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CUDA Implementation of Heart Health Risk Assessment System Using Ontologies

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Abstract: - Heart attack is one of the leading causes of death in both developed and developing countries. The abnormal physical activity of the person which leads to heart attack determined using data mining techniques over data gathered from their smartphone`s sensors like accelerometers, gyroscope, magnetic sensors. One of the primary challenges is to detect lack of real time response to the risk because Physical activity monitoring datasets are quite large and involves heavy computations for classification. These tasks are often complex and computationally expensive which result in a demand for high performance computing platforms. Random Forests (RF) has been proven to be a competitive algorithm regarding both computation time and classification performance and it is a suitable candidate for parallelization; implement random forest algorithm using CUDA (Compute Unified Device Architecture) can increase the performance of classification. We present an alert management tool that supports cares in their task of validating alarms raised by the system using ontology techniques.

Keywords- Ubiquitous computing, Domain ontology. Compute unified device architecture

I. INTRODUCTION

Coronary heart disease (CHD) is the most common cause of death in India, and the mortality rate in the India is still higher than many Asian countries. With the advancement of computing devices, technology is playing an ever increasing role in society by making jobs quick and easier, providing new medians for communication, and most importantly, increasing quality of life with medical devices. The rapid growth in hardware technology has become an attractive option to gather data using a wide set of available sensors. However, there is a need to depend on nonintrusive sensors trying to keep a minimal deployment and especially to avoid annoying users. Indeed, built-in cheap sensors are now integrated into day to day use devices, such as mobile phones. Exploiting built-in sensors leads us to the possibility of large scale human sensing and collecting large datasets. Ontologies are content theories about the classes of individuals, properties of individuals, and relations among individuals that are possible in a specified domain of knowledge. They define the terms for describing our knowledge about the domain. An ontology of a domain is beneficial in establishing a common (controlled) vocabulary for the describing the domain of interest. This is important for unification and sharing of knowledge about the domain and connecting with other domains. In reality, there is no common formal definition of what ontology is. However, most approaches share a few core items such as concepts, a hierarchical IS-A-relation, and further relations. For the sake of generality, we do not discuss more specific features like constraints, functions, or axioms in this paper instead we formalize the core in the following way:

Definition: Ontology is a tuple

$O = (C, \text{is\_a}, R, \sigma)$ where

C is a set whose elements are called concepts,

is_a is a partial order on C C (i. e., a a binary relation is_a C X C which is reflexive, transitive, and anti-symmetric),

R is a set whose elements are called relation names (or relations for short),

$\boldsymbol{\sigma} : R \rightarrow C^{+}$ is a function which assigns to each relation name its arity.

The adoption of Ontologies inspired approach yields good results in terms of standardizing healthcare guidelines. All decision support systems require some form of language representation to encode domain knowledge and their interactions. CUDA (Compute Unified Device Architecture) is a parallel computing platform and programming model created by NVIDIA and implemented by the graphics processing units (GPUs). CUDA permits developers direct access to the virtual instruction set and memory of the parallel computational elements in CUDA GPUs.

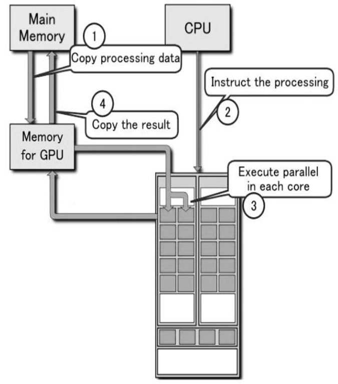

Fig 1.1: CUDA processing flow

Using CUDA, the GPUs can be used for general purpose processing (i.e., not exclusively graphics); this approach is called as General Purpose Graphics Processing Unit (GPGPU). GPUs are have a parallel throughput architecture that emphasizes executing many concurrent threads slowly, rather than executing a mono thread very quickly. The PAMAP2 (Physical Activity Monitoring dataset) contains data of 18 different physical activities (such as walking, cycling, playing soccer, etc.), performed by 9 subjects wearing 3 inertial measurement units and a heart rate monitor. The dataset can be used for activity recognition and intensity estimation, while developing and applying algorithms of data processing, segmentation, feature extraction and classification. This paper is organized as follows: Section II discuss about the related works, Section III describes about system model. In section IV the conclusion work is given.

