7.1 SUMMARY

The work carried out in the thesis was aimed at the prioritization of multi objective test case system using an integrated approach using various techniques. The effectiveness of the proposed techniques on test case prioritization is demonstrated through various metrics and real time implementation. The results obtained during this research have shown that the integrated system is a feasible way to prioritize the test case and also it provides an effective ordering of test cases.

Thus, the highlights of the present investigation include the following:

1. Test case reduction using minimum Redundancy Maximum Relevance (mRMR) feature selection algorithm.
   - Test cases are reduced based on their mutual information value. This approach selects the test cases with maximum relevancy to the objective function and minimum redundancy among test cases.

2. Test case Optimization using birds flocking algorithm.
   - The test cases are clustered based on the objective functions and the dissimilar ones are treated as outliers.
3. Test case prioritization with genetic algorithm.
   - For prioritization, genetic algorithms are used because of its ability to solve complicated global optimization problems.

4. In regression testing, the performance of the system is compared before and after multi objective test case prioritization.

5. Real time implementation of an integrated multi objective test case prioritization scheme.

7.2 MAJOR FINDINGS

The major findings of the research carried out “AN INTEGRATED MULTI-OBJECTIVE TEST CASE PRIORITIZATION SYSTEM” can be summarized as follows

1. By comparing test cases prior to prioritization and after prioritization
   a. Using APFD metric the results found out are in case of
      i. Project1 – 78% before prioritization and 92% after prioritization respectively
      ii. Project2 – 69% before prioritization and 93% after prioritization respectively.
   b. Using APSC metric the results found out are in case of
      i. Project1 – 71.8% before prioritization and 91.2% after prioritization respectively
ii. Project 2 – 69.9% before prioritization and 93.3% after prioritization respectively.

c. Using APBC metric the results found out are in case of

   i. Project1 – 68.4% before prioritization and 87.8 % after prioritization respectively
   
   ii. Project 2 – 65.3% before prioritization and 89.1% after prioritization respectively.

d. Using APPC metric the results found out are in case of

   i. Project1 – 78.4% before prioritization and 89.3 % after prioritization respectively
   
   ii. Project 2 – 65.3% before prioritization and 87.8% after prioritization respectively.

e. Using APFC metric the results found out are in case of

   i. Project1 – 85.4% before prioritization and 92.3 % after prioritization respectively
   
   ii. Project2 – 75.5% before prioritization and 91.7% after prioritization respectively.

f. Using APFDc metric the results found out are in case of

   i. Project1 – 67% before prioritization and 70 % after prioritization respectively

   Project 2 – 65% before prioritization and 75% after prioritization respectively.
2. Results of the different techniques applied in case of Project 1 and Project 2 according to different modules

a. mRMR Feature Selection Technique – first module
   i. Project 1 – 943 test cases of input reduced to 617 test cases of output.
   ii. Project 2 – 1023 test cases of input reduced to 816 test case of output.

b. Birds Flocking Technique – second module
   i. Project 1 - 617 test cases of input reduced to 323 test cases of output.
   ii. Project 2 – 816 test cases of input reduced to 435 test case of output.

c. Genetic Algorithm Technique – third module
   i. Project 1 - 323 test cases of input reduced to 41 test cases of output.
   ii. Project 2 – 435 test cases of input reduced to 112 test case of output.

3. Results obtained by making relevant comparison using APFD and APFDc metric between some of the existing test case prioritization methods using single level and the integrated test case prioritization method developed by the researcher using three levels are as below

a. Using APFD metric
   i. Project 1 –
      Ant colony algorithm : 89%
      Genetic algorithm : 88.2%
      Hybrid Approach : 90.1%
Integrated Method : 92%

ii. Project 2

Ant colony algorithm : 86.9%
Genetic algorithm : 88%
Hybrid Approach : 91.6%
Integrated Method : 93%

b. Using APFDₜ metric

i. Project 1 –

Ant colony algorithm : 69%
Genetic algorithm : 68.2%
Hybrid Approach : 69.1%
Integrated Method : 70%

i. Project 2

Ant colony algorithm : 69%
Genetic algorithm : 68%
Hybrid Approach : 73.9%
Integrated Method : 75%

In all the comparative techniques adopted by the researcher, the results obtained in all cases clearly indicated the fact that the Integrated System developed proved to be highly effective and superior to the others cited and examined in terms faults detection, execution time(cost), coverage and memory utilization.
7.3 POLICY SUGGESTIONS MADE

Based on the major findings made the following policy suggestions are given to make the software system performance more effective while using regression testing.

1. Dynamic System

The performance of the system whether traditional though latest and integrated can still be increased by making the system more dynamic to incorporate the changes in technology, system setting, requirements, etc.

2. Multi-objective Test Cases

To make good the application of minimum redundance and maximum relevance to the System taken, multi-objective test cases when applied may prove to be more useful and beneficial not only to the individual concerned but also to the entire society instead of a single objective oriented test case system.

3. Application of Levels

Invariably the traditional but latest techniques used in test case prioritization of software system clearly demonstrated the use of a single level and stopped with it. Hence, such traditional though latest are found to be ineffective in terms of the results obtained when projects were analyzed in the present research. It is suggested here that to make the software system more effective, the test cases adopted involving prioritization may be endowed with the application of different levels to accommodate levels of changes in any field of human life.
7.4 CONCLUSION

Since the single objective test case system cannot solve complex problems based on the results obtained using traditional but latest test case prioritization for regression testing, the usage of multi objective test case prioritization system using an integrated approach involving mRMR Feature Selection, Birds Flocking and Genetic Algorithm as done in the present research validates the efficiency and efficacy of the testing system by reducing the execution time, memory usage and by increasing the fault detection rate and coverage.

The limitations of the work are only 4 objectives are used, it is not a fully automated system and also the system is not a dynamic system.

The approach can be applied to the real projects with some slight modifications. As full automation and dynamic nature are the main need of real project, they have to incorporated before applying the approach to the real project.

7.5 SCOPE FOR FUTURE WORK

Based on the outcomes of the research, the following areas are open for future research.

a. **Other Variants of Feature Selection**: While doing feature selection, the present research has thrown much light on mRMR only. Hence, the other variants of feature selection can be thrown open for future research.

b. **Other forms of Particle Swarm Optimization (PSO)**: The present research has done a total concentration only on birds flocking algorithm leaving other forms of PSO to be taken up by future researchers.