7.1. Conclusion
In industrial plants online streaming of process data, data collection and data processing is very challenging job so different pattern identification and data clustering algorithms have to be used. This research studies different aspect of pattern classification, pattern identification and data clustering algorithms in general. A industrial process control application is taken in to consideration for implementation of different classification, recognition and clustering algorithms. Different noise resistant classification and recognition algorithms are also studied as these algorithm finds wide spread use in noisy industrial environment. Different conventional as well as fuzzy clustering algorithms have been used. Industrial plant process monitoring dataset for fault diagnosis is taken into consideration and these techniques are applied for clustering then a hybrid PSO (FPSO) algorithm is proposed.

It has been shown that K-cell means algorithm is strongly sensitive to initial points and quality of obtained final clusters depend strongly on the given initial set of clusters.

In ANN based SOM clustering technique a large dataset is first trained. Training of data is done using SOM neural network toolbox of MATLAB. Then fuzzy based clustering techniques are used for the same dataset. First Gustafsen-Kessal algorithm is used to find clusters of process data. The Gustafsen-Kessal algorithm represents the cluster centers and covariance of it by linking a data point and a matrix with every cluster. But in FCM there is a assumption that clusters produced by FCM
are only spherical in shape. As we have seen in results that this not the case with Gustafen – Kessal algorithm. GK also identify cluster in shape of ellipse. Fuzzy C-means logical algorithm is also having a weakness of being trapped in local maxima i.e. it does not produce good results for boundary values. To overcome this problem of being ignored for boundary values a hybrid PSO algorithm is proposed by combining the Fuzzy C means logical with PSO to get better results or clusters. Because PSO is considered as global optimization algorithm and it works on boundary values.

Cluster validity indices are used to compare proposed algorithm with Gustafsen-Kessal (GK) and Fuzzy C means logical algorithms. Cluster validity is a concept of defining that if a produced cluster of a dataset suitable to given fuzzy partition or not Here in this research for validating the proposed algorithm two validity indices are used. One is Partition Coefficient (PC) and other is Partition Entropy (PE).

It is observed from comparative results that as number of clusters increase the PC value decreases for GK as well as for FCM but it increase for proposed FPSO fuzziness exponent value \( m=2 \) and \( m=2.5 \) and value of FPSO is very high as compared to other algorithms. As Partition Coefficient should be high for good quality of clustering But PE is very high for GK and FCM as compared to hybrid FPSO. So as compared to other fuzzy algorithms the performance of proposed hybrid PSO is better for this industrial process monitoring application and proposed method is giving best result with any size dataset, with fuzziness exponent value 2.5. if we talk about PC index in that case best result of proposed hybrid PSO algorithm will be with \( c=4 \) and \( m=2.5 \). Even PE will be less comparatively other fuzzy algorithms. If
we talk about PE index in that case best results of proposed hybrid PSO algorithm will be with $c=2$ and $m=2.5$. PC will be high as compared to other fuzzy algorithms.

7.2. Future Scope

As in this research Industrial Process Monitoring Fault diagnoses application is taken into consideration and so many ANN, Conventional and Fuzzy algorithms are implemented on this by proposing a hybrid FPSO. Following things can be taken as future scope:

1. Fuzziness exponent can be improved for better results.

2. This research is done on 2-dimensional data. It can be tried on multi dimensional data.

3. Work can be extended further by finding shapes of each cluster and analyzing it.

4. Time complexity of all algorithms can be computed to know algorithm with least time complexity.