



# Autonomous Robot Path Planning and Internet of Things



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## Abstract

Robotics is known as a new revolution to the entity of beings that varies according to its uses. In modern day environments, robotics and automation are involved in almost every industrial activity and conveniently improve the efficiency, productivity and reliability of a system. Autonomous Guided Robot (AGR) systems are classified as rover based robotics that require vision type and touch sensors. The AGR should be able to maneuver and counteract with the environment using sensors to detect the obstacles around, remember its current position and calculate a new path to take. Robotics Automation with industrial robots in combination with Internet of things, the birth of intelligent flexible automation systems, with the technical advantages of intelligent flexible automation systems, the company recently signed several million more than the contract, industry all over the hot die forging automation, automation of internal combustion engines, engine Assembly, automotive automatic battery swap station and so on. Thus, in this paper an overview of the significance of path planning and internet of robotic things is presented.

**Keywords :** Industrial robot; path planning; Internet of things (IoT)

## Introduction

Robotics is implemented in medical practice, construction, outer-space exploration, household assistance, mobile transportation and quite recently, under water exploration [1-3]. Currently there has been study of automated guided robots which is used in transportation and exploration that can be configured for different terrain. These designs are on locomotion, Hopfield Neural Network, Genetic Algorithm and etc [4-6]. For example, JPL (Jet Propulsion Laboratory, NASA) in U.S.A have developed many rovers. Sojourner which were landed in Mars in 1997 adopted rocker-bogie locomotion, Blue Rover uses three-segment locomotion, the mini Mars rover Go-For has an active wheel-legged locomotion, Nano Rover utilize posable tructchassis and Elastic Loop Mobility System was also designed as new type of locomotion for planetary exploration [7].

Robot Path Planning or robot Motion Planning is one of the important areas of interest in robot's offline decision making algorithms. In this problem, the aim is to find a collision free path, which the robot can follow to reach the target from its start position. Analysis and research on autonomous path planning has included innovative advancements in the use of artificial intelligence (AI). With advancement in the study of this subject, technology with uncontrollable situations such as

outer space exploration and deep sea excavation can be further improved. New technology such as autonomous vehicle systems may also be able to utilize such algorithms which are fail-safe. With sensors, robots are said to be able to obtain vision, sense of touch, balance, and even hearing. According to their tasks and application, robots are given the appropriate sensors that function as the feedback systems in a controller [8].

Once the collision-free configuration space is described as a graph, the shortest path between two nodes can be searched. An overview about common path finding algorithms is given in [9] depth-first, breadth-first and best-first search, the algorithm of Dijkstra and finally the A\* algorithm. All these approaches find a solution, if one exists. Especially the Dijkstra and A\* algorithm are in the focus of research [10], as they promise the optimal path with a minimal computing time. The algorithm of Dijkstra was developed in 1959 and always finds the shortest path between two given nodes or proves that no solution exists [11]. For this purpose, the costs  $g(n)$  from the start node is assigned to each considered node  $n$ . There by the nodes with the smallest value of  $g(n)$  are prioritized which guarantees an optimal path.

On this basis, the widely used A\* algorithm was presented in 1968 [12]. The method finds a least-cost path between a start

and a goal node. This is achieved by evaluating a cost function  $f(n)$  of a node  $n$  to determine in which sequence the search visits nodes in order to expand the fewest possible nodes. The function  $f(n)$  is the sum of the known costs  $g(n)$  from the start node to  $n$  and the estimated costs  $h(n)$  (also called heuristic function) from  $n$  to the goal node. The A\* algorithm is complete it will always find a solution if one exists. Furthermore it computes the optimal path if the heuristic  $h(n)$  does not over estimate the costs to the goal and is faster than the algorithm of Dijkstra [13].

For a robot with  $m$  joints, the configuration space is an  $m$  dimensional space spanned by the degrees of freedom of the robot system and sub divided in collision-free regions. Based on this configuration space movements of the robot can be determined. Assuming a six dimensional standard industrial robot, the discretization of the space according to collisions would be a time consuming process. Consequently, an effective method for building a collision-free configuration space is needed.

