

# Significance of Robotics in Manufacturing, Energy, Goods and Transport Sector in Internet of Things (IoT) Paradigm

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**Abstract**—The advent of robotics itself a revolutionary process or change. It affect in factory automation in such a way that the process to the product path in manufacturing is totally changed. This operation performed by the robots and intelligent systems change the perspective of the industry by the end of 20<sup>th</sup> century. The field of robotics challenges among researchers, academicians and in the industry since last two decades. This is due to its vast application in every field includes medical, manufacturing, engineering, goods and transportation, defence, smart cities, etc. Today, robotics/robots are not only bounded by the process automation, but they are integrated part of Internet of Things (IoT) to provide some unsolved solutions. A robot as a service having all key features of IoT like autonomous, mobile, sensing and action taking. The infrastructure facility provided by the IoT facilitate to provider to use as a connected things and establish connections with other things using Internet, either as a end user and/or source of so called information. This paper clearly describes how robotics and IoT work together at different platforms.

**Keywords**—*Mobile and Humanoid Robots, Human Robot Interaction (HRI), Robot Operating Systems (ROS), Internet of Things (IoT), Industry 4.0, Advance Metering Infrastructure, Transportation, Autonomous and Semi-Autonomous Vehicles, Logistics.*

## I. INTRODUCTION

Over the past decade, the use of robots and other types of automation in industrial sector has grown exponentially. Across nearly all global end-markets, rising wage rates and the need for productivity enhancement have led to increased adoption of robots and automation in different kind of fields, and their remains a significant amount of whitespace in developed and developing countries alike. Automation demand is also an important part of the rising Internet of Things (IoT). The IoT revolution, which involves increasingly connected devices that share information, is shaping every aspect of our lives, from wearable fitness bands to smart home environment [1].

The impact of this IoT revolution is also having a profound effect in the industrial world. Industrial IoT (IIoT)

is defined by devices (sensors, machines, and robots) that are connected through networks to computing and other ERP systems that can monitor and/or manage these machines remotely. As a result, companies that provide connectivity equipment and solutions have generated significant interest from strategic acquires [2].

## II. HISTORY: ROBOTICS AND INTERNET OF THINGS

### A. Robotics

The term 'Robot' introduced by Czech writer Karel Capel in 1921 for the first time in his play *Rossum's Universal Robots*. If one wants to define robot, then it is 'simply a programmed machine to do work'. But with the advancement of automation gives new terminology as: 'a machine with intelligent behavior'. The foundation of robotics based on telemanipulators and the ability of numerical control of machines [3]. The emerging of *Mobile Robotics* give new wings in the field of transportation. Firstly, in the late seventies, it provided distinct feature in the factory floor process automation and recently driver less or autonomous transportation system being a focus of research among many researchers. The *Humanoid Robots* plays a vital role in the branches like medical, biomedical, rehabilitation, etc. [4].

The global emerging markets such as Brazil, Russia, India, China and South Africa (BRICS) having multidimensional growth opportunities consider for the future market and inspired for industry and research people to do more research and adoption of new technology [5].

### B. Internet of Things

With adoptability of IoT, a new concept of connectivity emerge across industries through smart & connected devices and having faster & efficient services too. This will change the life style of people globally, transformation in the business communities and open new doors of opportunities of innovation. In the coming years, it is predicted by the global firm that billions of connected devices deployed [6], which will generate multi-trillion dollars of economic growth [7] in almost all sectors of economy.

Implementation of IoT as a nationwide long range (LoRa) network, this kind of initiative taken by the Dutch government in the year 2016 [8]. The basic concept of connectivity through Internet will provide information about objects connected in the network, data transmission through them, and even more we can say that it will affect people living and business operations [9].

### III. INTERFACING BETWEEN ROBOTICS AND INTERNET OF THINGS

**Radio Frequency Identification (RFID):** RFID proves low cost solution to many applications, having vital role in the development of IoT and gives boost up the power of IoT in different domains. The advantages of RFID over barcode are: a) non-optical proximity communication, b) two-way communication ability, c) information density, and d) multiple simultaneous readings at a time [10].

