Comprehensive study on Load balancing for artificial intelligent cloud robot as- a- service (AICRaaS) in Virtual top classified test and training range

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Abstract: ***Artificial Intelligence is a capacity to solve any problem, with the help of actions done independently and intelligently. Machine learning is a subset of artificial intelligence which provides an ability to the systems to obtain without any specific program. Robotics is a branch of engineering dealing with the design, implementation, controlled usage with the help of electronics, mechanical and computer science engineering. Cloud is a technology for storing and accessing the data and programs on remote servers that are hosted on internet instead of a personal computer's hard drive or local server. It is an Internet based computing. A case is considered for the study of implementation aspects of inter-connected technological application. Area 51 is a Test and Training range in USA, used for different defence equipments testing and training operations. Unlike such physical existence one can make product evaluation in a virtual environment using some simulations. Although some of such defence simulations are existing within the defence communities across the world, common citizens are un-aware of such technological aspects. As since it is highly dynamic and it makes huge load on cloud environment, a Comprehensive study is done on the Load balancing for artificial intelligent cloud robot as-a- service (AICRaaS) in an environment called Area-oxo (Object Xtra Outpost). Area-oxo is a Virtual Top Classified Test and Training Range (VTCTTR,) provides all possible operational Infrastructure –as-a- service (IaaS) in terms of artificial intelligent cloud robot as- a- service (AICRaaS).***

Keywords: ***Artificial Intelligence, Machine learning, Robotics, Cloud technology, Hypothetical Evaluation, Area-oxo (Object Xtra Outpost), Virtual Top Classified Test and Training Range (VTCTTR).***

I. INTRODUCTION TO DIFFERENT TECHNOLOGIES

After the invention of mechanical computer, requirements have demanded to expand its capacity which has resulted to upgrade to electronic computers. These electronic computers has increased the capacity of computational speed and the reduced the size of the computer for better implementation results. Expansion growth of computational technology has ventured into the geometric progression today as it is endorsed by the Moore's law [1].

Artificial Intelligence is a branch of Computer Science which is intended to make the computers similarly intelligent as humans. As per the father of Artificial Intelligence John McCarthy, who Quotes as “Artificial Intelligence is a science and engineering of making intelligent machines, especially intelligent computer programs”. This technology enables the computers, or a computer-controlled robot, or any software to think intelligently, similarly as like that of the humans. Artificial Intelligence follows human activities such as thinking nature, learning nature and decision capacity and also problem solving capacity. Philosophy of Artificial Intelligence is to exploit the computational capacity of existing computational resources [2].

Machine learning can be considered as a subset of Artificial Intelligence, which has the ability to identify things out from the data and deliver Artificial Intelligence applications. Deep learning is, a subset of machine learning which makes the computers to solve more complexed problems. Therefore machine learning can be defined as “Machine Learning is a technique of parsing data, learn from that data and then apply what they have learned to make an informed decision”[3].

Robotic technology is a multi useful, again - programmable, automated modern machine. The robots have electrical parts for giving force and control the hardware. They have mechanical development, shape, or structure intended to achieve a specific wprk. It contains some sort of PC program that figures out what, when and how a robot accomplishes something. According to Issac Asimov, "Laws of Robotics", expresses that "A robot isn't permitted to harmed humankind, or, through inaction it permits mankind to come to harm"(Zeroth Law), "A robot can not harm a person, or, through inaction it permits an individual to come to hurt, except if it would abuse the higher request law(First Law), A robot ought to follow the requests given it by people, aside from when such requests give by people would strife with a higher request law (second Law), A robot is permitted to secure its own reality as long in that capacity assurance would not struggle with a higher request law(Third Law) [4].

Cloud which is a distributed computing frameworks are commonly settled in greater server farms. These server farms would be facilitated by an organization. The facilitating organization offers the types of assistance to the clients or the end clients. Before the distributed computing innovation

came in to presence, the customary business applications were existed. They are confounded. They required various sorts of Hardware, and Softwares to be introduced, arrange, test, run, secure and update intermittently by a gathering of specialists. Cloud computing is a disseminated registering office. Conveyed figuring office is given to the outsider. John McCarthy is the dad of this model of registering. Today distributed computing is a typical and significant figuring asset. Cloud computing enormously changed the innovation perspectives around the world. Distributed computing gives an approach to lease the framework, run nature and to have the administrations on pay and utilize model. Cloud style of conveying the administrations is characterized by 'Reese'[5].

