# Chapter I

# Introduction

## 1.1 Background of Study

The fluid flow phenomena such as flow in the rivers, channels, and lake can be described by a known mathematical model which is called shallow water equations (SWE)[13]. Consisting of mass (1.1) and momentum (1.2 - 1.3) equations, SWE in 2-dimension can be given as follows

$$\partial_t h = -\left(\partial_x(hu) + \partial_y(hv)\right), \tag{1.1}$$

$$\partial_t(hu) = -\left(\partial_x(hu^2 + \frac{1}{2}gh^2) + \partial_y(huv)\right), \tag{1.2}$$

$$\partial_t(hv) = -\left(\partial_x(huv) + \partial_y(hu^2 + \frac{1}{2}gh^2)\right), \tag{1.3}$$

where $h$ denotes the water depth/height, $u$ the lateral velocity in $x$ direction, $v$ the lateral velocity in $y$ direction, and $g$ a constant gravitational force. The variables $x$, $y$ and $t$ denote the space and time respectively.

The approximation solution of Equations (1.1 - 1.2) can be obtain using several methods. The most popular method is grid method known as the finite volume method (FVM). This method is developed into several numerical schemes which are widely applied and are shown robust scheme, for instance see the references [11, 12, 2, 16] and [3]. However, the deficiency of this method is to solve the general water flow with a complex structure. Here, the LBM is the numerical method based on particle method. LBM is already applied in many applications of fluid flows [22]. The advantage of LBM is the complexity of boundary condition can be omitted [21]. However, LBM can gain higher computational cost than the other methods.

In order to accelerate the computation in time, the parallel computing techniques will be elaborated. In references [15, 9, 10, 4] and [5], parallel computing is shown as a good idea to accelerate the numerical computation. Thus the goal of this paper is to obtain the performance of parallel computing for simulating LABSWE. Additionally, here the shared parallel architecture using OpenMP platform will be used.

## 1.2 Problem Formulations

Problem formulations of this final project are

1. How to approximate Shallow Water Equation solution using Lattice Boltzmann Method?
2. How to apply parallel performance in Lattice Boltzmann Method for Shallow Water Equation algorithm?
3. How big the effect of parallel performance in Lattice Boltzmann Method for Shallow Water Equation algorithm?

## 1.3 Objects of Study

There are several objects of study that must be achieved in this paper, i.e:

1. to know the process of approximation Shallow Water Equation solution using Lattice Boltzmann Method;
2. to know the application of parallel performance in Lattice Boltzmann Method for Shallow Water Equation algorithm;
3. to know how big the effect of parallel performance in Lattice Boltzmann Method for Shallow Water Equation algorithm.

## 1.4 Problem Limitations

Here the limitations for the problem of this paper,

1. Conservation of mass and momentum in the particle are assumed as the velocity received with another particle;
2. The parallel performance just applied on 2 and 4 threads of OpenMP programming.