Cased—based Visual Retrieval of Fractures

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Purpose

Fractures are common and some of them require a surgical intervention. Statistics from the Swiss Federal Office of Statistics (SFOS) show that in Switzerland in 2000, 62,535 hospitalizations were due to fractures, and the direct medical cost of hospitalization of patients with osteoporosis and/or related fractures was 357 million of Swiss Francs [1]. Helping the surgeons to plan an intervention in an optimal manner is important from both clinical and economic aspects.

Clinicians rely largely on X—ray images to find out the exact nature of a fracture and to plan an adapted intervention. Image databases of cases treated in the past contain valuable information. At the surgery department of the University Hospitals of Geneva, a database of more than 30’000 images has been collected over ten years, containing often images before and after an operation, plus sometimes images of follow up visits several years after the interventions. However, the exploitation of this database is not optimal as search is only possible by keywords and thus browsing can take much time to find similar cases to compare to that is being prepared for an operation. To optimize the use of this database and provide an alternative possibility for the information access, content-based visual information retrieval (CBIR) is applied. The goal of this application is to allow surgeons to submit images of a case to be operated as query and find past cases ordered by visual similarity to the query case.

Methods

This study is based on a version of the database containing 2’693 fracture cases associated with 43 different fracture types based on Müller classification. Beside images, a few clinical attributes such as age, sex, implant type and exact diagnosis are available in xml files. The fracture retrieval engine is purely based on visual information extracted from images and the diagnosis information is used only for evaluation. Image indexing is based on a bag of visual features strategy, where 1600 local descriptors based on Scale—Invariant Feature Transform (SIFT) were obtained at fixed positions (40x40 grid). Descriptors located at the corresponding position were gathered for variance analysis. Positions were ranked based on the variance as low variance leads to low saliency of the associated position. Only descriptors associated to the best 500 positions were taken. K—means clustering was performed to reduce the feature space. 1000 cluster centers were obtained. Each image was thus represented by a histogram of 1000 features.

To execute queries, a case—based query interface was developed (see Fig. 1). Similarity measurement based on histogram intersection is used to rank the returned cases. Both query and results are case—based and thus contain multiple images. A fusion strategy based on a mix of sum and max operators is in use.

To evaluate the retrieval we choose a maximum of ten cases per fracture type in the database as queries. A query used all images of one case. Only cases of the same fracture type were considered as relevant.

Results

Retrieval precision of the system using the selected subset of queries is shown in Table 1. Although performance is related to the number of existing cases per diagnosis in the collection, one observed challenge is to distinct two types of factures in the same bone. Typically the precisions for distal fractures are often worse due to the existence of a large number of diaphysis fractures and proximal fractures in the same bone.

Conclusion

A case—based fracture retrieval engine is available online as a treatment planning tool for the surgeons at the University Hospitals of Geneva. An evaluation of the retrieval precisions based on diagnosis information was performed. The exact location of the fracture is important for case-based retrieval, which may require user interaction. For diagnoses highly relying on images CBIR provides an alternative possibility for information access and facilitates the information exploitation from large image databases.

References

[1] Lippuner, K., Golder, M., Greiner, R.: Epidemiology and direct medical costs of osteoporotic fractures in men and women in Switzerland. Osteoporos Int 16(Suppl 2), S8–S17 (2005)

