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Automatisches 3D Laser Scannen für die Medizin

Automatic 3D Laser Scanning for Medical Applications

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Background/Problem

Virtual Reality Systems in the field of surgery training as well as surgical planning need very precise geometric models as basis for further processing. We are able to scan patients, by the use of a Minolta 3D digitizer, without the need of a-priori knowledge like the patient's distance or the scan angle. For registration we use a stochastic Trimmed ICP algorithm.

Method and Tools

We implement this software as a component of our medical simulation framework MEDIFRAME [2]. Since the single scans overlap only in parts we use the so-called Trimmed ICP (TrICP) [1]. This algorithm makes use of partially overlapping scans. Our experiments with the classical ICP have shown that performance and robustness are not sufficient. There are two main modules:

a) Registration
Registration of Single Scans by the use of an adapted implementation of the TrICP. The TrICP differs from conventional ICP in the selection of the closest pairs in both point sets. The algorithm strongly depends on the selection of the proper overlapping region. Therefore we developed an algorithm, which in an iterative manner determines this region automatically and makes TrICP more reliable. We made our software more stable by adding Gaussian noise per iteration.

b) Triangulation
The single scans are individually triangulated using a-priori knowledge of the sequence of points received. Subsequently we transform the two surfaces with the help of results of the registration process and merge them together. For that we use an octree-based point

location algorithm which determines the nearest neighbors for all points. If the distance to the neighbor is below a predefined threshold we assume that these two points should be the same single point.

For combining these two meshes we eliminate superimposing triangles by distinguishing among four cases, depending on the number of coincided points; e.g. the triangle formed from the coincided points will be eliminated resulting in the correct final mesh.

Results

With this scanning tool, geometric modeling for medical simulations becomes quite easy. No manual intervention is necessary to get a three-dimensional model of a patient.

Conclusion

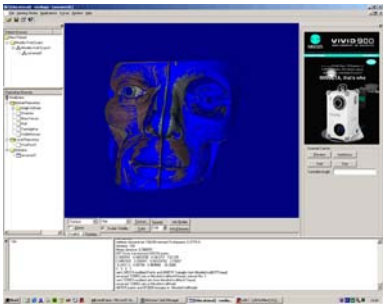
This would be very helpful for maxillofacial surgery to check the patient's postoperative appearance with the preoperative planning.

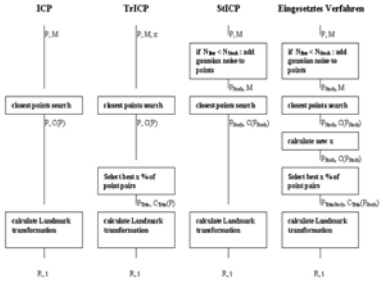
Novelty / Discussion

In contrast to other approaches we don't use a-priori knowledge and therefore a calibration process is not mandatory. With our efficient meshing algorithm we are able to fill holes on-the-fly by combining several triangulated surfaces from new scans into one complete surface mesh.

References

[1] D. Chetverikov, D. Svirko, D. Stepanov and P. Krsek: The Trimmed Iterative Closest Point Algorithm, Proc. ICPR 2002, Quebec City, Canada
[2] S. Seifert, R. Kussaether, W. Henrich, N. Voelzow, R. Dillmann: Integrating Simulation Framework MEDIFRAME, EMBS 2003, Cancun, Mexiko




ICP
TrICP
StICP
Eingesetztes Verfahren
P, M
P, M, x
P, M
P, M
closest points search
closest points search
If Nbm < Nmod : add gaussian noise to points
If Nbm < Nmod : add gaussian noise to points
P, C(P)
P, C(P)
Pmod, M
Pmod, M
closest points search
closest points search
Pmod, C(Pmod)
Pmod, C(Pmod)
calculate new x
Pmod, C(Pmod)
Select best x %of point pairs
Select best x %of point pairs
Pbm, Cm(P)
Pbestx%, Cm(Pmod)
calculate Landmark transformation
calculate Landmark transformation
calculate Landmark transformation
calculate Landmark transformation
R, t
R, t
R, t
R, t