cn**
China	**MSC. Software – China** **www.mscsoftware.com.cn**
Germany	**CAD-FEM** **www.cadfem.de**
Germany	**Dyna*More*** **www.dynamore.de**
India	**GissETA** **www.gisseta.com**
India	**Altair Engineering India** **www.altair.com**
Italy	**Altair Engineering Italy** **www.altairtorino.it**
Italy	**Numerica SRL** **www.numerica-srl.it**
Japan	**Fujitsu Limited** **www.fujitsu.com**
Japan	**The Japan Research Institute** **www.jri.co.jp**
Korea	**Korean Simulation Technlogies** **www.kostech.co.kr**
Korea	**Theme Engineering** **www.lsdyna.co.kr**

Software Distributors

Alphabetical order by Country

Russia	**State Unitary Enterprise** **www.ls-dynarussia.com**
Sweden	**Engineering Research AB** **www.erab.se**
Taiwan	**Flotrend** **www.flotrend.com.tw**
USA	**Altair Western Region** **www.altair.com**
USA	**Engineering Technology Associates** **www.eta.com**
USA	**Dynamax** **www.dynamax-inc.com**
USA	**Livermore Software Technology Corp.** **www.lstc.com**
USA	**ANSYS Inc.** **www.ansys.com**
UK	**Oasys, LTC** **www.arup.com/dyna/**

Consulting Services
Alphabetical Order By Country

Australia Manly, NSW www.leapaust.com.au	**Leading Engineering Analysis Providers** Greg Horner info@leapaust.com.au 02 8966 7888
Canada Kingston, Ontario www.mfac.com	**Metal Forming Analysis Corporation** Chris Galbraith galb@mfac.com (613) 547-5395
India Bangalore www.altair.com	**Altair Engineering India** Nelson Dias info-in@altair.com 91 (0)80 2658-8540
Italy Torino www.altairtorino.it	**Altair Engineering Italy** sales@altairtorino.it
Italy Firenze www.numerica-srl.it	**Numerica SRL** info@numerica-srl.it 39 055 432010
UK Solihull, West Midlands www.arup.com	**ARUP** Brian Walker brian.walker@arup.com 44 (0) 121 213 3317
USA Irvine, CA www.altair.com	**Altair Engineering Inc.Western Region** Harold Thomas info-ca@altair.com
USA Windsor, CA www.schwer.net/SECS	**SE&CS** Len Schwer len@schwer.net (707) 837-0559

Educational & Contributing Participants
Alphabetical Order By Counrty

China	**Dr. Quing Zhou**	**Tsinghua University**
India	**Dr. Anindya Deb**	**Indian Institute of Science**
Italy	**Professor Gennaro Monacelli**	**Prode – Elasis & Univ. of Napoli, Frederico II**
Russia	**Dr. Alexey I. Borovkov**	**St. Petersburg State Tech. University**
USA	**Dr. Ted Belytschko**	**Northwestern University**
USA	**Dr. David Benson**	**University of California – San Diego**
USA	**Dr. Bhavin V. Mehta**	**Ohio University**
USA	**Dr. Taylan Altan**	**The Ohio State U – ERC/NSM**
USA	**Prof. Ala Tabiei**	**University of Cincinati**
USA	**Tony Taylor**	**Irvin Aerospace Inc.**

Informational Websites

FEA Informational websites	**www.feainformation.com**
TopCrunch – Benchmarks	**www.topcrunch.org**
LS-DYNA Examples (more than 100 Examples)	**www.dynaexamples.com**
LS-DYNA Conference Site	**www.ls-dynaconferences.com**
LS-DYNA Publications to Download On Line	**www.dynalook.com**
LS-DYNA Publications Index	**www.feapublications.com**
LS-DYNA Forum	**http://portal.ecadfem.com/Forum.1372.0.html**
LS-DYNA CADFEM Portal	**http://www.lsdyna-portal.com**