Artificial Intelligence is man-made brainpower which is an intensity of new distributed cloud computing age. Presently a day significant Cloud suppliers organizations like Google, Amazon, Microsoft and IBM have fusing of Artificial Intelligence abilities in distributed computing. They gives cloud AI stage and AI cloud administrations likes computing vision, efficient speech recognition mechanism, efficient content examination, quick and dynamic interpretation, very keen on pursuit, smart language and clever information. Thus, Artificial Intelligence improves the intensity of Cloud Computing and furthermore a stage of new age of Cloud Computing [6].

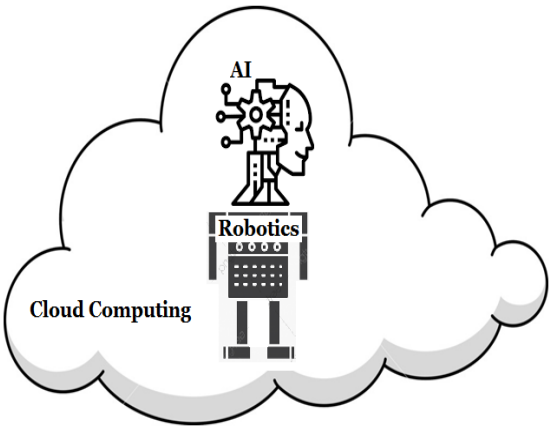

Fig.1. Cross technology application utilization Icon (proposed)

II. ROBOTIC SIMULATION FOR –VIRTUAL TOP CLASSIFIED TEST AND TRAINING RANGE

To carryout different tests and to evaluate defense products there is a need for Top Classified Test and Training Range (TCTTR). In USA there is a location called Area 51, which is approximately 100 kms from Las Vegas. It is a secret place and no-fly zone which covers approximately 1,30,680 million square feet. As per Central Intelligence Agency (CIA)'s declaration in 2013, Area 51 is "a flexible, realistic and multidimensional battle-space to conduct testing tactics development, and advanced training".

Although it is not possible for every one, to carry out their operations in such a gigantic area and the sophisticated environment, it is always better to conduct all such operations in virtual test and training range. This study has ventured in to some of these aspects and attempted to create a test area which is proposed to call as Area-oxo (Object Xtra Outpost). This Area oxo is a Virtual Top Classified Test and Training Range (VTCTTR).

Robot simulation is an essential tool for the design and development, performance evaluation of robots in the realistic scenarios. There are many number of robotic tools are existing as of now such as Webots, Gazebo, V-REP, Microsoft Robotics Developer Studio, Roboguide etc[7]. However For this present study Gazebo simulation is used.