RFID provides low cost solutions with greater flexibility and having dynamic environment. Due to this feature, we consider that the robot is connected to the IoT, viewed as on IoT thing. A robot getting updated real time information through IoT features without any kind of physical boundaries. The combined technology of robotics and IoT provide greater opportunities in the field of supply chain, transport, energy, ambient and assistive living [11] are some of domains among all.

**Human Robot Interaction (HRI):** Till the end of twentieth century robotics is a branch of just industrial process applications and academic research. However, in recent years robotics technology significantly matured and as a result of it, Human Robot Interaction emerge and plays a significant role not only in academia but also in the industry to cater needs of fourth industrial revolution. The meaning of interaction here is to have a communication channel between robots and humans. A process of communication depends on the nearness of human and robot, and it is categories as: i) Remote interaction, and ii) Proximity interaction. A designer has to take care of several factors for designing human robot systems like autonomy, information exchange, structure, learning and adaptability in the system, task, etc. [12].

**Robot Operating Systems (ROS):** Nowadays, we all have knowledge that with flexible and dynamic features of IoT, it is a focus point of current research, but yet fundamental tools for its overall development not established. A ROS fulfil this gap having instinct features such as access external hardware like sensors, actuators, etc. very easily and effectively. ROS also encompass the facilities of additional future devices connectivity, this modular implementation approach of ROS gives foundation platform for IoT [13].

### IV. APPLICATION DOMAIN OF ROBOTICS AND IoT

#### A. Manufacturing Sector

The one of major advantage of autonomous robots is about handling a difficult task without knowing the environment, it means that not much more complex programming needed nor human based control strategies. They are very suitable in dynamic environment, not matters whether industrial or service based robotic applications. The fourth industrial revolution leads by the advanced robotics with IoT interfacing. The use of autonomous robots in different sectors apart from its practical limitations enhance

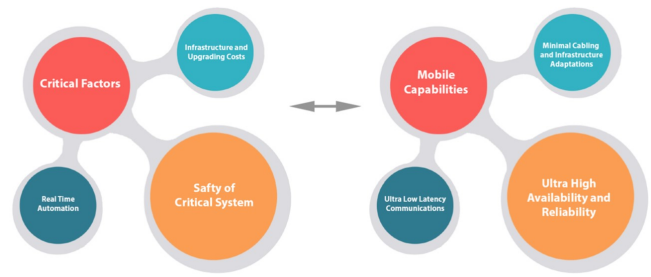


Fig. 1. Mobile connectivity to robots

more flexibility [14]. As a key element of the IoT and an enabler of the fourth industrial revolution, robotics and robots will vary greatly in terms of application, agility, complexity, cost, and technical capability. But most-if not all- robots will require wireless connectivity to the cloud and wider analytic ecosystem, will be provides by IoT [15].

When deploying a cloud-based robotic system, constant and reliable connectivity for each robot is essential, irrespective of the type of robot, the tasks it carries out, or the environment in which it operates. As Fig. 1. shows, with wireless connectivity a robot achieves more flexibility. And so, when changes need to be made, for example, to the layout of a manufacturing plant to adapt to a new production process, or to add new robots, the flexibility offered by wireless connectivity ensures that modification costs can be kept to a minimum, which in turns offers greater flexibility in decision making in the business level.

#### B. Energy Sector

The consumption of energy is easily monitor and manage with the entry of IoT in energy sector. As a need of current energy scenario, the appliances are smarter and they conserve the energy to comply the consumer requirements. The essence of smart metering is to provide real time consumption of each appliances and due to this, burden of existing power sources reduces and leads to improve the quality of power [16]. By incorporating the IoT in the domain of generation, transmission, distribution and monitoring will yields connected benefits for future smart grids.

The smart grid has the characteristics like Intelligent, Efficient, Accommodating, Motivating, Opportunistic, Quality Focused, Resilient, and Green to Environment [17]. To make grid smarter, smart meter deployment is the first step as shown in Fig. 2.



