International Journal of Current Engineering and Technology
ISSN 2277 - 4106

Available at http://inpressco.com/category/ijcet

Research Article

A Proposed Framework for MAD-Cloud and MAD-Expert Service Module

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Accepted 15 December 2013, Available online 25 December 2013, **Vol.3, No.5 (December 2013)**

Abstract

In the current era of liberalization every sector is competitive including agriculture, as it plays a major role either directly or indirectly in improving economic status of a country. Cloud computing, a recent IT revolution, can be used as a new computing paradigm to the agriculture sector. Cloud computing data centers will allow in storing vast database securely on which many complex calculations can be done as required by the researchers, scientists or farmers. It can provide timely and accurate data to take right decisions and to make better plans for the farms or fields. This paper proposes a framework for Management of Agriculture Data (MAD) and MAD-Expert Service Module as a part of MAD Cloud.

Keywords: *MAD (Management of Agriculture Data), MDPL (MAD Data Processing Layer).*

1. Introduction

Agriculture plays major role directly or indirectly in improving economy of developing countries. In the current era of liberalization every sector is competitive including agriculture, so as to compete agricultural sector should also use Information technology to achieve maximum benefits. Recent Information technology revolution Cloud computing which has evolved by making base of ICT, Internet, Web services and other existing technologies. As we know IOT is also part of it we can use this along with new Computing paradigm to the agriculture sector to improve quality and to achieve better crop results by using information precisely. Cloud computing can be viewed as a new paradigm for dynamic and controlled provisioning of sharable computing resources, maintained by state-of-the-art data centers based on network of Virtual Machines running on high powered physical machines.

Cloud computing data centers allows you to store vast historical data securely on which many complex calculations can be done which is required for agricultural scientists for new inventions.

In rural areas if the departments of agriculture provide, timely and accurate agricultural information stake holders, researchers can make the right decisions, planning the development of farm lands. If the Information technology is improved Agricultural science and education Personnel can improve the research capacity and level of education by gathering the latest agricultural information resources and deliver the same to the end users. So in this paper we have proposed MAD-Expert service as part of MAD-cloud which will benefit agriculture experts, Government officials, farmers.

The motivation behind this arises after witnessing many problems and requirements faced by the farmers, researchers related to lack of knowledge about the accurate and timely data. We worked to relate the agriculture field with the recent and popular computer technology, i.e. Cloud Computing. The main goal is to provide efficient enough agriculture related data, even if they are related to different fields, on a single platform through Cloud Computing.

2. Proposed Framework/Design of MAD-Cloud Architecture

Cloud computing and with combination of Internet of things offers resources and services at cheaper cost which is essential for farmers working at cultivation lands, so we have proposed this framework of MAD-Cloud which offers expertise service to farmers regarding cultivation of crops, pricing, fertilizers to be used etc. Scientists working at Agriculture research stations can add their discoveries, suggestions regarding modern techniques for cultivation, usage of fertilizers, can obtain cultivation history of the region etc.

MAD-Cloud can benefit Government officials/private organizations by obtaining/inserting information regarding pricing of crops, farming of lands at various places, benefits to be given to farmers for various crops like supplying seeds, fertilizers etc. MAD-Cloud framework at SaaS layer supports various services to Farmers to interact with cloud by using any cheaper ways or IOT such as

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Sensors, Mobile devices, Scanners etc., to query for information and access it in no time at free or cost from free services and by paying meager amount for pay services. MAD-Cloud can use existing cloud infrastructures like networks, servers etc., other than the resources discussed below. The proposed MAD-Cloud framework shown in fig-1 is a layered architecture contains layers like:
1) MAD-Data Acquisition layer (MDAL).
2) MAD-Data Processing layer (MDPL).
3) MAD-Data Storage Service layer (MADSSL).

1) MAD-Data Acquisition layer(MDAL) uses Internet and IOT which provides services to be used by farmers, agriculture experts or government officials to add or query data by using their applications service interfaces either through browsers, Tablet PC's, sensor(RFID) device or mobile devices. MDAL is deployed as **SaaS** in Cloud which provides various interface services to be used by different types of consumers with different devices. ADAL services layer mainly used for agriculture data acquisition and supply solutions to users. Vast data or historical data used for various purposes is stored in MAD-DB.