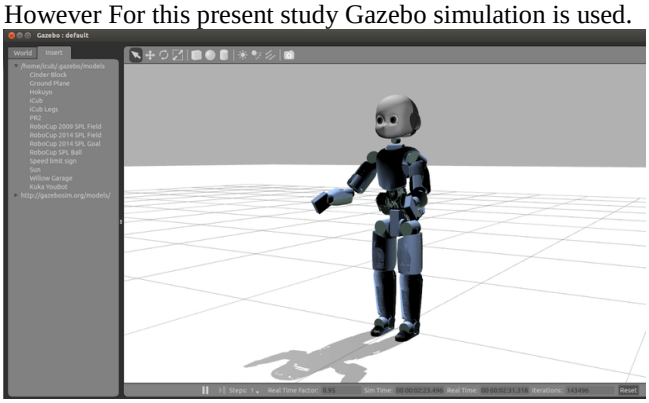

Fig.2. Robotic Simulation

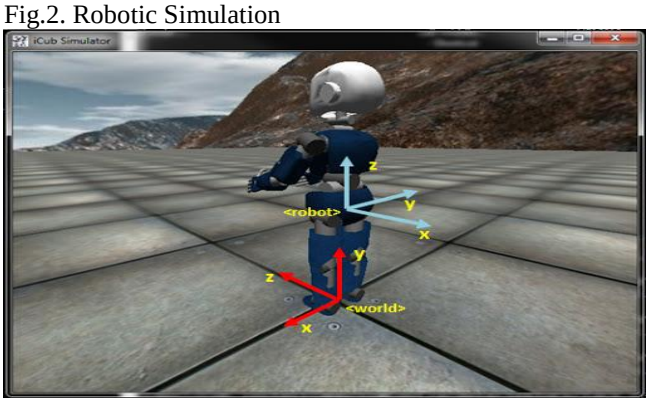

Fig.3. Robotic Simulation environment

III. SIMULATION METRICS

To evaluate these simulators it is available some of the parameters such as Stability of the simulation, Speed of the simulation, precision of simulation. Gazebo Simulator can be used for creating, testing and evaluation of Area-oxo. Gazebo is a multi-robot simulator for outdoor environments. But these operations has some limitations such as controlling a robot's motion which relies heavily on sensors and feedback of controller may not benefit much from the cloud. Cloud-based applications can get slow or unavailable due to high-latency responses or network hitch. If a robot relies too much on the cloud, a fault in the network could leave the robot doing some useless activity rather than it is intended to do. To do some particular operations by the cloud robot in the Area- oxo, There are three basic types of needs which are needed to satisfy. They are vision related requirements, sound related requirements, intelligence related requirements. Vision related requirements will include detection, identification, analysis and organizing of required images [8]. Sound related requirements includes (the controller from a data center) conversion of sound to text (using natural language process) and from there to robot

understandable binary language. Intelligence related requirements include decisional knowledge, Linking the intelligence with services, knowledge of people, locations and events etc. If any other things encountered by the cloud robot, it could searched and taken appropriate decision.

Fig.4.Satillite over view of world before identifying any location

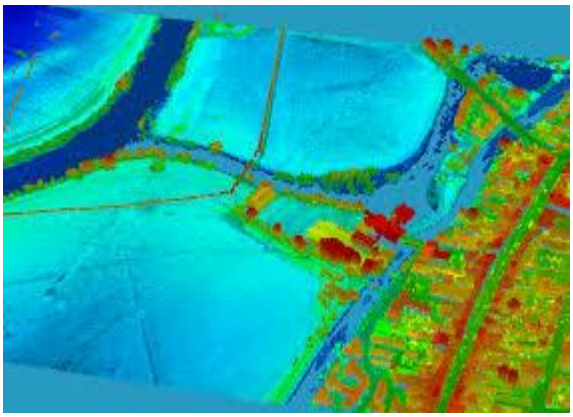

Fig.5.Location overview Area-oxo after selecting a location on the globe

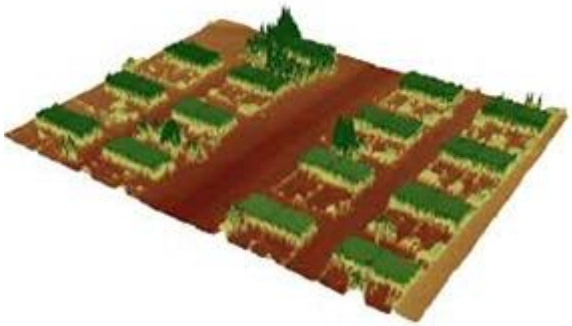

Fig.6. Simulation Flip and Rotation view of the Area-oxo for better understanding.

IV. CLOUD ROBOTS IN AREA-OXO AND THE DATA FLOW

When the end user enters some instructions from his/her hardware machine it is carried to the application residing in the same machine and later it is sent to the connected network. An appropriate web application sends/receives the user's instructions from /to the web-server. Some particular virtual machine will handle the web-server operations and it is sent to the cloud operating system [9]. The cloud operating system will initiate with the cloud hardware and then to the cloud network. The Flow of data from end user to the cloud can be depicted as given below.

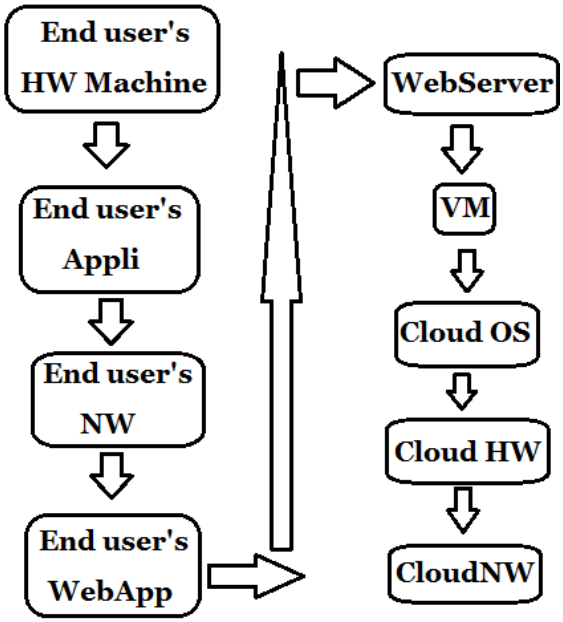

Fig.7. Flow of data from end user to the cloud.

