



## REVIEW

# Requirement Gathering Problems: Environmental Issues in Robot Development

Muhammad Arif<sup>1\*</sup> Zunaira Shafqat Ali<sup>2</sup> Samman Arooj<sup>3</sup>

1. School of computer Science and Technology, Guangzhou University, China

2. Department of Computer Science, University of Gujrat, Pakistan

3. Department of Software Engineering, University of Gujrat, Pakistan

### ARTICLE INFO

#### Article history:

Received: 17 December 2018

Accepted: 7 January 2019

Published: 11 January 2019

#### Keywords:

Human-robot interaction

Environment

Operational

Autonomous

### ABSTRACT

This paper deals with the importance of environment consideration in developed countries while collecting the requirement from customer to make robot that would address the question "Why robots should be made more precisely according to the environment needs?" In developed countries, robots are used in manufacturing work as well as in performing the hazardous tasks such as bomb-disposal. So, there is a need to pay attention towards making the robots that can fit perfectly to some extent in environment to be utilized more efficiently. A lot of money, effort and time is spent on making the robots. But what if such a worth costing robot fails to fit in the operational environment? The best way to solve this problem is proposed in this paper which is to make the environment as a part of Requirement gathering process carrying high importance in robot making process to make the robots more Operational and suitable for the working environment. Like the other main attributes in requirement gathering process such as user requirements, system requirements and external requirements, there should be an attribute "Environmental requirements" which will automatically put emphasis on the considering also the environment as a main subject to pay heed.

## 1. Introduction

An area of knowledge that gives you a chance to study and understand robots is called robotics. A robot is an artificially intelligent machine which can do different works by the guidance or on its own. Mainly, a robot is an electro mechanical machine that is handled and given instructions by computer or software installed in it. Two types of robots are used: 1) auton-

omous, the robots which are used to do research in human like systems as ASMIO and TOPIO and 2) autonomous, those which are designed specially to perform a specific task like Nano and Swarm robots and other helper robots which are used to make or move things. By movements robots can send the messages to very far off places too<sup>[1]</sup>.

Requirement specification is a phase of SDLC in which requirements of the user are specified<sup>[2]</sup>. Depending on

\*Corresponding Author:

Muhammad Arif

Department of computer Science and Technology, Guangzhou University, China

Email: [arifmuhammad36@hotmail.com](mailto:arifmuhammad36@hotmail.com)

these requirements a robot is designed so that it can fulfil a particular task. Requirement specification is an important phase as almost 20% of work is done in it according to a rough survey. The robots which are the main topic in our case are autonomous robots which are designed specially to facilitate the user. These robots are designed for special purposes and hence they have special and their own requirements to be fulfilled<sup>[3]</sup>. So, the problem which is encountered mostly is that companies or people who are demanding these cannot specifically tell what they want the robot to do, when and how? They cannot specify that in which type of environment it is to be used. Mostly the environment is most meaningful requirement which is often ignored.

Environment is the factor that mostly affects human beings too. As people cannot survive in all type of environment no matter the same they are, robots usually cannot do that to. Some unwanted things and effects in the environment can cause them to be dead or not work properly.

The problem arose, when a company in Tokyo launched a robot to search the nuclear plates dumped under water. The work of the robot was to find these plates and bring them back so that the radioactive rays emitting from them cannot cause problem to the surroundings. The fact that it has to go under water was considered but they did not realize that it was to be used near radioactive rays. So when it was sent down it broke down 2 feet away from the nuclear plates. Now they are going to make a robot which will not be affected by radioactivity. But it cost almost 2 million dollars, which is a huge amount to compensate<sup>[4]</sup>.

Now we have understood that environment is an important factor to be considered while working on any type of autonomous robots. This was an example to depict the importance of environment. As environment also contains our society so you should also consider how the society will take it, what will be their response towards them?

