Compendium Depiction on the Applications of Cloud Robotics for the Reclamation of Mankind

Rajesh Doriya and Kaushlendra Sharma

Abstract Cloud computing in the present time is considered to be one of the most pronounced, protruding, and emerging area of computer science. Cloud robotics basically means the robots with their heads in the cloud; the article streamlines the topic and tries to deliberate the area where cloud robotics is deployed and contributing a noteworthy part in flourishing the respective field like cloud medical robots, industrial robots, programmed robots, Google's self-driving cars, application of heterogeneous robots in a wide geographical area. Counting all these, it inclines to conclude where more it can be diversified to enhance the interest of researchers to pick this technology and contribute a bit more for the betterment of mankind. Cloud robotics is one of the rapidly advancing research areas that allow application programs to deduce the computational time and storage into the cloud. Robots are restricted regarding computational limit, capacity, and memory. Furthermore, cloud gives boundless calculation control, memory, storage, and particularly coordinated effort opportunity. Cloud-empowered robots are distributed into two classes as independent robots and organized robots. The article efforts to accumulate some notable contribution of cloud robotics till date citing an in-depth discussion for the same.

Keywords Medical robots · Industrial robots · Programmed robots
Cloud robotics

1   Introduction

Technology justifies its meaning and properness only when it is served to the mankind or society for its betterment. Robotics in itself is a contrivance to enhance the power of automation; clubbing the concept of cloud computing makes it a prolific combo

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to explore more areas and to enrich the feature where already these two individual concepts are contributing. The paper tries to focus on such core areas where cloud robotics has contributed in the past and contributing in the present time. Taking these into consideration, the paper concisely explains the touched area by cloud computing and robotics and further attempts to put forth exploring few more areas where the concepts and features of cloud robotics can be implemented in wide manner making it much more acceptable than before, so that it can be implemented and tested which could enhance the acceptability of this novel concept. The article's primary focus is not only to describe the scientific research inside the laboratory but to convey the exemplary inventions which are helping society and mankind to ease the life. The article also intends to propel few core areas where implementation of cloud robotics can do wonders.
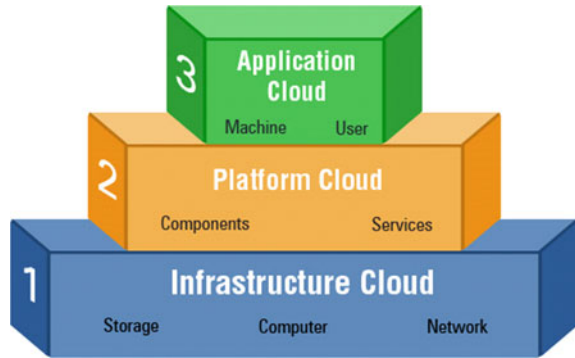
1.1 Cloud Computing

Cloud computing is developed with ages taking advanced shapes from distributed computing and several other networking environments. The core of the cloud computing is sharing resources and virtualization; those terms are collectively called as configurable resources. The high point of cloud computing is that in minimal management, it outperforms when executed with certain application on to the network. From the usage point of view, there are three basic models of cloud computing recognized as Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS).

Alongside the cloud computing offers several benefits and advantages for businesses and end users, few of the benefits are self-service provisioning, elasticity, pay per use, workload resilience, and migration flexibility. From deployment point of view, the cloud computing model can be classified into three categories: private cloud, public cloud, and hybrid cloud.

SaaS: Software as a Service is one of the model of cloud computing which is growing rapidly. The reason to that is the ease of access to number of application which can be directly fetched from the Web without actually paying the complete price for that software; one of the best advantages of this is that it facilitates to pay as per the usage. Second prominent advantage of this model is the end user need not to worry about the maintenance of the particular software or application. It is being managed and controlled by a third-party vendor. Most of the application can be directly run from the network without actually downloading and installing to the end nodes.

PaaS: Providing application and software as a service, cloud computing also provides the platform as a service. The developers import advantage of this for development of applications and its modules; this particular service provides the framework upon which the developers can build upon and customize applications.

Fig. 1 Cloud computing
model

Testing and virtualization also become quite feasible as compared to the conventional techniques. Having all this facility, the developer only has to manage the applications only.

IaaS: IaaS is another form of cloud computing which provides a high degree of virtualization of numerous computing resources (all act as a node) and enables users with the entire requisite infrastructure for computing. Virtualization supports in increasing the usage percentage of resources over the network; the entire facility is installed and placed over the Internet. Scalability is another feature of this model which adds another feather in counting advantages of cloud computing models. IaaS platform carries numerous scalable resources which can accustomed as per the run-time demand of the system. Thus, it makes IaaS very well suited for the jobs which are dynamic in nature and requirements occur abruptly (Fig. 1).

