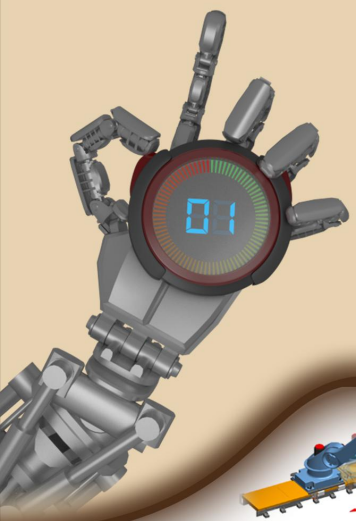


$$\int_{\Omega_0} T(x)\cdot\frac{\partial}{\partial\theta}f(x,\theta)dx = M\left[T(\xi)\cdot\frac{\partial}{\partial\theta}\ln L(x,\theta)\right]\int_{\Omega_0}$$

$$\int_{\Omega_0} T(x)\cdot\left(\frac{\partial}{\partial\theta}\ln L(x,\theta)\right)\cdot f(x,\theta)dx$$

MCL

„new dimension of safety“

MCL is Continuous Collision Detection Library for Real Robots. It supports sophisticated multi-axis robotic arms and devices with arbitrary number of articulated joints. Articulation can be done by engines with arbitrary motion interpolations. The only necessary inputs for MCL library are CAD models and motion description. MCL employs innovative approaches that deliver significant advantages.

MCL main goals are

- **the fastest continuous collision detection on market**
- **the 100% safe continuous collision detection**
- **easy integration**
- **high utility value**

The fastest

Speed matters and that's why MCL uses a new exceptionally fast continuous collision detection algorithm. MCL excels at computation with Robotic arms using high degree of articulation. It can be assumed that the current MCL prototype is already several times faster then any other solution on market. MCL software will be available for comparison when its alfa version is finished.

100% safe CCD

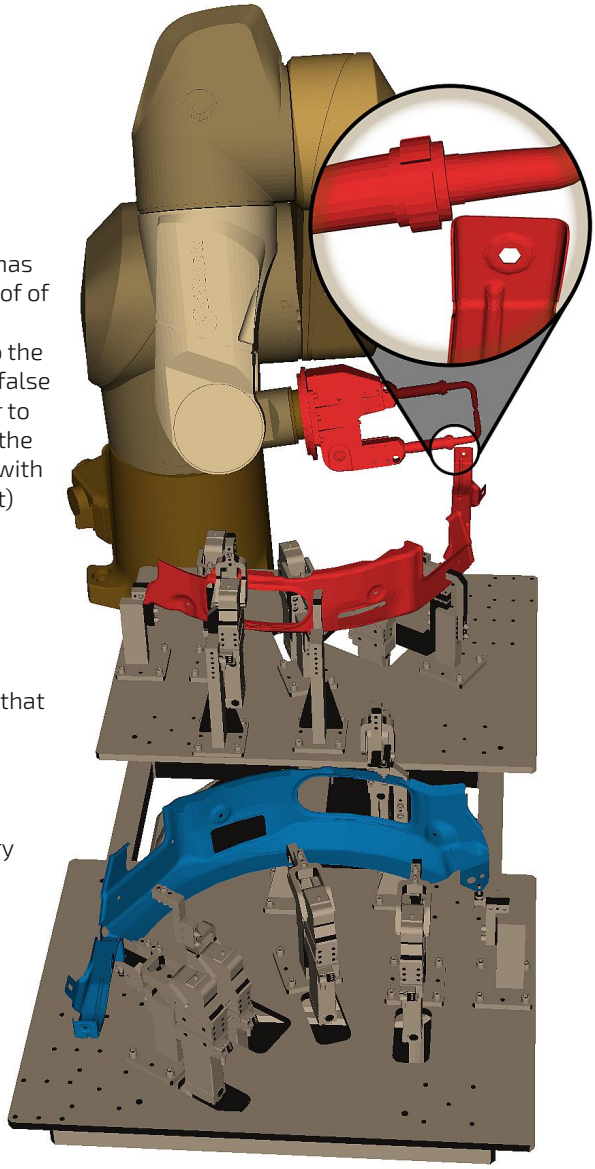
Any part of MCL's continuous collision detection algorithm has the mathematical proof of its correctness. The algorithm uses no approximation so the whole movement validation has no false positives or false negatives. In order to minimise implementation mistakes the whole software is being developed with strict TDD (Test Driven Development) process.