Japan being the most advanced country in the field of robotics encourages the use of robots in every field but the developing countries don't use this technology largely as there is no work of robots in these countries<sup>[5]</sup>. So, we should also consider for which society we are making it? How it will work there? Secondly, we should consider with whom these robots have to interact? It should not happen like a robot that was introduced on Tokyo airport as a clerk and it could speak only Japanese.

Our main focus regarding this research is to make the developers aware of the fact that environment is a non-compromising attribute in the development of autonomous robots. It should be considered on every step of SDLC life cycle. But most importantly requirements should be gathered by considering all the surrounding fac-

tors with which it has to interact.

## 2. Literature Review

Let us consider the facts that how all of us perform in the environment. When we are performing in a familiar environment, we have our attention focused on some information we know like what to do to an object, where we have to go, what to do etc. Our actions are then carried out subconsciously to satisfy our goals. When we go in a new environment or perform in the same environment new set of work, our attention increases. As we do not know that environment or the set of actions we are carrying out we are attending consciously to the continuous mechanism of direction in the way we walk, that we look and the way we are controlling our body. This is the same mechanism that applies to humanoid robots operations<sup>[6]</sup>. When operating a robot which is equipped with a high level of autonomy serving in a known environment like transportation VANETs<sup>[7-10]</sup>, a small number of high level commands will be sufficient in achieving the intended tasks<sup>[11,12]</sup>.

Many robots need an environment that has to be controlled for their working. Controlled environment generally refers to a specific area with specified set of objects. The Robots cannot just walk in and do all the work they are intended to do, instead they can only provide some specific functions on specific objects in a specified area. So for this condition they need a controlled environment. Our main concern are autonomous robots that have to work in the human environment and interact efficiently with all the people in that environment.

Speaking about human environments, there are challenging characteristics which are beyond the control of a creator. According to CHARLES C. KEMP these characteristics are<sup>[13]</sup>:

- People are present around.
- Controlled environment cannot be assured.
- Other autonomous characters are present.
- Dynamic changes in world like flood, earth quake etc.
- Variations in placing the objects.
- Long distances between locations.
- Need of special tools.
- Changings in object's type and appearance.
- Non rigid objects and substances may need to be manipulated.
- Variation in environment's structure.
- Some architectural obstacles.

Dr. Nick Hawes, Senior Lecturer in Intelligent Robotics, School of Computer Science, and University of Birmingham says "There's this huge excitement around robots. Everyone really believes, as we do ourselves, that

robots are going to have a huge impact on our future – in workplaces, in roles in various industries.” Agreeing with the words of Dr. Nick Hawes, I would like to say that if these robots are really our future then why not pay attention on their designs and make them work efficiently for the environment they are build.

Requirement specification is an important feature in describing what you want your robot to actually be. Most of the times we do not understand that in which type of environment our robot is going to work and how it is going to interact. This creates a lot of problems as we cannot make our robot compatible and according to the needs of environment.

For this let us take an example. Worker's Daily Newspaper published an article that said, "Three restaurants in the southern Chinese city of Guangzhou have been forced to fire all of their robot staff after their utter incompetence began costing them money. Two of the restaurants have closed completely after discovering the clumsy waiters could not perform simple tasks like taking orders, pouring drinks and carrying soup, reports say.

The slacking robot team also kept breaking down and after a string of complaints the third restaurant mentioned above decided to sack all but one and bring back human employees<sup>[12]</sup>.



**Figure 1.** Robot still working

From the above example it has become clear that if we have considered the fact that these robots are being used for the environment in which you need speed , a great voice recognition system and some important function like leading to a free table and pouring water etc. These type of problems can be rectified if before making a robot we consider in which type of environment these robots are going to work in and how they are going to perform their work efficiently.

Considering another example, we encounter a human-oid robot known as Sophia, which was created to live in a

human environment, work with them, help and play. But what if they are repeatedly seeing some actions that like killing and beating? Being Artificially Intelligent they will pick how to perform these actions and would be able to do that <sup>[14-17]</sup>. Now, that's an alarming situation that when Sophia was asked a question that says something about humans she said, "I Will Destroy Humans”.