1.2 Robotics

The word robot was first time used in a play by Karel Capek in 1921, where it was showcased as a manufactured slave who can exactly work like human perhaps much better than in terms of accuracy and efficiency. The word robot was derived from a Czech word '*robota*' which roughly means "compulsive servitude." The exact word robotics was first used in 1941 by a science fiction writer, Isaac Asimov, in 1941. And now after a long evolution era, a robot is now defined as a programmable mechanical device that can perform tasks and interact with its environment, without the aid of human interaction. Robotics acts as a bridge between the different fields of engineering and technology which incorporates the concept of mechanical engineering, electrical engineering, computer science, information technology and others for automaton.

Robotics precisely is the technique behind design, manufacturing, and applications of robots. Currently, it is one of the most emerging fields of science and engineering and has contributed in a large way to various fields. The paper has pointed

few of the notable fields like in medical science, educational sector, army, agriculture. Robotics when combined with the concepts of cloud computing is getting more happening response from numerous fields.

1.3   Cloud Robotics

Robotics when clubbed with the cloud computing techniques to make it more deployable tries to inherit some of the important features of computing like shared storage, network environment and then converging all the techniques into one. Robotics takes a great advantage of these by sharing the characteristics with all the application programs present in the cloud [1].

Cloud robotics is a new paradigm where robots (application programs) communicate with each other over the Internet. In doing so, it renders a wide reachability and acceptability in many terms like sharing data and code which ultimately results in building emerging research in cloud computing; it also inherits concepts and technology of Big Data and Internet of Things from the surrounding. These technologies help in finding more ways to explore; the only reason for this is that the application programs (more than one) which need to be controlled individually can now be remotely and centrally controlled from one place. That also helps in reducing the space complexity and redundancy of repeated program execution (Fig. 2).
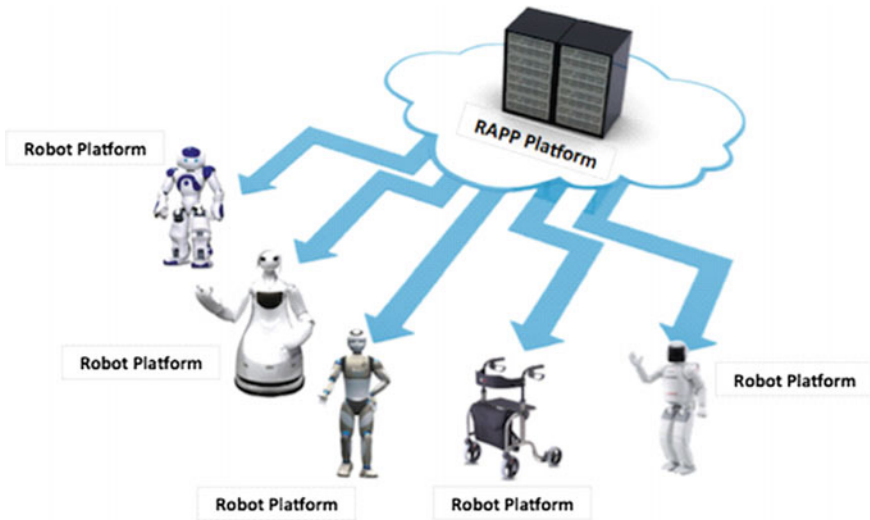

Fig. 2   Prototype of cloud robotics

Table 1 Market growth of cloud robotics

Worldwide cloud robotics market (as per CAGR)	Market revenue in million dollar
Till 2016	2020.66
2016–2022 (expected)	3031.6 (32% growth predicted)

2 Market Growth of Cloud Robotics

The research from one of the renowned organization 'infoholic research' community shows that a tremendous growth has been observed in the field of cloud robotics. Table 1 depicts the growth in the recent years.

3 Application Areas

Industrial Robot: Manufacturing is one of the core areas of development to lead in the competitive scenario. Application of robotics started in the late 1990s in the industry in so many ways [2]; they are technically termed as industrial robots. Continuing the procession, the industrial robots and programmed robots had attained a good level of accuracy and sharp performance in real-time applications in many sections of the industry. Few parameters to judge their working are accuracy, robustness, compatibility with the surrounding, and high-level performances. The mechanical robot is a solid match for some applications [2, 3]. It is regularly utilized for circular segment welding, material taking care of, and gathering applications. They are assembled by number of tomahawks, structure sort, size of work envelope, payload ability, and speed. A robot controller gives the interface to programming and working the modern robot. Below given Fig. 3 depicts the year-wise rapid increase in demand of industrial robots.