www.feainformation.com

Previous FEA Information Site News
Archived on the Weekly News Page

Aug 02	**Paracel**	We welcome Paracel as a Participant. A leading provider of applied high-performance computing solutions to solve the most technically challenging problems
	JRI	2004 Japanese LS-DYNA & JMAG Users Conference will be held at Akasaka Prince Hotel in Tokyo. Sept 21st, 22nd.
	SGI	Archaeology meets Advanced Visualization with SGI Technology
Aug 09	**ETA**	eta/VPG (Virtual Proving Ground) is a revolutionary new systems analysis software package.
	Oasys	*Oasys* LS-DYNA *Environment* Download. The Latest: Oasys 9.1 software available for download from OASYS Website
	LEAP	Distributor – Australia - Leading Engineering Analysis Providers (LEAP)
Aug 16	**FEA**	Latest AVI # 201 Car Front Rail Impact
	HP	Co-developed by HP and Intel, the Intel® Itanium® architecture offers significant advances for technical computing.
	MFAC	MFAC has spun-off a new company. At Medusa Computing (see www.medusacomputing.com) we build clusters of PCs running under RedHat Linux.
Aug 23	**FEA**	Heat Transfer Analysis Site: Latest AVI # 71a Multi Forging Metal Forming Simulation Site: Latest AVI # 30a Manufacture Pipe
	Intel	The Intel® Pentium® M processor utilizes a new microarchitecture to meet the current and future demands of high-performance, low-power embedded computing.
	FUJITSU	PRIMERGY is based on the Intel architecture (IA) for good reason. Due to their high level of standardization, IA servers deliver the best price/performance ratio
	DYNAMAX	Located in an automotive environment near Motown Detroit, Dynamax, Inc, has more than ten years professional experience in using LS-DYNA software.
Aug 30	**AMD**	Now available in Model 2800+ - The AMD Athlon™ MP processor for workstations provides exceptional performance on demanding applications.
	NEC	To build the future "A supercomputer that can be used freely and more personally as a laboratory unit" Under this development concept, NEC launches the latest HPC server: SX-6i.
	ERAB	Engineering Research AB is a centre of excellence in the field of Computational Structural and Solid Mechanics, CSM, and Simulation Based Design.

Asia Pacific News
LS-DYNA CHINA
www.ls-dyna.cn

We welcome as a participant Quing Zhou, PhD. - Professor - Tsinghua University - Department of Automotive Engineering - Beijing, 100084, China.

This site is dedicated to LS-DYNA Users – Academic Institutions – Professors – Students – Companies and Engineers – If you are interested in participating contact mv@feainformation.com

Events

2004	
Sept. 21-22	2004 Japanese LS-DYNA Users Conference hosted by JRI, will be held at Akasaka Prince Hotel in Tokyo.
Sept 21-23	ANSYS CHINA - Annual User Conference
Oct. 11-12	The Nordic LS-DYNA Users' Conference 2004 will be held at Quality Hotel 11, Goteborg
Oct.14-15	3rd local LS-DYNA Conference - Bamberg, Germany sponsored by DYNAmore
Oct. 18 - 20	MSC.Software's 2004 Americas Virtual Product Development Conference - October 18 - October 20 2004 Hyatt Regency Huntington Beach, CA, USA
Nov 10-12	22. CAD-FEM Users' Meeting 2004 - International Congress on FEM Technology & ANSYS CFX @ ICEM CFD Conference
2005 & 2006	
May 25-26, 2005	5th European LS-DYNA Conference - The ICC, Birmingham UK
July 25-27	8th U.S. National Congress on Computational Mechanics – Austin, Texas
June 3, 2006	9th LS-DYNA International Users Conference – Dearborn, Michigan

MSC.Software Corporation's

2004 Americas Virtual Product Development Conference

October 18-20, 2004
Hyatt Regency
Huntington Beach, CA, USA

Register to attend MSC.Software's 2004 Virtual Product Development Conference, October 18-20, Huntington Beach California. Discover methods for managing the people, processes, and technologies to accelerate innovative product development. Hear more than 80 technical and management presentations, plus executive keynotes from Boeing, Ford, DaimlerChrysler, and Lockheed Martin.

Register at http://vpd2004.mscsoftware.com , and be entered to win one free night at the Hyatt Regency and Resort.

Keynotes: Get the inside information from industry-leading executives on how their companies are using VPD to develop the next generation of market-winning products.

Frank Perna, Jr.
Chairman and CEO
MSC.Software Corporation

Bob Ryan
Executive Vice President
Product Division
MSC.Software Corporation

Lawrence J. Achram
Vice President
Virtual Engineering and Chrysler Crossfire
Chrysler Group

Lory Arghavan
JSF Program Integrator
Information Systems & Technology
Lockheed Martin Aeronautics Company

Nancy L. Gioia
Engineering Director
Small FWD and RWD Vehicle Platforms
Ford Motor Company

John Hallquist
President
Livermore Software Technology Corporation

Frank Statkus
Vice President
Advanced Technology, Tools & Processes for 7E7 Program
Boeing Commercial Airplanes

European Press Release
Germany

Introduction by FEA Information

LS-DYNA is well-suited to analyze complex problems in metal forming. The many components of LS-DYNA address problems in full detail and with high efficiency, without the need for separate, external modules.