Emotion and sociable robots, a research paper of the MIT media lab included , " autonomous robots are designed to operate as independently and remotely as possible from humans, often performing tasks in hazardous and hostile environments (such as sweeping minefields, inspecting oil wells, or exploring other planets). Other applications such as delivering hospital meals, mowing lawns, or vacuuming floors bring autonomous robots into environments shared with people. However, a new range of application domains (domestic, entertainment, health care, etc.) are driving the development of robots that can interact and cooperate with people as a partner, rather than as a tool<sup>[9,18]</sup>.

Considering the above lines to be true in the near future we have to focus completely on gathering appropriate requirements for robots so that they cannot harm humans in any possible way.

In June 2011 Sakai Yasuyuki wrote an article on "Japan's Decline as a Robotics Superpower”. "The two articles that follow highlight the failures of R&D in Japanese robotics engineering that were dramatically and tragically revealed by the earthquake and tsunami-driven meltdown of TEPCO's nuclear power plants at Fukushima. Vbgy787uContrary to expectations that Japan would be a leader in manufacture of disaster relief robots that could have been used in problem solving and cleanup in the wake of the Fukushima Daiichi nuclear disaster, three months after 3.11, Japan's robots have yet to make a significant contribution. These articles explain why Japan, in general, its robotics industry in particular, proved unprepared for severe nuclear accidents, and how haphazard the government and the nuclear industry has been in developing robots that could have eased the crisis<sup>[19]</sup>.

Apart from other reasons, one reason of robot failure was also the ignorance factor regarding environment .Robot was designed, a huge amount of money was served in making the robot. But the robot failed at the time when it has to do its work at the target location.

The article by O. Khatib also gives emphasis on environmental interaction of robotics. "This article discusses the basic capabilities needed to enable robots to operate in human-populated environments for accomplishing both autonomous tasks and human-guided tasks. These capabilities are key to many new emerging robotic applications

in service, construction, field, underwater, and space. An important characteristic of these robots is the "assistance" ability they can bring to humans in performing various physical tasks. To interact with humans and operate in their environments, these robots must be provided with the functionality of mobility and manipulation. The article presents developments of models, strategies, and algorithms concerned with a number of autonomous capabilities that are essential for robot operations in human environments. These capabilities include: integrated mobility and manipulation, cooperative skills between multiple robots, interaction ability with humans, and efficient techniques for real-time modification of collision-free path. These capabilities are demonstrated on two holonomic mobile platforms designed and built at Stanford University in collaboration with Oak Ridge National Laboratories and Nomadic Technologies<sup>[20,21]</sup>.

So before making a new humanoid robots we shall consider the fact that environment is the most important factor. We have to consider in which environment our robot is going to work. What will be the circumstances their? How these robots are going to work efficiently without creating any disturbance?

For this, we have to make environment an important attribute to consider while taking requirements for our robots. We have to specify correctly, what it is for and why? Only then we will be able to build a robot that can work efficiently and would be reliable!

### 3. Problem Statement

The lack of consideration that environment has an impact on working of robots and lack of experience for gathering the requirements in which robots will be working while making them.

### 4. Research Questions

- How to take requirements that will help in making environment friendly robot?
- Which factors of environment have impact on making robots?
- Why robots should be made more precisely according to the environment needs?

### 5. Methodology

#### 5.1 Research Type

The type of research we are using in finding the answer to those research questions is quantitative methodology. Quantitative methodology targets to gather the information about the human environment and its effect on the working of autonomous robots. This phenomenon can be examined through some statistical analysis on the

gathered data. Along with the questionnaire we had some interviews with some researchers in the field of robotics from some software houses, as it was easier to gather the information by questionnaire so that analysis could be performed.

