**Thesis Title**: Hybridization of Moth Flame Optimization and Gravitational Search Algorithm and its application on detection of Food Quality

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**Semester:** First Semester

**Session:** Aug-Dec ‘16

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**ID No:** 2013A7TS114P

**Abstract:**

Gravitational Search Algorithm is an optimization algorithm inspired by the Newton law of Gravitation and the Newton’s laws of motion. Moth Flame Optimization is another optimization algorithm, motivated by the locomotion of moths around a light source. Both these algorithms, have tried to model the search agents, and altered its properties like mass, Gravitational constant, fitness, location etc. in order to find the most optimal value. The optimization algorithms usually solve only a class of problems, and therefore the search for a faster, and more comprehensive algorithm is always on. By combining the Moth Flame Optimization and Gravitational Search Algorithm, the performance is expected to improve across various measures.

Project Food Sense aims to use this improvement in order to find the degree of rottenness of various food items. This will help decrease the losses in food storage, and early detection of spoilage of food, in order to minimize monetary losses due to food and storage. This hybrid method is used in improving the results of segmentation. We have successfully implemented it over K-means and Multi-level thresholding.

On application of our optimization algorithm to K-means clustering, we aim to reduce the mean squared error from each data point to the centroid of the cluster. Since the initialization of the cluster centers is random in the original algorithm, the mean squared error varies with each application, even on the same dataset. Through the application of optimization algorithm, we aim to bring down the mean squared error and bring uniformity to the application of K-Means clustering.

For Multi-level Thresholding, the brute force approach to finding the thresholds is a very expensive process. Finding the threshold, for multiple clusters, where each threshold could be a value anywhere between 0 and 255, the task becomes very expensive. Also, this is mostly a manual process. However, the optimization algorithm aims to bring down this complexity by using multiple search agents, each trying to find the most optimal threshold value, while communicating to each other the most optimal value. This reduces the algorithm complexity, and in turn automates the whole process of finding the right values. This has multiple applications as the problem complexity increases as the dimensions or color space changes. However, this method can be extended to multiple color spaces, finding the best threshold values for each color space parallelly.

Analysis is done through these improved segmentation techniques and then texture analysis techniques like Grey Level Co-Occurrence Matrix, Local Binary Pattern etc. are explored and applied to detect the food quality. Each segment detected through the segmentation techniques mentioned above are then labelled according to its disease, and a model is created. These are then tested for in the test images.

In addition to the vision data, odor sensors also find their place in the midst. Intuitively, the food items are checked for quality by looking and smelling them, when done manually. Our aim to automate the process of detecting deterioration is therefore supported by the use of QCM gas sensors. These return the value of presence of particular gasses in the carrier gas, and each reading in PPM becomes another feature for training the model. We have used Alpha Fox 2000 foe collecting the gas data for the infected fruits.

The long-term aim of the project remains real time application of the proof of concepts we have tested. The features extracted, including the texture analysis on the vision data, and the gas sensors’ readings, show great promise our aim of reducing losses through spoilage in food storage facilities and improving food safety in messes.