The goal of LS-DYNA is to deliver one multi-physics code that can address all aspects of transient problems including static initialization. LS-DYNA provides both implicit and explicit capabilities, and offers meshless, Lagrangian and Eulerian analysis methods. Additionally, a thermal solver is part of LS-DYNA.

BMW has licensed LS-DYNA for metal forming applications. Details are given in the following press release in German:

DYNA*more* GmbH
Gesellschaft für FEM-
Ingenieurdienstleistungen

Pressemitteilung 4/2004

Vermehrter Einsatz von LS-DYNA in der Umformsimulation

Stuttgart, 01.August 2004 – Die DYNAmore GmbH, der LS-DYNA Distributor im deutschsprachigen Raum, vermeldet mit der BMW AG einen weiteren wichtigen Großkunden aus der Automobilindustrie. Die Lizensierung von LS-DYNA im Bereich der Metallumformung ergänzt die dort schon seit langer Zeit eingesetzten Softwaretools hauptsächlich für die Berechnung des Rückfederns von tiefgezogenen Bauteilen. Die flexible Lizensierungsart innerhalb der von der BMW AG beschafften LS-DYNA Site-License erlaubt die Nutzung des Programms im Unix-Workstation-Netz sowie auf speziell für die Simulation konfigurierten Linux-Clustern. Mit der auf diese Hardwareplattform optimierten parallelen Version von LS-DYNA können auch komplexe Bauteile mit über 500.000 Elementen problemlos berechnet werden.

Mit LS-DYNA wird die bestehende Softwareumgebung bei BMW im Bereich der Umformsimulation um ein allround-tool ergänzt, das insbesondere im Bereich Parallel-Performance, Kopplung von impliziten und expliziten Berechnungsverfahren, Elementformulierungen und Netzadaption Stärken hat. Neben diesen speziellen Programmfeatures war ein wichtiger Punkt, dass sich die Softwaretools nahtlos in die bestehende Prozesslandschaft integrieren lassen. Hierbei spielte der flexible und kompetente Beratungsservice der DYNA*more* GmbH eine entscheidende Rolle.

Nähere Informationen:
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Industriestr. 2, D-70565 Stuttgart
Tel.: 07 11 - 45 96 00 – 0
Fax: 07 11 - 45 96 00 - 29
e-mail: info@dynamore.de
Internet: www.dynamore.de

SPH Performance Enhancement in LS-DYNA

Gregg Skinner and Dennis Lam
Advanced Technical Computing Center
NEC Solutions (America), Inc.

Masataka Koishi
Yokohama Rubber Corporation

Hiroki Shimamoto
NEC Corporation

Abstract

The Smoothed Particle Hydrodynamic (SPH) method had been implemented in LS-DYNA for some time. However, SPH had not been used extensively; therefore, performance issues were never highlighted and never addressed. Recent efforts to run SPH on NEC SX systems revealed substantial performance problems. NEC, Yokohama Rubber Corporation and LSTC collaborated to enhance the performance of SPH. As a result, the performance of SPH function in LS-DYNA has been improved on NEC SX-6 vector-parallel supercomputer by a factor of four. This article provides some background information about the code tuning effort, the SX series vector-parallel supercomputers, and the performance improvement achieved

Introduction

The implementation of smooth particle hydrodynamics (SPH) in LS-DYNA expanded further the capability of LS-DYNA to solve highly nonlinear problems. SPH method was developed in late 70's to solve astrophysical problems. Because of the distinct advantage to handle very large deformation, SPH method has been adopted to solve other applied mechanics problems. The complicated automotive tire behavior such as hydroplaning is difficult to simulate with traditional finite element method. SPH in LS-DYNA stands out as the best tool to solve this type of problem. However, the initial performance of SPH was rather poor on SX vector-parallel supercomputer. A joint project among NEC, Yokohama Rubber Corporation, and LSTC was set up to address performance issues.

SX Systems

SX vector-parallel supercomputers were developed and manufactured by NEC. In 1983 NEC launched SX-2. It was the beginning of NEC's commitment to provide the most powerful computer for scientific computing. The current generation of SX series vector supercomputers, SX-6, is the most powerful and competitive vector-parallel supercomputer that NEC has ever built. Although the technology behind SX-6 evolved from its predecessors, SX-6 is remarkably different from all previous generations.