II. RELATED WORK

David Geer [6] Describes GPUs are typically used in game consoles or as graphics coprocessors to CPUs, mainly for rendering geometric primitives such as polygons. Researchers have studied the use of graphics hardware for general-purpose computation since the late 1970s. Major graphics chip manufacturers such as NVIDIA and ATI Technologies have added support for floating-point computation and released compilers for high-level languages.
Yisheng Liao (7), authors compared the performance of CudaTree algorithm with scikit-learn and wiseRF on the six datasets such as ImageNet subset, CIFAR-100, covertype, poker, PAMAP2 and intrusion. Across the six datasets, CudaTree is 1.8x - 7.6x faster than scikit-learn and for the four larger datasets, also faster than wiseRF.
Claudio Bettini Oliver Describes Context can be considered as a specific kind of knowledge. Thus, it is quite natural to investigate if any known framework for knowledge representation and reasoning may be appropriate for handling context. The tradeoff between expressiveness and complexity of reasoning has driven most of the research in symbolic knowledge representation in the last two decades, and description logics have emerged among other logic-based formalisms, mostly because they provide complete reasoning supported by optimized automatic tools. Since ontologies are essentially descriptions of concepts and their relationships, it is not surprising that the subset of the OWL language admitting automatic reasoning (i.e., OWL-DL) is indeed description logic. Ontology-based models of context information exploit the representation and reasoning power of these logics for multiple purposes:

The expressiveness of the language is used to describe complex context data that cannot be represented, for example, by simple languages like CC/PP
By providing a formal semantics to context data, it becomes possible to share And integrate context among different sources;
The available reasoning tools can be used both to check for consistency of the set of relationships describing a context scenario, and more importantly, to recognize that a particular set of instances of basic context data and their relationships.
A random forest is an ensemble of randomized decision trees which vote together to predict new labels. CudaTree parallelizes the construction of each individual tree in the ensemble and thus is able to train faster than the latest version of scikits-learn.

III. PROPOSED SYSTEM

In the purposed system the abnormal physical activity which leads to heart attack, determined using data mining techniques over data gathered from smartphone sensors like accelerometers, gyroscope, magnetic sensors and it validated over the PAMAP2 (physical activity monitoring dataset). The proposed system provides a GPU-based parallel implementation of the Random

Forests algorithm. Both the training phase and the classification phase are parallelized in CUDA implementation.

Advantages

The general-purpose computing on GPU (GPGPU for short) is highly parallelization and powerful computing ability of float point.

The data processing latency reduced by parallelized random forest algorithm on a CUDA.

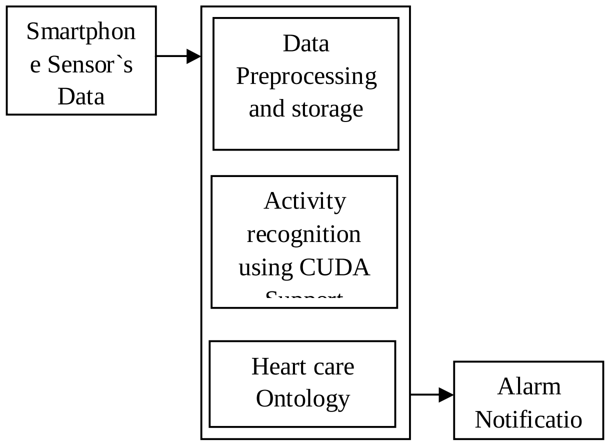

Fig 3.1: System Architecture

A. Context Data Acquisition

From the registered users smartphone the sensors data transferred to remote server via UDP protocol. The static data like the user id, Gender and age data transferred from the client`s mobile to remote server also done in the same manner. The previously introduced datasets provide timestamped raw sensory data from the 3 IMUs and the heart rate monitor, and timestamped activity labels. All this data is synchronized in the preprocessing step.