Fig. 2. The role of Advanced Metering Infrastructure (AMI) in IoT

Today's grid itself work as a distributed grid, in which can add number of new energy sources even though their dynamic characteristics i.e. non-conventional energy sources. The effectiveness of grid depends on real time information about demand and consumption. To this end, we have to deploy more remote terminal units (RTUs), which are capable of measuring, monitoring and analysis of energy data and by doing this the grid become more efficient, vulnerable to disturbances, sustainable, and having increase capabilities of decision making. Smart metering fulfil such a requirement of healthy grid at base levels. The work of smart meters can be classified as: i) They collect the energy consumption data information from houses and send to utilities, and ii) Through IoT enabling technologies, a meter also display energy consumption detail of each appliances at the customer end [16].

Sensing and tracking of power line is a key role of any grid. The role of inspection robot is to detect the power theft by remote current measurement on power line, and consider as "thing" as it connected through communication channels. An inspection robot detect illegal current movement during its inspection and send its location information to operator. For detailed information refer [18, 19].

### C. Goods and Transport Sector

The sense of doing business in the logistic sector changed due to advent of IoT and the behavior of customer-market segment too. This features of IoT comes with new progressive and emerging ideas into entire sector including freight transportation, supply chain, warehousing management, delivery systems, tracking of consignments, etc. It yields to look the areas of customer requirement, satisfaction, efficiency, new business model, safety and security in a new way. Also, IoT provide solutions for the operational and business issues in a very easy ways as it is see in Fig. 3.

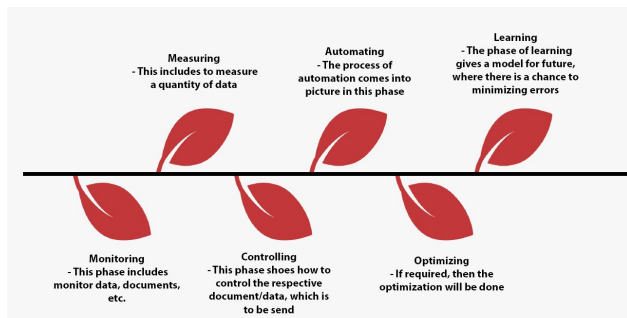


Fig. 3. IoT based transportation/logistic system environment

In the revolutionary era of IoT, logistic industry also benefited. IoT plays vital role in tracking of shipments, movement of shipments, delivery systems and prediction of delivery, etc. IoT connect with different assets of logistic and after analysing data, will provide suitable solution to the connected entity. By doing so, IoT improves the efficiency, develop new models of business and asset management, and provide customized dynamic services to the customers [20]. Considering current scenario of electronic market where prices are falling for small chips, equipment; faster communication and wireless services; increasing data usability are some of factors which ensures the unpredictable faster growth of IoT in logistic sector in the next decade.

We experienced in the last decade about semi-autonomous vehicles are more attractive in public due to its real time traffic information system, fuel warning system, etc. Expanding these capabilities into autonomous where vision based movement of driver's leg, real-time trajectory tracking of path, driver's behavior based sensing, advance traffic management and warning systems, facial and speech based recognized system, information about CO<sub>2</sub> emission, etc. deploy to enhance driver's capability and improve efficiency. Man to machine communication and behavioural based approach yields more solutions than the former one including avoid traffic jams, unnecessary fuel consumption, accident avoidance, optimal efficiency, etc. among them.

### V. CONCLUSION

An advent of IoT raises many opportunities and technological issues which are previously not attended or focused. The role of robotics in the domain of IoT is to enhance its capability into the new spectrum of research. Here, we are try to reach a much more awaited sectors of business. The Manufacturing sector having an ample potential as far as the economy of any nation is concern. The Energy sector is the sector which directly or indirectly connected to each one and Goods and Transportation too.

Although, given techniques to be apply through robotics and IoT platform, there are challenges too. It includes addressing and tagging, connectivity, openness and data model standards, security, privacy, hardware configuration and detection, architecture, computing power and performance, etc.

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