CSE 591 Computational Conformal Geometry

General Course Information

- Instructor: Dr. Yalin Wang
- Office: BYENG 432
- Office Hours: T Th 3:00 pm-4:00 pm
- Email: ylwang@asu.edu
- Meeting Times: T Th 10:30 am-11:45 am
- Location: BYAC 260
- Prerequisite: MAT 343 (or MAT 342) or only instructor approval

Catalog Description

An introduction of computational conformal geometry for pattern recognition and geometric modeling. It covers some basic concepts from algebraic topology, differential geometry and Riemannian surface. It studies algorithms to compute universal covering space, fundamental domain, harmonic map, conformal mapping, holomorphic 1-forms, conformal slit mapping, discrete Ricci flow, inversive distance Euclidean curvature flow and discrete Yamabe flow, etc. Two applications in medical imaging field, including image registration and shape analysis, are used as example problems to illustrate these concepts and algorithms.

Objective

Students who complete this course can

1. Understand the basic theoretical concepts underlying computational conformal geometry for various computer vision and geometric modeling applications.
2. Are able to understand the research literatures on these topics.
3. Are able to develop software to implement these concepts in an interactive computer graphics environment.

Reference Books

- *Shapes and Diffeomorphisms*, Laurent Younes, Springer, 2010

Grading

- Project: 50%. There will be four programming projects. Each project: 12.5%.
- Exam (2): 45%. There will be two exams. One paper page cheat sheet is allowed for both exams.
- Class participation: 5%. Students are required to attend the lecture and participate in the class discussion.
## Tentative Class Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to conformal mapping, Cauchy-Riemann equation, uniformization theorem</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Introduction to image registration and shape analysis, introduction to statistical inference</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Homotopy group, homology and cohomology; topological algorithms, fundamental domain, homotopy identification</td>
<td>Proj. 1</td>
</tr>
<tr>
<td>4</td>
<td>Differential geometry of surfaces, orthonormal movable frame, covariant differentiation, Möbius transformation; harmonic map, spherical conformal parameterization</td>
<td>Proj. 2</td>
</tr>
<tr>
<td>5</td>
<td>Review; Midterm</td>
<td>Proj. 3</td>
</tr>
<tr>
<td>6</td>
<td>Exterior differential calculus, harmonic forms, holomorphic forms; holomorphic flow conformal parameterization, conformal slit mapping</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Riemann surface, hyperbolic Riemann surface, Teichmüller space, quasi-conformal mapping; discrete Ricci flow, inverse distance Euclidean curvature flow, discrete Yamabe flow</td>
<td>Proj. 4</td>
</tr>
<tr>
<td>15</td>
<td>Review.</td>
<td></td>
</tr>
</tbody>
</table>

## ASU Policies on Academic Integrity

Violations of the University Academic Integrity policy will not be ignored. Penalties include reduced or no credit for submitted work, a failing grade in the class, a note on your official transcript that shows you were punished for cheating, suspension, expulsion and revocation of already awarded degrees. The university requires that should I implement any of these penalties, I must report the matter to the Dean's office. The university academic integrity policy can be found at [http://provost.asu.edu/academicintegrity](http://provost.asu.edu/academicintegrity).