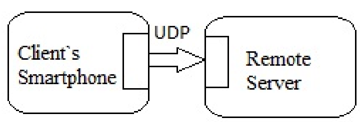

Fig 3.2: Data transfer from client to remote server

B. Activity Recognition Using Curf And Performance Analysis

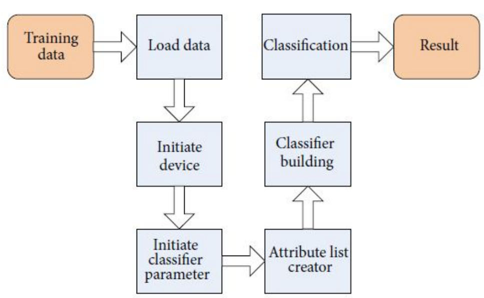

Fig 3.3: Flowchart of the proposed CuRF algorithm.

Training and testing data are loaded to host memory from disks.

Initialization of the device includes query device, Information, allocation memory space, and copy of Training data into device.

In this step, the system will set up some parameters from user. For instance, the minimum numbers of data of a leaf are the maximum depth of the classifieris.

Creating attribute lists in device. We will move each attribute to corresponding position. After finishing the data movement, we would sort all attribute lists in devices.

Instead of using the recursive model of decision tree building algorithm, we use random forest for our proposed system. Host plays a role of a manager and is in charge of working flow of the whole system.

For data sizes less than 500 python and numpy performs extremely well and CUDA performs badly since communication between device and host exceeds the computation time. But when data size exceeds 50000 CUDA performs extremely well in fraction of seconds. For data sizes greater than 5*10^6 default programming fails to perform computation while CUDA performs it 0.6 seconds

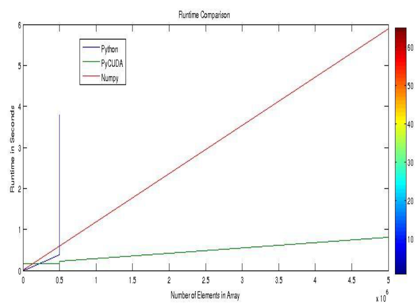

Fig 3.4: Performance Comparison of Normal Python Vs NumPy Scientific Library Vs PyCUDA Run time for Various Datasize

C. Heartcare Ontology

Heartcare Ontology contains the most relevant terms, relationships, and restrictions in the health care domain In particular, it contains basic biometrics features, user's contexts (with special interest in a medical context), and different types of physical activities. In the first place, the ontology captures several biometrics features about each person, including age, weight, height, and current heart rate, among others. Moreover, each person could be classified according to her gender, physical condition, and so forth. (e.g., a disjoint classification between man and woman is included in the ontology, but they are not exclusive with elderly or sportsperson. Therefore, a person could be classified as an elderly woman who practices sports). The subclasses of person are based on the considered alert situations, but they could be extended taking into account other types of person when necessary. For each type of activity, the model records the maximal and minimal limits of the relative intensity of the activity (expressed as percents of the maximal heart rate of the person) along with its associated heart rate. Moreover, it is possible to define default values for each intensity level (i.e., VeryLightActivity, LightActivity, etc.) that can be inherited for new activities whose specific values are unknown.

Elderly(?p) ∧
performsActivity(?p, “$Stair\ Climbing$”) ∧
exceeds(?$p.hr\ current$, 120) ∧
hasContext(?p, ?c) ∧
MedicalContext(?c)
⇒ set($c.alarm\ leVel$ = “$Medium$”)
⇒ set($c.alarm.comment$ = “$Climb\ the\ stairs\ slower\ next\ time$”)

Algorithm1

D. Alarm Notification

Pseudo Code:

If specified condition is not a attack then:
    Remain idle
Else if it is an attack:
    Get caretaker mobile number from configuration
Get the timestamp and type of attack Wait in sms queue to be processed
If no GSM compatible gateway found then: Retry
Else if successfully sent then:
    Exit

IV. CONCLUSION

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We have presented a new parallel version of the Random Forests machine learning algorithm CuRF, implemented using the compute unified device architecture (CUDA) for the early detection of heart attack using smart phone sensors data. And the false alarm reduced by the HCO (Heart care ontology) model.