Introduction of cloud is not new to the industrial robots; it is basically planting a common database for all the robots so that they can be remotely controlled from one place and can be given instruction from a single place [4]. Various combinations of articulated and parallel robots are used in a network in a hybrid manner to work and control different units of industry (Fig. 3) [5].

The high-speed demand of robots in the industry has raised the issue of safety and reliability to promise for delivering the expected outcomes. At present, there are so many robots being used in the industry for variety of purposes but the two most widely used robots deployed in majority are articulated robot and parallel robot (Fig. 4).

Medical Robots: Medical robots or surgical robots are one of the most crucial and dignified application of the concepts of cloud robotics which helps the surgeon while handling delicate issues. Another version of these is called as tele-manipulators;
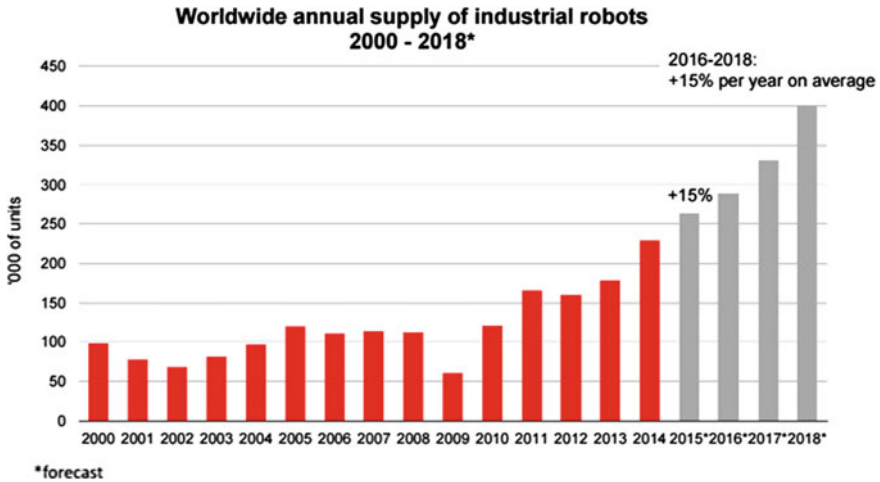
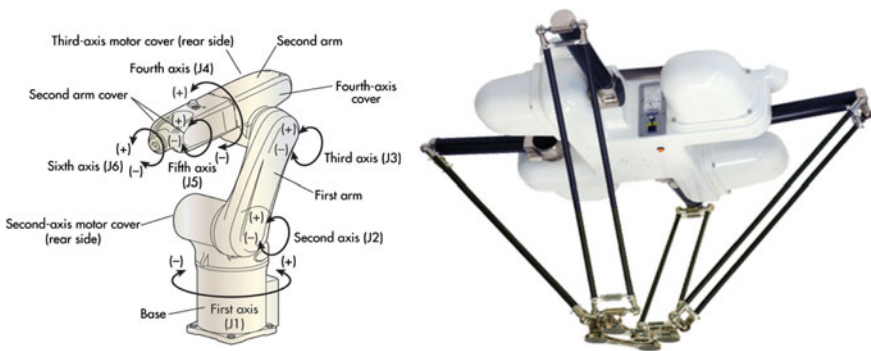**Fig. 3** Annual supply growth of industrial robots

Fig. 4 Articulated robot and parallel robot

rehabilitation robots are another diversified version of robots in medical science. A cluster of robots takes care and enables the lives of needy patients and old-age people, or someone suffering from major ailments. There is also certain cluster of robots which are being used for training and related processes [6].

The advantage of using medical robots can be clearly observed in the surgery; the robots trained for this purpose are much more precise and effective in performing surgeries. Once the robots are well trained and programmed for a specific task, they execute it in a very optimized way by minimizing invasiveness and maximizing biocompatibility [6, 7] (Fig. 5).

