Sample Project Report, CMSC 878R/AMSC 698R

A Student ...

December 7, 2002

Abstract

An abstract about your problem

1 Format for project submission

1.1 Summary Information

Title of the Project:	Solution of the Laplace equation
Student's Name:	Nail Gumerov
Dimensionality of the Problem:	2
Fast computational method used:	MLFMM
Mother Function:	$\Phi(\mathbf{y}, \mathbf{x}) = \ln \lvert\mathbf{y} - \mathbf{x}\rvert$
Size of the problem:	$N \sim 10^4, \quad M \sim 10^4$
Computational domain	Square, $[0, 10] \times [0, 10]$
Max allowed error	10^{-6}, absolute

You can also provide other details such as

Whether FMM is part of an iterative procedure	No; Yes, for linear system; Yes for something else
What is the iterative method	PCG, GMRES, Arnoldi, etc,
How many iterations does it take	
Whether preconditioning was used	

You can also include details on your MLFMM implementation

Type of E2 neighborhood	3-neighborhood, 5 neighborhood ...
Scheme of translation	reduced
Translation operators	$p \times p$ matrix
Single S|R-translation complexity	$O(p^2)$ for matrix evaluation and multiplication
Language of implementation	mixed: C++/Matlab

1.2 Project Description

1.2.1 Background

Solution of 2D Laplace equation is important for many physical applications including fluid dynamics, magneto and electrostatics, and computation of particle motion in potential fields.... (one paragraph).

Also mention if this project is of research interest for you, and if you intend continuing working on it ...

Some literature review ...

1.2.2 Mathematical Background

(at least one paragraph)2D Laplace equation can be written in the form

$$\nabla^2\phi = 0, \quad \nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}.$$

Fundamental solution of this equation (Green's function) is... .

1.2.3 Statement of the Problem

The problem addressed in the project is to develop a fast method for evaluation of the potential generated by a large number of sources of arbitrary intencities and spatial locations... (one paragraph).

1.3 Method of Solution

1.3.1 Description of the FMM version used

Middleman, SL, ML

1.3.2 R- and S- bases

Whar are the function basis for the R and S expansions

1.3.3 S|S-, S|R-, and R|R-operators

How do you translate? How do you compute the entries of the matrices?

1.3.4 Error Bounds and Selection of the Truncation Number

1.3.5 Selection of Grouping (Clustering Parameter)

Analytical optimization, numerical optimization

1.4 Comments on Implementation

1.5 Results of Computations

1.5.1 Performance

Compare fast and slow methods.

1.5.2 Error

Illustrate error of computation.

1.5.3 Optimization

Tell what parameters of the FMM you varied to achieve better performance (e.g. variation of the groping parameter in range showed, that the optimal parameter should be...)

1.5.4 Computational Examples

E.g. several random and regular point distributions. Some analysis and discussion.

1.6 Future Work

Do you plan to continue working on this?

1.7 References