Cloud robots are used and controlled at by a particularly designated and authenticated person such to do some activities like warfare activities. The designated person can activate the cloud robot with some biometric authentication process. All activities and decisions cannot be stored in to the robot due to the cost effect of memory and also for the precautionary measures. These robots are equipped with appropriate connection with remote cloud servers using appropriate secured cloud protocols. At the backend it can be connected with some of the powerful storage applications like Big data [10]. In this study ROSLink protocol is used for the cloud robot networking. This protocol is considered as much more lightweight and asynchronous protocol used for communication for the robots and the end-users using the cloud technology.

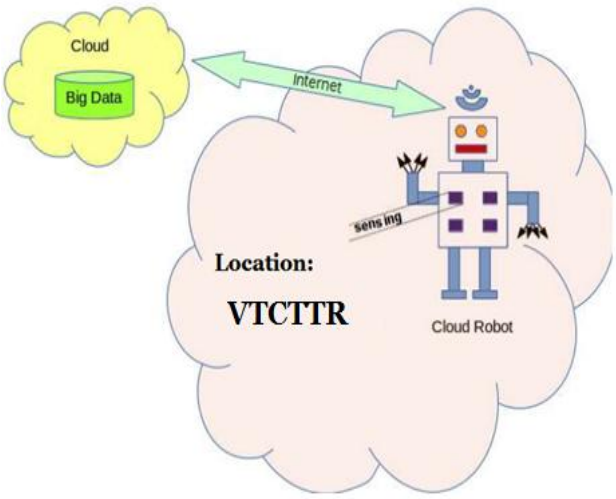

Fig.8. Cloud Robots cloud working at Area-oxo (VTCTR)

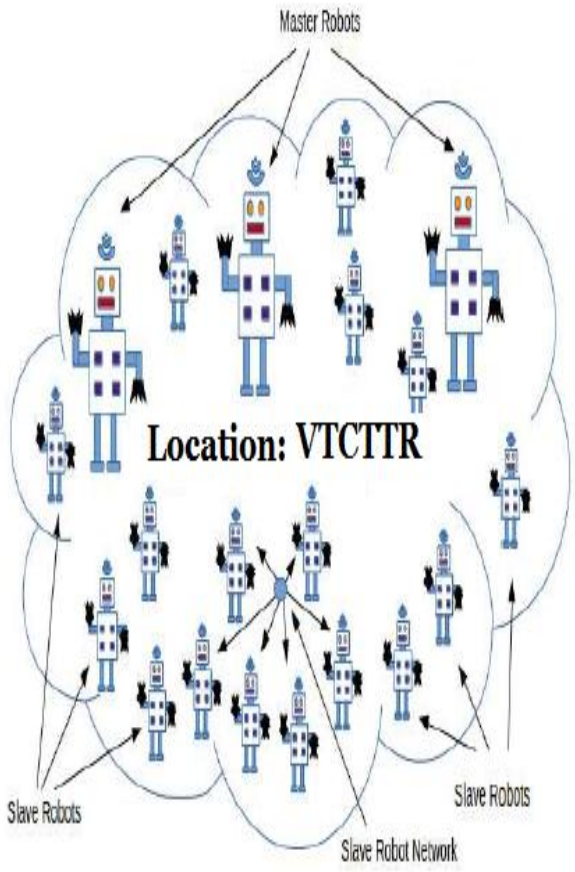

Fig.9. Master Cloud Robot and Slave Cloud Robots Infrastructure at Area-oxo (VTCTR)

The present study uses the cloud computing system in a large, complicated and highly dynamic system. There is a need to schedule appropriate works for the existing cloud robots. If any cloud robot gets overloaded with the scheduled tasks they transfer their some of its work load to their slave robots by using appropriate decision using artificial intelligence [11]. One can never predict accurately whether which cloud robot gets overloaded and decreases the its performance violating SLA constraints to provide QoS, and also one can never ever precisely estimate which cloud robot remains idle. Therefore there is a need to study such un-deterministic scheduling model with some probabilistic mechanism using some of the stochastic prototypes [12]. It is NP-Hard problem.