2) MAD-Data Processing layer(MDPL) is a Data processing layer contains libraries which will accept data in various formats from various devices and converts into uniform format and performs computations on large data sets and reports to consumers of MAD-cloud. Platform as a service encapsulates a layer of software and provides it as a service that can be used to build higher-level services. MDPL is deployed as **PaaS** in MAD-Cloud which contains libraries or readymade program modules to be used to build high-level agriculture based applications. MDPL provides service contains libraries for Data security, Data Processing, Expert Decision making and Data Reporting.
Further MDPL has divided into following modules:
a) MAD-Secure Data Service module.
b) MAD-Data Processing service module.
c) MAD-Expert Service Module.
d) MAD-Solution reporting Service module
a) MDPL uses MAD-Secure Data Service (MSDS) libraries to provide authentication, integrity, secrecy for incoming data from various sources or reporting them with solutions. Every data source or users are Authenticated by using secure algorithms to access resources of cloud like VM.s, databases etc. MSDS deny accessing of malware programs in modifying cloud data or destroying cloud resources deliberately by using agent based IDPS.
b) MAD-Data Processing (MDP) service contains libraries for Analyzing the data, Conversion of data from various devices into uniform format MAD-Cloud Data Open source(MCDO), data Computation, natural language processing of data sharing and data sharing if required.
c) MAD-Expert Service (MES) is an expert service layer contains libraries which allows to provide solutions or decisions after processing sensor, image, mobile, query related data from consumers and generates reports sent to MSRSL. MDESL uses various expert service modules which use fuzzy logic, AI techniques for providing solutions dynamically.
d) MAD-Solution Reporting Service (MSRS) contains libraries which provide reporting service to customers in formats required by them to various devices after conversion to their respective languages by using natural language processor. MSRS will convert data into MCDO format and it can be consumed by applications in SaaS for reporting users in various ways to them.

3) MAD-Data Storage Service layer (MDSSL) is data storage layer supports database infrastructure facilities to store large amounts of data which is required in agriculture sector for results to be accurate. MDSSL is deployed at **IaaS** level in cloud which allows data sharing and usage. Agriculture data base contains MAD-Expert knowledge Database(MKDB) contains rules, inferences for decision making purposes, Image Knowledge Database(IKDB) to make decisions based on images received from farmers or consumers from farm lands, Statistical knowledge Database(SKDB) which allows to make decisions regarding amount of land to be cultivated, quantity of seed, fertilizers to be used etc,. Business Knowledge Database (BKDB) contains data to make business related decisions for pricing or for comparisons of business at different locations on different agriculture products. MDSSL uses MAD-Secure Data Service (MSDS) libraries for securing cloud data storage by encrypting it at storage and decrypting during its usage by various services. Encrypted data is stored in MKDB, IKDB, SKDB, IKDB in Agriculture Data base layer for security reasons.

3. Operational Aspects of MAD-Cloud

MAD-Cloud when deployed on cloud will work in layered architecture where layer below will provide services to high level layers. Farmers, Agriculture experts, Government officials etc., will interact with MAD-Cloud by using various devices like Web browsers, Sensors, Mobile devices, PDA etc., will use appropriate application interfaces available at SaaS layer in cloud. SaaS layer will be used as Data Acquisition layer to give input to MAD-Cloud system to update databases by the experts from Agricultural research stations. Farmers at Farm lands can obtain solutions through expert systems available regarding the query given in their natural language.

The PaaS layer in MAD-cloud contains API's to process and analyze data, provides security and authentication to data and its users and delivers expertise solutions through expert service module available. The data from the experts are accepted only through proper authentication provided by the MSDS. MDP service module will process data from experts and converts into unified format and stored as knowledge based inference rules in MAD-Database in IaaS which will be used by expert system to provide solutions to farmers. Data from Experts are classified into Image data, Sensor Data, Statistical data, Rule based data, business related data and stored in appropriate databases in encrypted format by

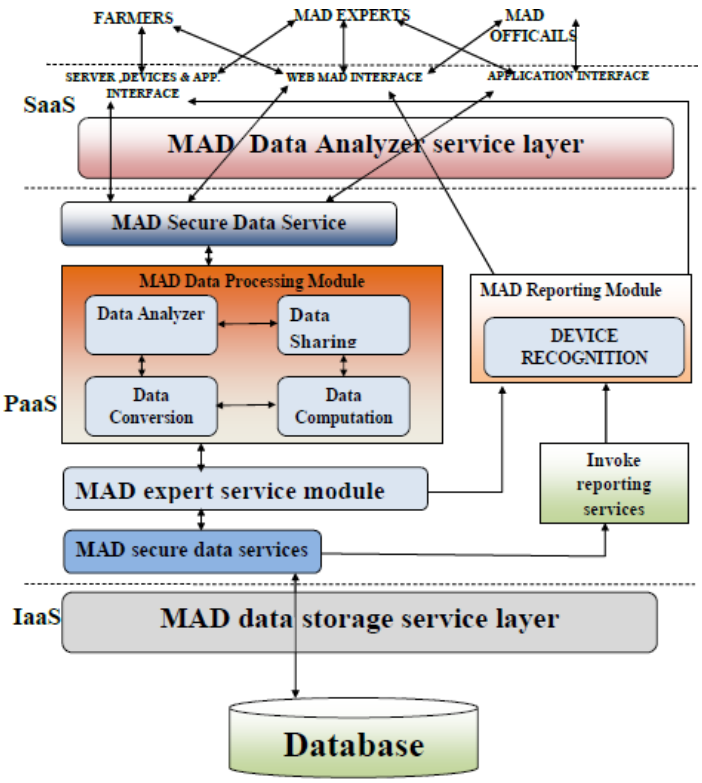

Fig.1 Proposed MAD-Cloud Framework

encryption and decryption service provided by MSDS. MDP will perform computations and Sharing of data if require for computation in secure manner.