An SX-6 node, which has been upgraded in forth quarter of year 2003, is a complete parallel-vector systems consisting of 2 to 8 vector processors each with 9 GFLOPS of peak performance. The processors are coupled to a uniform shared main memory of up to 128 GB capacity. The SX series solution for large scalability is a hybrid system. A powerful SMP single node with uniform shared memory provides high performance for running both LS-DYNA/MPP and LS-DYNA/SMP. Multi-node, distributed-memory, configurations are available for running LS-DYNA/MPP at higher performance. In a multi-node configuration, up to 128 nodes can be connected through an Inter-node Crossbar Switch (IXS). SX-6 series multi-node models can be scaled up to 1024 CPUs and a peak performance of 9 TFLOPS. Although they are built on distributed memory architecture, multi-node systems still provide a single system image.

SPH Performance Enhancement

Although SX series vector-parallel supercomputers have the most powerful processors to run LS-DYNA, the performance can suffer significantly if the software code cannot be vectorized. At the onset of this project, certain subroutines in SPH implementation were not vectorized. Based on two SPH input data from tire simulations at Yokohama Rubber, we set performance goals to increase by four times the original performance and to reduce the turn around time of the larger simulation to less than two days. The resulting performance improvements benefit not only tire simulations, but also any LS-DYNA simulation that uses SPH method.

Using SUPER-UX profiling tools on SX-6, we identified the most time-consuming SPH subroutines. In these subroutines we found core SPH calculations that were not executing in vector mode. We modified these loops so that they could be vectorized by the FORTRAN90/SX compiler. In particular, we examined closely a calculation that is expensive in both finite element and SPH, which is a bucket sort followed by a search for neighboring segments or particles.

In finite element method, the bucket sort can be performed infrequently, perhaps every 200 program cycles. SPH particles must be sorted more frequently, often once every program cycle. In the original LS-DYNA SPH, the bucket sorting algorithm was not vectorized. We modified the bucket sorting operations so that they could be vectorized by FORTRAN90/SX compiler. The ordering produced by the vectorized sort is identical to the original ordering.

The search for neighboring segments or particles is time-consuming for both finite element method and SPH method. In LS-DYNA the finite element neighbor search is highly tuned for vector-parallel processing. The original SPH neighbor search was parallelized, but not yet vectorized. We modified the SPH neighbor search to match the highly tuned vector-parallel algorithms already used by finite element method.

Finally, we vectorized some SPH subroutines using simple transformations such as unrolling an inner loop and moving subroutine calls (which inhibit vectorization) to a separate loop.

The optimized subroutines greatly improved the performance of SPH. Figure 1 and 2 show the performance of SPH before and after the optimization effort. For the smaller model (Figure 1), the elapsed time required was reduced from 40.6 to 11.0 hours with four processors. With eight

processors, the small model ran in 6.7 hours. For the larger model (Figure 2), the elapsed time was 43.7 hours using three processors, and 25 hours using six processors.