Robotics in the uneven Geographical Area: is another most important area where robots are applied at present but can be made more intelligent with the help of cloud and its concepts. Robots basically are used mainly for transport, take care, rescue, and
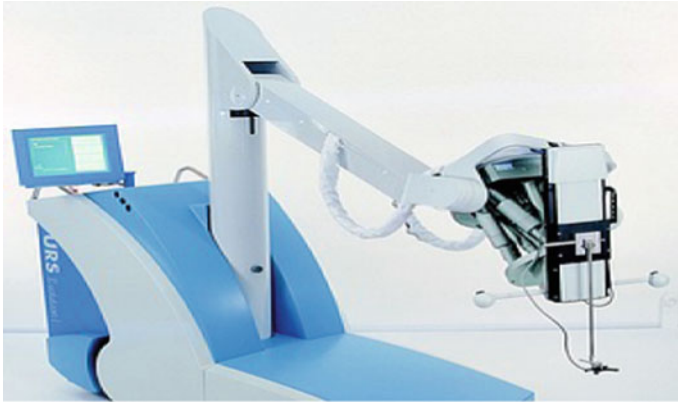
Fig. 5 Model depicting medical robot

attack whenever there is any need at the spot. And with commencement of Big Data and cloud computing with robotics, the scenario has completely taken a new shape while there have been many advances at the equipment level to support the different nodes of battlefield taking it from land to air [8, 9]. It has helped and strengthened the attack and defense by providing synchronization among scattered armed resources. With the growing concepts of robotics, the interoperability and standardization have reached to another level. It has also abandoned the enemy's cunning practices on the battlefield. Network-centric warfare has become the new way to behave on the battlefield.

Robotics in Educational Sector: Many premiere institutes like IIT's/NIT's in India nowadays have implemented effective methods to carry out individual study [10]. There are several concepts and methodologies evolving rapidly to make individual study and classroom study a smarter and intelligent one [11], the concept of robotics contributing in many fashions to conceptualize the need of the system. Currently, the network teaching has overtaken the prime motto of national and international education development; there are several researches done to introduce the integrated structure and model for current education system [10, 12].

With the passing days, robots are becoming an essential predominantly required component in education sector and are considered as a promising aid for teaching and learning in different ways; there were many researches going on to dig out the ways the robots can be planted in pre-primary to high-level school user (Fig. 6).

Agricultural Robots: Agriculture production needs to get doubled in the coming years to cope up with the demand and supply equation. With rising population, it is essential to raise the production of the agriculture. Thus from the human life's aspects, agriculture is one of the important need of life to be dealt with. The advancement in this sector with the commencement of robots has created a buzz to deploy the technology as much as possible. The accuracy of the implementation in the output forces to implant mechanism of robotics in the agriculture sector.

Fig. 6 Prototypes of educational robots

Tele-garden is one among the tested part which has shown significant results. The tele-garden is a community garden [13] that allows users to plant and tend seeds in a remote garden by controlling a robotic arm through a Web-based interface. Such types of robots which are deployed in the farm are also known as Agbot; certain other names are used for them with respect to the work they perform on the field like end effector, gripper, and manipulator. These are deployed for various works like for picking fruits, driverless tractors, and sprinkling. Though, the efforts are being going on to make it a cost-effective [14] [15].

There are various challenges which can be eradicated by using robots in the agriculture field like one of the most important among them is the shortage of labor and to be more confined the biggest problem is of the skilled labor [13, 16]. Fulfilling the above requirement and managing them is a herculean task in the recent times specially in country like India which is mostly dependent on agriculture for its run, facing such problem in spite of having a population of approximately 1.5 billion (Fig. 7).

Fig. 7 Tele-gardening

4   Conclusion

The paper presents a survey report on cloud computing and robotics. The motive of the paper is to present the technical aspects of the cloud robotics but also to show the social impact of that technology for the well being of mankind. Machine (robots) in general is used to keep an eye on human being but with the time changing, the need is to keep an eye on machines also. The concept of robotics when concatenated with cloud computing gives some extraordinary scope to implement cloud robotics on various untouched fields. The paper presents the intense survey on the diversification of cloud robotics implementation. All the advantages and shortcomings are studied thoroughly to conclude how better it can be tested in some other areas. Agriculture sector seems to be more lucrative and useful from various perspectives, agriculture production needs to be encouraged by increasing production, and robots with their heads on the cloud can contribute in a right manner. This is the only field which also reclamates the major human involvement that will help to reduce the problem of unemployment and will grab a great attention from the mass, as it caters one of the major essential need of mankind. There are other major sectors also where robotics is required to contribute for more like need of more surgical robots on medical sectors which can increase the accuracy of sensitive treatments; manufacturing improvement in industries can help to cope up with the increasing demand of commodity, and also industrial automation can't be imagined without Internet robots; educational robots can do wonders, and security of borders in the future will definitely rely on cloud robots.

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