Partnership for International Research and Education
A Global Living Laboratory for Cyberinfrastructure Application Enablement

Project Title: Pattern Matching with Key Identification Application

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National Science Foundation

I. Research Overview and Outcome

MOTIVATION

- Computer vision is not new field but it is mostly unexplored.
- Pattern matching can be used for myriad of applications.
- We wanted to investigate available algorithms for pattern matching and implement it in a specific task.

THE TASK

- Lock key identification.
- User takes a picture of a key in a controlled environment. Program sends image to processing unit which returns information about the key from previously stored database.
- The task is to match acquired key to most similar key in the database or to add it to the database.
- Recognition is done using extracted features.

THE TOOL

- Program is intended for wide use. The code should be portable to as many devices as possible.
- Limited number of APIs available for implementation.
- The best software package for image processing and computer vision is MATLAB.
- Problem – not portable. (Not available on mobile devices)
- Best available solution – Open CV library.

OpenCV is a computer vision library originally developed by Intel. It is free for use under the open source BSD license. The library is cross-platform.

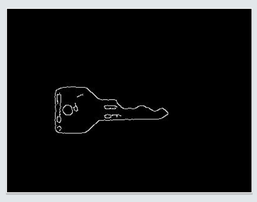
The library is mainly written in C.
Wrappers for languages such as C#, Python, Ruby and Java (JavaCV) have been developed to encourage adoption by a wider audience.
Since version 2.0, OpenCV includes both its traditional C interface as well as a new C++ interface.
OpenCV runs under FreeBSD, Linux, Mac OS and Windows.

ALGORITHM WORKFLOW

User acquired image using the camera on the device.
Environment should be controlled as much as possible.

Acquired image is converted into binary image.
Threshold is set dynamically, depending on the image contrast.

Edge detection. Robust, but…
Sensitive to environment,
Computationally complex,
Edge histogram too complicated.

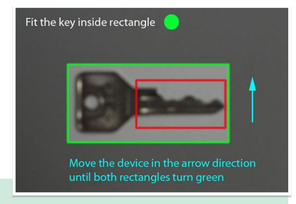


Contour convexity analysis.
Implemented on BW image,
Not compute expensive.
Descriptors simple and small.

Match contour descriptors with those in database.
Simple, short arrays matched using shortest distance.

POSSIBLE IMPROVEMENTS

- We can try to improve capturing process.
- Include 'guides' in the application UI.



Make the user conform to some restrictions.
Using feedback guide for better acquisition.

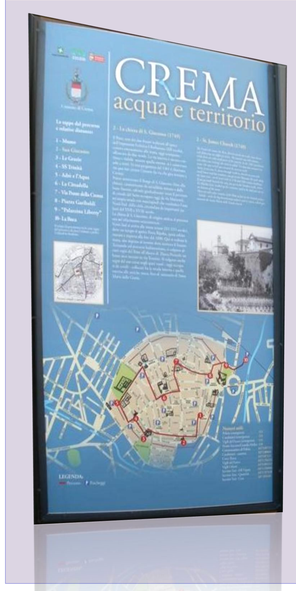
FUTURE WORK

- Test the application on various platforms, using reasonably large dataset of key images.
- Try to expand the implementation of the algorithm to other classes of objects.
- Submit a publication related to this work.

REFERENCES

▪Canny, John, "A Computational Approach to Edge Detection", Pattern Analysis and Machine Intelligence, IEEE Transactions on , vol.PAMI-8, no.6, pp.679-698, Nov. 1986
▪Lowe, D. G., "Distinctive Image Features from Scale-Invariant Keypoints", International Journal of Computer Vision, 2004, 60, 91
▪S. Suzuki and K. Abe, "Topological structural analysis of digital binary images by border following," Computer Vision, Graphics and Image Processing 30 (1985): 32–46.
▪Zehang Sun, George Bebis, Ronald Miller, "Object detection using feature subset selection", Pattern Recognition, Volume 37, Issue 11, November 2004, Pages 2165-2176

II. International Experience



Crema

- A town and commune in the province of Cremona, in the region of Lombardy in northern Italy.
- The population is around 35,000 (2006. estimate)
- Famous sites are: a Romanesque cathedral (13th century), a 16th century Town Hall, the Palazzo Vescovile and the Augustinian monastery of S Agostino with the Museo Civico and the Palazzo Terni de Gregory.
- Crema's main economic activities traditionally relate to agriculture and cattle breeding, but Its manufactures include now cheese, iron products and cotton and wool textiles.

Meet our hosts

Our stay in Italy would not have been so nice if there wasn't for our hosts.
They went far beyond the academic advising to make us feel comfortable…as if we were home!


Dr Ernesto Damiani


Dr Stelvio Cimato


Dr Marco Anisetti


Dr Fulvio Frati


Interazione multimediale tra uomo e ambiente: Crema diventa partner internazionale del progetto Pire. Presentati i quattro dottorandi della Florida Atlantic University
di Luna Boschiroli

5 minutes of fame. Sort of…

Just 4 days after we arrived to Crema, we had a reception in the Municipality Chamber and a Press conference!
All four students from FAU, along with two PhD students from Benin were introduced to several local journalists. Next thing we know – we are all over the newspapers next day! You can still check out the story at their website – the address is:
http://cremaonline.it/articolo.asp?ID=11039

Most important accomplishments

- Encountered rich Italian culture from both historical and contemporary perspective.
- Visited some of the famous sights
- (Cathedrals, Museums, Monuments, Castles, but also Stadiums and Restaurants).
- Interacted with Italian people, both in academic and ordinary environments.
- Met people that I'm still in touch with – got new friends.
- Learned new Italian words and expressions.
- Had unique experience of following Italy's soccer matches among the Italian fans (unfortunately, they played very bad in most of their matches at World Cup).

III. Acknowledgement

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