Computer Vision

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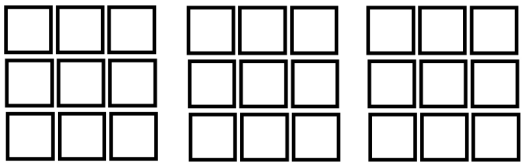
M2R GVR Mid-term Exam, Novembre 2009

Test conditions: All documents and reference materials are authorised. You may NOT communicate with anyone other than the exam Proctor or the course professor. You must answer all questions in INK on the official exam forms. You may use scratch paper to prepare your answer. You may respond in English or French (or both), but you MUST write legibly. Use Mathematics as well as English and French to communicate. Illegible text will not be graded.

Duration : Maximum 3 hours.

Rubik's Cube



Perpendicular views of the faces

Luminance image

You are provided with an RGB image with 1024 x 1024 pixels of a Rubiks Cube as shown above. Each face of the cube contains nine "squares" with one of six colors: (White, Red, Green, Blue, Yellow, Orange). Your problem is to devise a system to provide three rectified images of the faces of the cube. To do this you are asked to estimate the homographic transformation for each face of the cube, and use this transformation to rectify the image of the face to create a perpendicular view.

1) (3 points) Simply converting the RGB image into a luminance image will leave some faces of the cube difficult to detect. Propose a color transformation that will transform the RGB image into 3 color-opponent images that amplify the contrast between the colors. (Provide the matrix formula for the transformation).

2) (3 Points). Propose an operation to detect the boundaries of the squares in the 3 color-opponent images using contrast (edge) detection.

3) (3 points). Explain how to use a Hough transform to estimate the line equations for each of the squares of the three faces from the contrast. Give the algorithm for computing the Hough Space and for detecting the lines parameters. How large should your Hough Space be?

4) (3 points) Propose a method to assign each line detected in the Hough space to one of the three faces of the cube (overhead, left, right).

4) (2 points) Give the formulae for computing the interesections of the lines from each face.

5) (3 points) Describe how to estimate the homography to tranform each of the three faces to a perpendicular view.

6) (3 points) Describe the algorithm to transform each face into a rectified image.