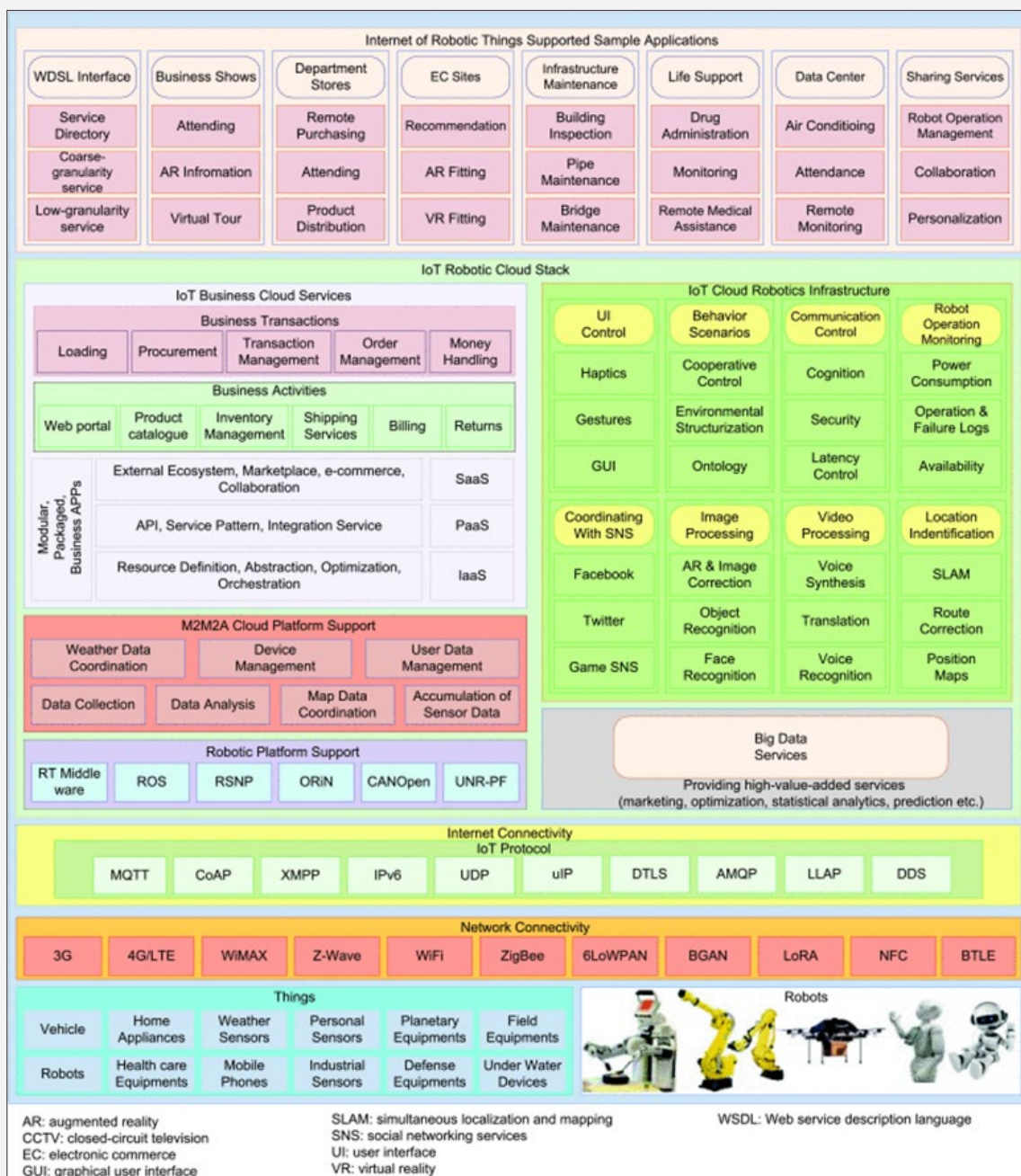


Figure 1: Conceptual diagram of internet of robotic things architecture.

Robotic system has brought tremendous changes in various socio-economical aspects of human society during the past decades [14]. Industrial robot manipulators have been widely deployed and used in all sorts of industries to perform repetitive, tedious, critical, and/or dangerous tasks, such as product assembly, car painting, box packaging, and shield welding. These preprogrammed robots have always been very successful at their accomplishments in several structured industrial applications due to their high accuracy, precision, endurance, and speed. Robotic technologies have been integrated with existing network technologies to extend the range of functional values of these robots when deployed in unstructured environments while fostering the emergence of networked robotics during 90's [15]. The limitations have motivated the researchers to think of new form of efficient robotic systems i.e., "Cloud Robotics". Cloud robotics may be described as a system that relies on the "Cloud Computing" [16] infra structure to access vast amount of processing power and data to support its operation [17]. That means not all sensing, computation, and memory is integrated into a single stand alone system as it was in case of *networked robotics*. *Cloud Robotic* systems often include some portion of its capacity for local processing for low-latency responses when network access is unavailable or unreliable i.e., offline. One example of *Cloud Robotics* is the *Google self-driving car* that indexes the Google maps, images, and other relevant information, collected by the satellites and the crowd sourced Clouds to facilitate accurate localization. Although, *Cloud Robotics* is benefited from big data analytics, cloud computing, human computation, and collaborative robot learning, it suffers from various issues such as inter operability, heterogeneity, time-varying network latency, security, multi-robot management, common infrastructure design, Quality-of-Service (QoS), and standardization [17,18]. Due to the IoRT's inherent virtues of qualitative handling of mentioned issues, it is envisaged that it will overcome these constraints, leading to more intelligent, collaborative, heterogeneous, efficient, self-adaptive, context aware, and yet cheaper robotic networks. An architecture of robotic internet of things is shown in Figure 1.

In the developed world, automated production line equipment for industrial robot automation equipment has become the mainstream and the future direction of development. Foreign car industry, electrical industry, engineering machinery industry has extensive use of industrial robots, such as automated production lines in order to guarantee the quality of products, to increase productivity, while avoiding a large number of occupational accidents. Global industrial robots used in many countries for nearly half a century of experience has shown that the popularization of industrial robots are automated production, improve production efficiency and effective means of promoting enterprise and development of social productive forces. Things with perception, information transmission, intelligence

analysis and decision making characteristics such as through perception, equivalent to added features to industrial robots, vision, touch and even taste through network messaging, smart analysis and decision, equivalent to industrial robots human intelligence has given so that robots can do most people is needed to complete the work.

### Conclusion

Internet of Robotic Things allows robots or robotic systems to connect, share, and disseminate the distributed computation resources, business activities, context information, and environmental data with each other, and to access novel knowledge and specialized skills not learned by them, all under a hood of sophisticated architectural framework. This opens a new horizon in the domain of connected robotics that we believe shall lead to fascinating futuristic developments. It indeed allows adapting into connected ecosystem where resource constraint deployment of inexpensive robots shall be leveraged by heterogeneous technologies, be it, communications network, processing units, different genre of devices, or clouds services. Enormous developments could be foreseen to get benefited from the IoRT approach such, SLAM, grasping, navigation, and many more that are beyond the discussion. In this paper, a novel Internet of Robotic Things architecture is proposed considering conjugation between recently grown IoT and robotics together.

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