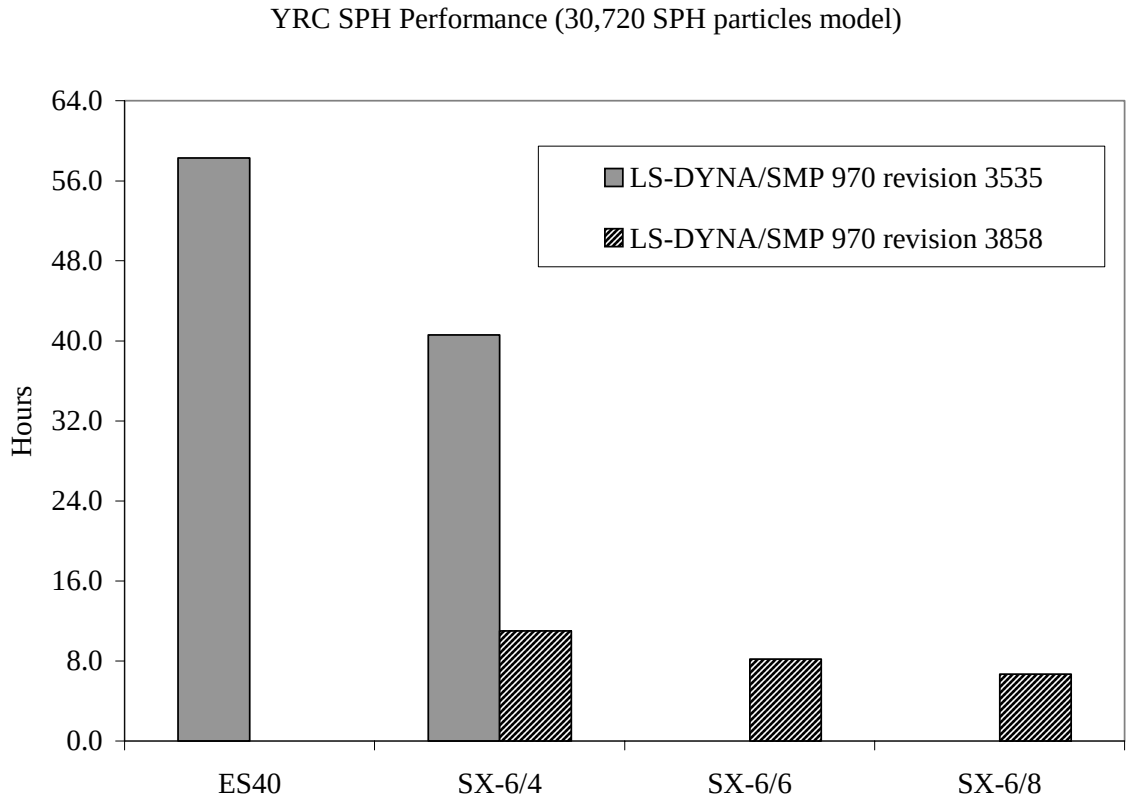

Figure 1

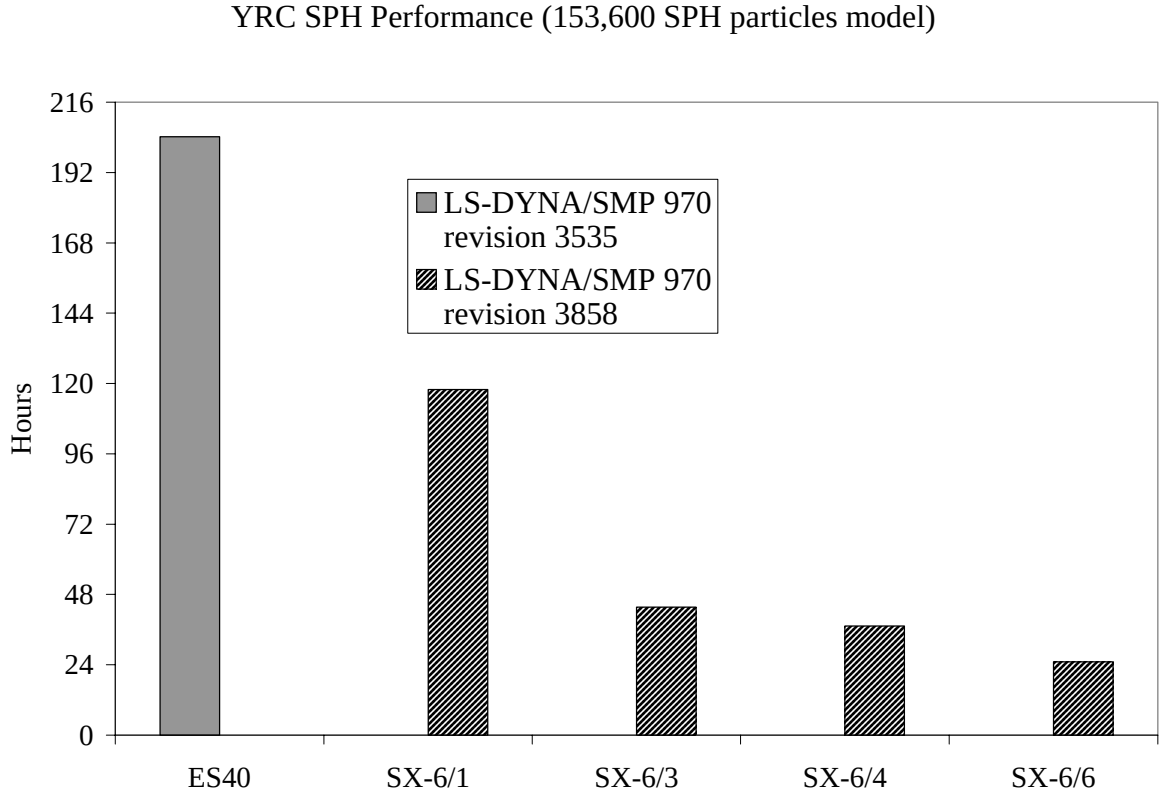

Figure 2

At the end of this SPH performance tuning project, we checked that the forces computed by the original and tuned SPH subroutines were not significantly changed.

Conclusion

The LS-DYNA code modifications from this joint project resulted in greatly reduced execution times for all simulations using SPH method on SX-6 vector-parallel supercomputer. The improvement goals based on two tire simulation models were achieved. The optimizations have been incorporated into newly released versions of LS-DYNA, revision 3858 and later.