The main purpose of Agriculture cloud is to provide the solutions to farmers in rural areas for problems related to cultivation at cheaper cost or at free of cost (if funded by government). MAD-cloud uses MAD-Expert system shown in fig-2 which is available as API or libraries or executable code module at PaaS layer to be used by higher layers to provide solutions regarding cultivation or business. AES can be used in various ways like, for example a farmer can send a query through a mobile regarding any cultivation problem and the Intelligent solution provider will direct the query to MAD-Cultivation expert and in turn to Mobile expert module which in turn uses DSS/Inference engine to check the query or rules against the data in MKDB/SKDB/SKDB for required solution and send it back to farmer mobile device by using MSRS.

Similarly, for Statistical data or image data, if the disease crop image is send to MAD-Cloud system through any interface it will use Image expert system to find the crop disease from IKDB and sends the name of fertilizer or remedy for the problem in crop in cultivation land. Also farmer or consumer of MAD-cloud service can send a query through a mobile or through any interface in SaaS regarding pricing for crop in particular location then the Intelligent solution provider will direct the query to MAD-Business expert which will in turn use DSS/Inference engine to check it in BKDB and reply back to client MSRS in a natural language of the client at that location. AES can provide information regarding amount of fertilizers that they must apply to a particular kind of soil and crop. Government officials at that region/location can educate farmers regarding this by querying the system with soil type and nutrients in soil so that they can suggest quantity and type of fertilizer the farmer can use for that soil in that season. MAD-Cultivation Expert will use inference rules or knowledge in MKDB for providing the solution.

The knowledge acquired from knowledge acquisition layer from domain experts is represented into structured form. There are many approaches for representing knowledge into the knowledge base. Such representation in ESTA is the rule based representation in logical paradigm of simple ***if-then*** rules in backward or forward chaining. We have chosen here the backward chaining for knowledge representation with simple ***if-do*** pair in place of ***if-then*** rules. These rules are stored in MKDB for fast decision making and achieving solutions to problems from farmers. Here we have considered two major knowledge representations namely Sections and Parameters. The top level of representation of knowledge in ESTA is section. It contains the logical rules that direct the expert system how to solve problem, actions to perform such as giving advice, going to other sections, calling to routines etc. The first section in ESTA is always named as ***start*** section. The advice is given when condition(s) in the section is(are) fulfilled. Parameters are used as variable and it determines the flow of control among the sections in the Knowledge Base. Image Expert system will analyze crop disease by analyzing the crop color with the stored high resolution images in IKDB. To process it very highly complex image processing algorithms for clipping, smoothing,

segmentation are executed to classify images along with various image attributes and to give final solution. In mobile expert service module Questions or images from mobile is accepted is processed accordingly to report appropriate solutions to the end users.

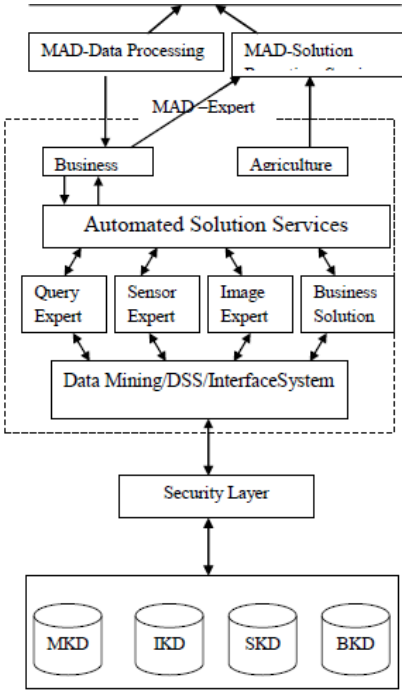

Fig.2 MAD-Expert System

MAD-Data Storage Service layer (ADSSL) which serves as storage layer for agriculture database which is deployed in IaaS layer of MAD-Cloud. The large amounts of agriculture data is stored in databases at cloud data centers in encrypted format for security purposes. The knowledge information to be used by above layers is stored in databases (which in turn tables) MKDB, IKDB, SKDB, BKDB as discussed in above section.

Conclusion

In this paper we have proposed MAD-Cloud model along with MAD-Cloud framework with appropriate technical aspects to provide assistance to farmers during crop cultivation to analyze soil, climate condition, crop cultivation and crop diseases during cultivation in a cheaper means through latest technologies like cloud computing to Farmers, Agriculture Experts, and Government officials. An application of cloud computing is more suitable for agriculture as large agriculture data is to be processed and stored at cheaper prices which is essential in developing countries at this juncture. In future we deploy MAD-Cloud by using open source cloud computing technologies as proposed in this paper.

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