Project Details (SR/S4/MS/:745/12)

- **Project Title:** Conforming least-squares h−p spectral element methods for three dimensional elliptic problems on non-smooth domains using parallel computers
- **Project No.:** SR/S4/MS:745/12
- **Funding Agency:** Department of Science and Technology (DST), New Delhi
- **Principal Investigator:** Dr. Akhlaq Husain (akhlaq@lnmiit.ac.in)
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- **Project Duration:** 2014-2016 (03 years)
- **Project Cost:** Rs. 13.62 Lakh
- **Institution:** The LNM Institute of Information Technology Jaipur

Summary

Elliptic partial differential equations arise in many fields of science and engineering such as steady state distribution of heat, fluid dynamics, structural/mechanical engineering, aerospace engineering, medical science and seismology etc.

In three dimensions it is well known that the solutions of elliptic problems have singular behavior near the corners and edges of the domain. The singularities which arise are known as vertex, edge, and vertex-edge singularities. Due to the presence of singularities the conventional numerical methods are unable to provide accurate numerical solutions and the rate of convergence of these methods degrades. In order to improve efficiency of computations and accuracy of the solutions, it is desirable to find efficient numerical techniques along with standard methods such as finite difference method (FDM), finite element method (FEM) etc.

Least-squares spectral element methods (LSQSEM) are based on two important and successful numerical methods: spectral/hp element methods and least-squares finite element methods. Thus, least-squares spectral element methods are very powerful since they combine the generality of finite element methods with the accuracy of the spectral methods and also have the theoretical and computational advantages of the least-squares methods. These features make the LSQSEM a competitive candidate for the solution of large-scale problems arising in scientific computing. LSQSEM employ global polynomials of higher order to recover the so called exponential/spectral convergence. Use of high performance parallel computers to solve large problems has become popular now to reduce the time complexity up to a great extent. In this project we plan to propose an exponentially accurate least-squares h−p spectral element method for three dimensional elliptic problems on non-smooth domains using parallel computer. In this method we shall choose the spectral element functions to be conforming on the wirebasket (union of vertices and edges) of the elements. The values of the spectral element functions at the wirebasket of the elements constitute the set of common boundary values and we need to solve the Schur complement matrix system corresponding to the common boundary values. A probing preconditioner can be obtained for the Schur compliment of the common boundary values which will allow the problem to decouple.