INTRODUCTION

Papillary Renal Cell Carcinoma (pRCC) is the second most common type of renal cell carcinoma. It forms in the tubules within the kidney that filter the waste from the blood and that makes the urine.[1]

Currently, a biopsy is necessary to determine the stage (Fuhrman Grade 1-4) of the carcinoma. However, biopsies are quite invasive and often result in the incorrect classification of tumor.

Texture analysis can be used to break down into quantitative measurements the features of the tumors. These features can then, in turn, be used to assign a Fuhrman Grade. Fuhrman Grades of 1-2 are defined as “low” and Fuhrman Grades of 3-4 are defined as “high”.

METHODS

Image Acquisition & Segmentation: The tumor images were segmented by trained Radiologists. Images from two phases of the CT scan were used: the Corticomedullary Phase and the Nephrogenic Phase.

Texture Analysis: A texture analysis (GLRL, GLC, and Hu Moments) along with histogram features were measured for each image using Matlab.

Feature Extraction: A t-test was performed on the features extracted from the Texture Analysis to determine the significance of each feature.

Classification: Multiple classification methods were used, trying various amounts of features to achieve the highest accuracy possible: SVM, Support Vector Machine, KNN, k-Nearest Neighbors, AdaBoost, Gradient Boost DT, Gradient Boost Decision Tree, XGBoost: Extreme Gradient Boost. 5-fold Cross Validation was then performed to determine the accuracy of each classification method.

RESULTS

<table>
<thead>
<tr>
<th>Features Extracted</th>
<th>SVM</th>
<th>KNN</th>
<th>AdaBoost</th>
<th>Random Forest</th>
<th>Gradient Boost DT</th>
<th>XGBoost</th>
</tr>
</thead>
<tbody>
<tr>
<td>4%</td>
<td>0.78</td>
<td>0.77</td>
<td>0.72</td>
<td>0.88</td>
<td>0.88</td>
<td>0.90</td>
</tr>
<tr>
<td>20%</td>
<td>0.69</td>
<td>0.72</td>
<td>0.60</td>
<td>0.84</td>
<td>0.77</td>
<td>0.79</td>
</tr>
<tr>
<td>40%</td>
<td>0.80</td>
<td>0.60</td>
<td>0.63</td>
<td>0.86</td>
<td>0.77</td>
<td>0.79</td>
</tr>
<tr>
<td>100%</td>
<td>0.56</td>
<td>0.57</td>
<td>0.63</td>
<td>0.80</td>
<td>0.87</td>
<td>0.77</td>
</tr>
</tbody>
</table>

The features with the lowest p-values are shown to the right. These three compose the top 4% of features used in the classification methods.

Random Forest, Gradient Boost DT, and XGBoost Classifiers produce the highest levels of accurately classifying the low vs. high grade papillary renal cell carcinomas.

The XGBoost using the top 4% of features gave the highest accuracy at 90%.

CONCLUSION

The Random Forest, Gradient Boost Decision Tree, and XGBoost Classification methods are all capable of accurately classifying high vs. low grade pRCC tumors using various features 80% of the time. The XGBoost provides the highest level of accuracy when using only the top 4% of texture features. However, Random Forest has over 80% accuracy regardless of the percent of features used. These results indicate that papillary renal cell carcinomas have the potential to be accurately classified without using invasive measures such as biopsy.

FUTURE WORK

- Intensity Analysis: Look at differences in the perfusivity of the low vs. high grade tumors by looking at the difference in Intensity of the 2 different phases of the CT scans
- Differentiation between Cysts and Tumors

REFERENCES