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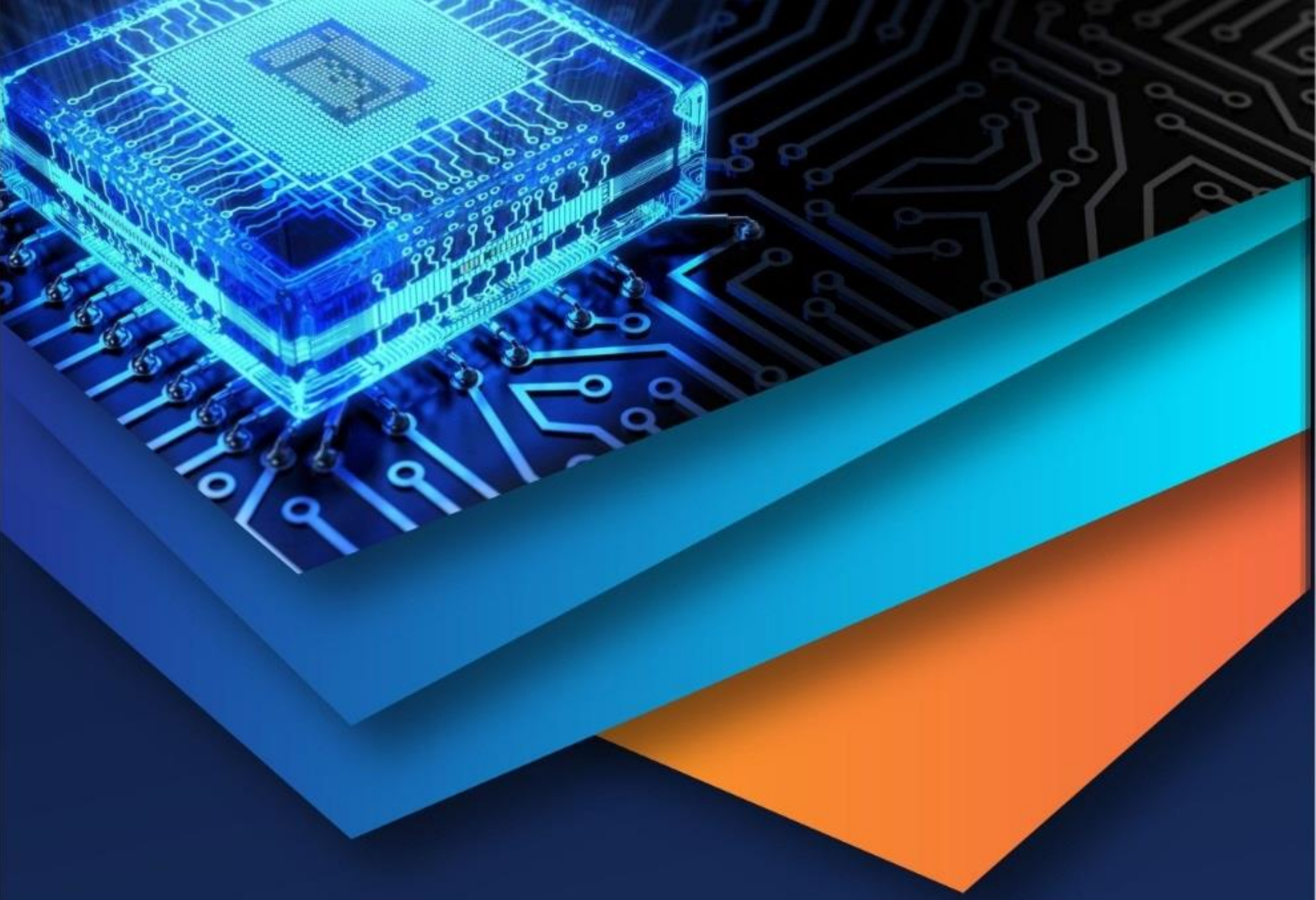

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