V. SCHEDULING STRATEGY

The average load on a particular virtual machine can be calculate using some of the calculations such as,

Let there be m request R1, R2, … Rm

Let there be n servers be S1, S2, … Sn

Let time taken 'o' time be T1,T2,....To

Load is an impact made on a particular sever for its request processing. Therefore on 'n'th server, to process 'm'th request, To time is taken. It can be written as,

'L' is the load on the server,

$L_{m*to} = \sum_{R=1}^{m} (Lm * to)$

$\sum_{R=1}^{m} K/n$

A single algorithm will not give the optimal solution; different algorithms are choosed for different purposes.

As since the environment is highly dynamic there is a need to consider a solution with maximum flow in the network and fastest way of solving the scheduling problem.

For the maximum flow determination Ford-Fulkerson Algorithm is selected in the network. The philosophy of Ford-Fulkerson algorithm as follows,

Step-1-Start with initial flow as 0.

Step-2- While there is a augmenting path (a simple graph without any cycles) from staring point to the destination. Add this path-flow to flow.

Step-3- Return flow.

For the fastest way of solving the scheduling problem Floyd–Warshall algorithm is selected. The algorithm Floyd–Warshall is considered to make use of to detect the shortest paths in the weighted graph with positive or negative edge weights. On the execution of this algorithm it would detect the shortest paths length and also the complete pairs of the vertices. With the time complexity of O(n3) this algorithm finds the shortest path to the destination. It is an application of dynamic programming to solve the shortest route search problem.

The combination of Ford-Fulkerson and Floyd–Warshall algorithms is proposed with a name Ford-Fulkerson Floyd–Warshall Hybrid (FFFWH) Algorithm.

The pseudo code of FFFWH is proposed as given below,

Step 1: let scheduler be associated with a readily availbel queue for processing PCB (PCB=Process Control Block)

Step 2: newly arriving requests be placed at the end of the queue in PCB.

```
let the flow at the begining be 'O'
let starting point be 'i'
let end point be 'j'
let position matrix with 'i' and 'j'  of augmented Path
i=1;i< n;i++
{
j=1;j< n;j++
{
k=1;k< n;k++
 {
([i][j]<[i][k]+[k][i]) ((i,j)=[i][k]+[k][j])
}
}
}
add path to flow
return flow
```

Step 3: always select the PCB from starting point of readily available queue.

Step 4: When process is completed in a given time slot, move it to last part of readily available queue.

VI. OBSERVATIONS

The considered parameters for this study are Processing time, Response time, Throughput, Network delay. Below are the results obtained as given below.

Processing Time	Response Time	Throughput	Network Delay
0.26	297.36	3.311	12.67

Table.1. Results obtained on FFFWH algorithm

V. CONCLUSIONS AND FUTURE WORK

A Comprehensive study is carried on implementational aspects of inter-connected technologies. A case is considered for virtual environment Area-oxo (Object Xtra Outpost) which is is a Virtual Top Classified Test and Training Range and the activities of artificial intelligent cloud robot as- a-service (AICRaaS). For cloud robotics Gazebo simulation is used, and ROSLink protocol is used for the cloud robot networking. As since the environment is a cloud computing system in a large, complicated and highly dynamic system, huge load on cloud environment is possible. There is a need to schedule appropriate works for the existing cloud robots. If any cloud robot gets overloaded with the scheduled tasks they transfer their some of its work load to their slave robots by using appropriate decision using artificial intelligence. It is to consider a solution with maximum flow in the network and fastest way of solving the scheduling problem. The study carried out focusing on the Load balancing in the cloud system. The combination of Ford-Fulkerson and Floyd–Warshall algorithms is proposed with a name Ford-Fulkerson Floyd–Warshall Hybrid (FFFWH) Algorithm has shown some improvements. However it is the first of its kind there is a need to compare with some other mechanisms to know how best is, which is left over for the future work.

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BIOGRAPHY

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