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VLSI Implementation of Swarm Unit for PSO Algorithm

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Abstract— This research paper represents the swarm unit implementation for Particle swarm optimization algorithm. In this work the importance of swarm unit in PSO algorithm is been discussed. In this manuscript, the architecture are parameterized and designed by IEEE 754 standard of 32 bit single precision floating point arithmetic for the swarm unit implementation. The swarm unit includes the basic and important PSO algorithm equation on which the PSO algorithm works. In this paper the inputs are in form of floating point which are designed in MATLAB. This research paper represents the redesign of swarm unit. The proposed design is simulated using Xilinx Isim Simulator and synthesized and implemented using Xilinx ISE on Nexys – 4 DDR FPGA devices. The hardware implemented results is shown.

Keywords - Swarm Unit, PSO Algorithm, Floating point Arithmetic, hardware implementation, Single precision

I. INTRODUCTION

The optimization algorithm is basically the best result of the solution determined based on the specific case. The basic goal of an optimization algorithm is to find the optimal solution for a certain problem. Initially conventional optimization algorithm faces non-linearity's and performs very complex calculations [1]. There are many optimization techniques such as Genetic algorithm and Particle Swarm optimization. There have been wide comparisons between genetic algorithm and particle swarm optimization as both are nature inspired and population based algorithm. [2] There are many comparisons of particle swarm optimization and genetic algorithm implemented on field programmable gate array (FPGA). Genetic Algorithm (GA) is similar to the PSO, but due to the hardware complexity of the GA, PSO is recommended.

The optimization paradigm of meta-heuristics is a significant and vitally important that may be applied to modern engineering problems. Population-based algorithms make up a significant subset of meta-heuristics. The particle swarm paradigm has attracted increasing interest from scientists worldwide in recent years [3]. Nature inspired by the swarm intelligence, particle swarm optimization (PSO) was introduced by Eberhart and Kennedy in 1995 [4-5]. The motivation of this optimization technique was the swarming simulation

of animal learning and information sharing as groups of insects and birds forage for food [6].

In this paper, for particle swarm optimization, random number are been used as inputs and as we know that random values are in real values. Real values can be fixed or floating point numbers. In this paper, because of the several advantages of floating point over fixed point numbers[7], we are working with floating point arithmetic operation mainly addition / subtraction and multiplication. This makes this work more accurate with simple regulations. The floating point conversion is done in MATLAB using float to binary function. The swarm unit includes the basic and important PSO algorithm equation on which the PSO algorithm works. In this paper, the swarm unit is implemented in Xilinx Isim Simulator and synthesized and implemented using Xilinx ISE on Nexys – 4 DDR FPGA device.

In section 2, PSO algorithm section describes the basic origin of PSO and also about the swarm unit is discussed briefly. Section 3, is the proposed design of swarm unit with the equation included in it. Section 4, presents the simulation section, in which the simulation result of swarm unit of PSO algorithm waveform generated through Simulator is shown. Here synthesis result of the of particle architecture of swarm unit. Finally the manuscript is concluded in section-5.

II. PSO ALGORITHM

There is a nature inspired algorithm which is one of the most popular optimization algorithm known as particle swarm optimization have received increased attention in recent years, revealing it potential talent. Nature inspired by the swarm intelligence, particle swarm optimization (PSO) was introduced by Eberhart and Kennedy in 1995 [5-4]. The motivation of this optimization technique was the swarming simulation of animal learning and information sharing as groups of insects and birds forage for food [8]. Unlike other optimization techniques, particle swarm optimization is simplified and easy to implement. Similar to previous optimization techniques, particle swarm optimization updates the population of individuals by using a variety of operators in accordance with fitness information gathered from the environment, allowing the population as a whole to move toward areas with better solutions [9].