

RESEARCH BRIEF

3D REPLICATION

The potential

The advent of low-cost and rapid copying technology has revolutionized the way offices operate today. Imagine how your life would change if you had ability to make 3D replicas cheaply and rapidly, as well. You could make a replica of your face and send it as a gift to your significant other. You could make a replica of the really old sculpture that your friend has. The possibilities are endless. After years of research, affordable 3D replication technology is almost here.

The challenge

Designing and machining molds for complex shapes is a time consuming task. Furthermore, traditional materials for building molds are very expensive and are not cost effective for making custom molds.

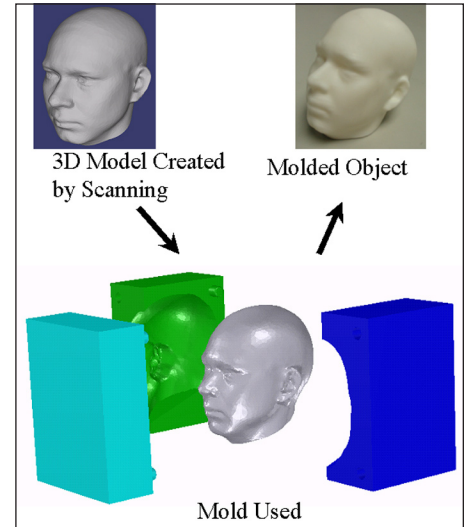
The research

Using 3D imaging and computer controlled milling machines, ISR researchers, led by Dr. Satyandra K. Gupta in the Computer Integrated Manufacturing (CIM) Lab, have demonstrated that it is possible to make 3D replicas inexpensively and quickly. Using a 3D stereoscopic imaging system and sophisticated geometric algorithms developed at the CIM Lab, the object being replicated is converted into a 3D model that a computer can understand.

The key breakthrough was making sure the model being generated is small in size while maintaining sufficient accuracy (currently the 3D models are approximately 25MB in size). Using the generated 3D model, advanced geometric algorithms developed at the CIM Lab are used to automatically design a mold.

ISR researchers also developed a new technique for making molds using machinable wax. The use of wax allows easy recycling of molds and eliminates tool wear during machining. This technique effectively reduces tooling material cost to approximately \$5 to \$10 for a typical mold.

Typical molds consists of many different types of geometric features of varying sizes, so manually planning how to machine such a mold can be very time consuming. Researchers at the CIM Lab have developed sophisticated operation planning algorithms that allow automatic generation of cutter paths for efficient machining of these molds. These cutter paths are fed into a computer-controlled milling machine that creates the mold within a matter of hours. Using this mold, polyurethane is poured into the mold and a replica of the original object is created.



This figure shows how a replica of a human face can be created. The estimated cost for creating this replica was \$75. Dr. Gupta believes that with additional research, the cost for creating a replica of a typical human face can be reduced to \$30. The next step is to add colors into the 3D models being produced. Dr. Gupta is currently leading process innovations that allow use of multiple different materials into a single mold. Hopefully, these process innovations will result in a technology that will produce 3D copies with color.

Research team

Contributors to the idea behind affordable 3D replication include:

- Dr. Satyandra K. Gupta, Associate Professor of Mechanical Engineering and the Institute for Systems Research;
- Greg Fowler, Undergraduate Student, Department of Mechanical Engineering;
- Ira Golden, Undergraduate Student, Department of Mechanical Engineering;
- Alok Priyadarshi, MS Student, Department of Mechanical Engineering;

- Klaus Stoppel, exchange student from Germany; and
- Zhiyang Yao, PhD Student, Department of Mechanical Engineering.

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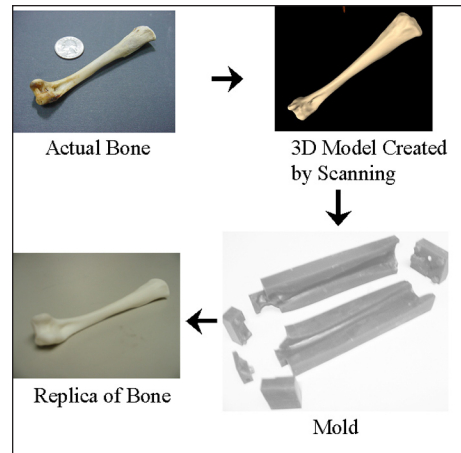
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This figure shows how a replica of a bone can be created. Dr. Gupta is currently leading process innovation efforts that will allow fabrication of hollow and perforated structures.