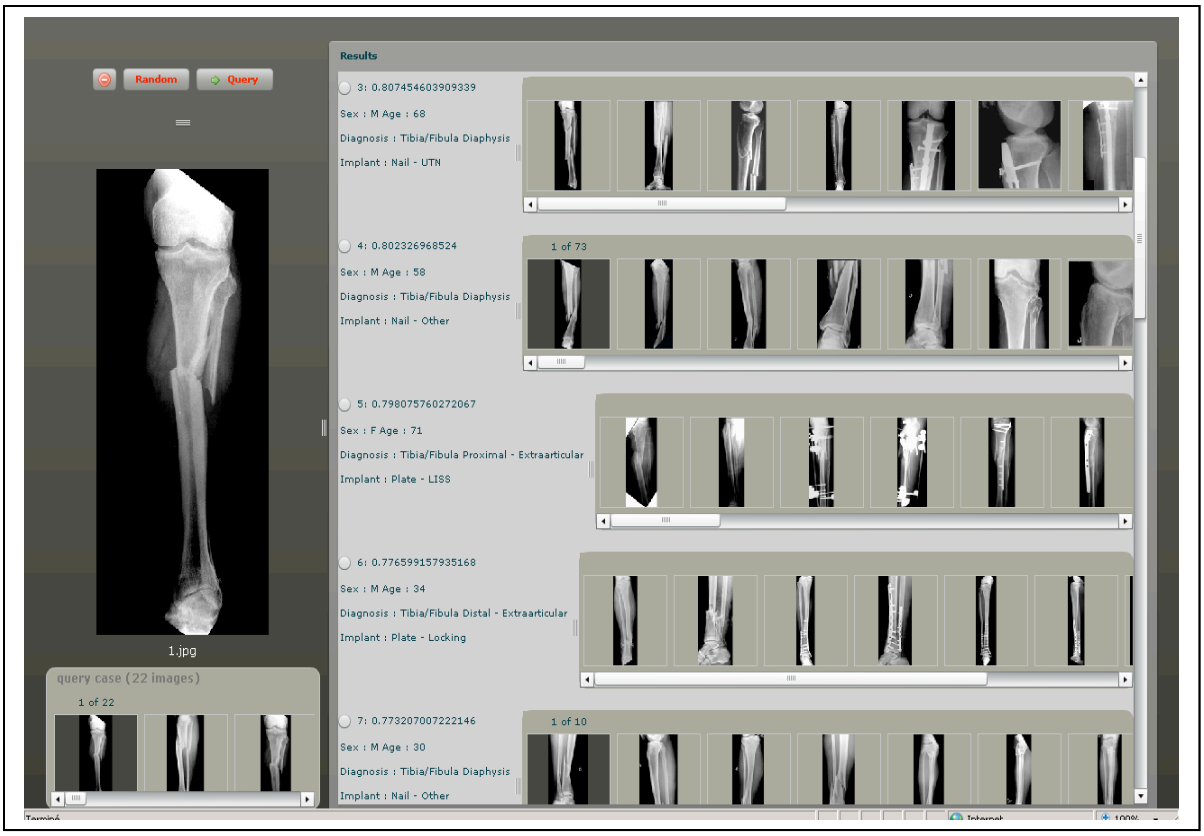

Fig. 1. Case—based fracture retrieval interface.

Class	P1	P5	P10	P20	P30	Nb cases
Acetabulum	0.11	0.09	0.06	0.04	0.03	31
Ankle Weber A	1.00	0.42	0.29	0.19	0.17	44
Ankle Weber B	0.90	0.66	0.51	0.46	0.46	244
Ankle Weber C	0.90	0.38	0.31	0.20	0.18	156
Calcaneus	0.40	0.16	0.09	0.14	0.13	33
Clavicle	0.44	0.36	0.24	0.16	0.14	40
Femur - Subtrochanteric	1.00	0.46	0.31	0.28	0.25	132
Femur Diaphysis	0.30	0.34	0.31	0.36	0.35	169
Femur Distal - Extraarti	0.00	0.04	0.09	0.10	0.09	55
Femur Distal - Intraarti	0.10	0.18	0.20	0.16	0.14	50
Femur Proximal - Intertr	0.00	0.08	0.07	0.08	0.07	54
Femur Proximal - Neck	0.10	0.20	0.14	0.11	0.10	72
Femur Proximal - Pertroc	0.70	0.74	0.66	0.62	0.59	419
Humerus Diaphysis	0.20	0.14	0.14	0.19	0.18	119
Humerus Distal - Extraar	0.20	0.06	0.05	0.06	0.06	30
Humerus Distal - Intraar	0.30	0.12	0.10	0.08	0.07	61
Humerus Proximal	0.80	0.70	0.62	0.54	0.50	172
Metatarsal-Phalanx foot	0.90	0.42	0.38	0.34	0.27	62
Patella	0.44	0.33	0.24	0.16	0.13	34
Pelvic Ring Fracture	0.20	0.14	0.15	0.15	0.14	43
Radius and-or Ulna Diaph	0.30	0.22	0.19	0.13	0.13	46
Radius and-or Ulna Dista	0.10	0.04	0.06	0.05	0.05	14
Radius and-or Ulna Proxi	0.40	0.24	0.15	0.10	0.11	58
Shoulder	0.00	0.02	0.03	0.02	0.02	16
Talus	0.30	0.28	0.16	0.15	0.13	32
Tarsal - Other	0.10	0.06	0.05	0.06	0.05	17
Tibia-Fibula Diaphysis	0.70	0.52	0.54	0.48	0.44	205
Tibia-Fibula Distal - Ex	0.30	0.24	0.26	0.20	0.18	52
Tibia-Fibula Distal - In	0.10	0.10	0.13	0.16	0.16	57
Tibia-Fibula Proximal	0.50	0.44	0.46	0.36	0.33	121
Average	0.73	0.39	0.29	0.22	0.21	

Tab. 1. Early precision of a set of queries for each diagnosis.

Further instructions:

- *The length of your abstract should not exceed 2 pages (approx. 1000 words)*
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