Easy integration

Support of the most widespread CAD geometry formats, candidates are STEP, Parasolid and ACIS. MCL can work with any sophisticated articulated robot that contains arbitrary DOFs (Degrees of Freedom) with arbitrary motion interpolations, including fully customizable Third Order Smooth interpolation.

High utility value

MCL provides unified collision safety system that replaces variety of heuristics, slow safety moves and unnecessary safety restrictions. MCL as the fastest continuous collision detection library provides new possibilities for CAM software and other applications. Real-time planning and other operations that require high safety can be now performed without forward testing.



Screenshot from MCL's Visualization Tool

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MCL applications

- **Electron Microscopy**

There are many delicate and costly components and devices inside the electron microscope vacuum's chamber. Any wrong move can destroy equipment costing tens of thousands dollars. MCL will improve safety and speed of sample manipulation inside the electron microscope's chamber and thus make higher utility value of the device.

- **Motion planning**

There are many applications of motion planning, for instance: manipulation robots, humanoid robots, manufacturing, computer-generated movies, molecular simulation and architectural design. Any motion planning can't work without collision detection. The Rolls-Royce among collision detection software would be the fastest continuous collision detection with 100% correct validations. That's the course where MCL software heads towards.

- **Medicine and surgery**

Robotically-assisted surgery was developed to overcome the limitations of minimally-invasive surgery and to enhance the capabilities of surgeons performing open surgery. Speed and high safety of robotic arms movements are in this field very crucial. Robotic surgery and computer-assisted surgery would greatly benefit from MCL collision prevention and avoidance system.

- **Robotic rovers and Robotics in outer space**

Space technology is usually on the edge of our possibilities. Requirements for robotics in outer space are demanding. Robotic rovers has sophisticated arms with switchable tools. Movements of its arms should be efficient, precise and without any collision (every mistake can be fatal). MCL software offers solutions for such requirements and together with good motion planning software would also lower movement energy consumptions.

- **Heuristics replacement**

There are plenty of heuristic that are frequently used in automation. Main reason for their deployment are safety restrictions. Systems with high number of safety heuristics in use are usually fragile and hard to maintain. Development of new features becomes a challenge. Especially bad results are obtained by safety heuristics for simultaneous movement of many robotic arms all at once. MCL alone can reduce and simplify most of safety heuristics. MCL together with motion planning software can replace all of them.

Let us know if

- **you are interested in our MCL product**
- **you miss something important in our MCL product**
- **you would like to participate in our MCL project**
- **you have other proposals or suggestions**

Recent events

- We've applied for the fourth tender ALFA of TAČR, passed formal control and waiting for evaluation (results expected in June 2014)
- Laboratory participation of Institute of production machines, systems and robotics VUT Brno in MCL project

MCL benefits

- Collision Prevention and Avoidance
- Significantly Improves Safety
- 100% Correct CCD (no collision can be missed)
- Saves time (shorter production cycle)
- Simultaneous movement verification of many robotic arms
- Support of CAD formats (current candidates are STEP, Parasolid and ACIS)
- Complex interpolations with wide options for customization
- Visualization tool

MCL Features

- Tolerance (highly customizable tolerance and safety clearance)
- Proximity and Collision Analysis
- Dramatically increased lifetime of mechanical components
- Multi-platform and Multi-threaded
- 64-bit architecture support

Curiosity

Fukushima incident in 2011 kicked off a new wave of world-wide research and development in robotics. Robots have failed Fukushima Power Plant in 2011 and are still failing. One of the problems being solved is offline and online motion planning and corrections. Their vital part is a collision detection system such as MCL software that could be an excellent candidate for significant improvements in this area.

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