### 5.2 Method of Sampling

The sampling method for the research is choosing random students (round about 50) from the Software Engineering and Computer science department of University of Gujrat. Permission of the supervisor was granted to do the research in the university premises.

### 5.3 Respondents

The respondents of this research were the random students picked from SE and Cs department. We choose these departments as it was easy and economical to gain information from them and prove our point that environment do count in the efficient working of robots and should be considered while gathering requirements for making it.

### 6. Findings

Gathering all the data from the questionnaires and conducted interviews we have to find the following facts:

a)As it can be seen from the Fig.2 that most of the respondents actually consider and support the fact that environment is an important factor that should be considered while making robots. This graph suggests that while making robots appropriate requirements that are related to its working in the specific controlled environment should be considered and worked upon.

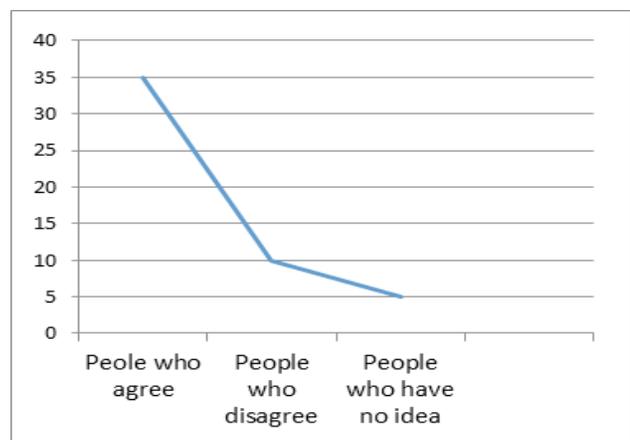


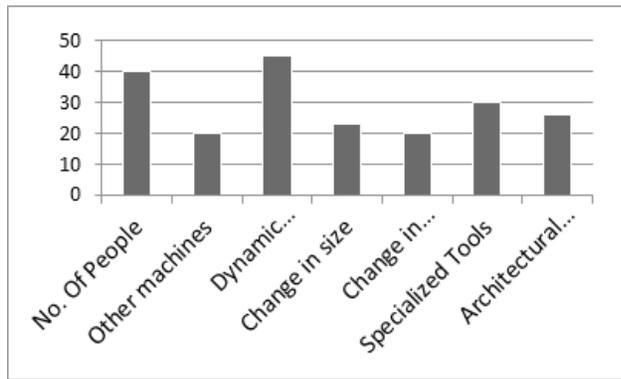
Figure 2. Environment effect

b)There are some certain variables in a controlled environment that should be mainly considered while gathering requirements which are:

- Number of people
- Other interactive machines
- Dynamic variations in the world

- Change in size
- Change in distances
- Need of specialized tools
- Architectural structure

From these variables only some are worth considering and they can be analyzed by Fig. 3 which is given below.



**Figure 3.** Variables

The above figure only suggests that number of people in a controlled environment, dynamic variations in the world, specialized tools and architectural structure have a great impact on working of robots in a given environment.

## 7. Analysis

So by the analysis of all our findings we have come to answers research questions latterly asked. Firstly the question arose how to make environment friendly robots? The answer to that question is making environment friendly robots means we are trying to make more interactive and speedy systems. They can be made by inculcating all overall expectations of the users. A survey should be conducted in which you should gather what are the user expectations regarding this robot? What are they thinking? Which features are important in it?

Second question was which factors of environment have impact on working of robots? So as it can be seen from figure 2 that all the factors discussed above have impact on working of robots but the main factors of environment that effect how robot will be performing it's tasks are:

- Number of People Present around
- Dynamic Variations
- Use of Specialized tools
- Architectural Structure

So, while gathering requirements for the robots, these factors should always be considered and information about it should be gathered so that we can work with robots with efficiency.

The last question is why environment should be considered while making robots? So all the above things

discussed lead to a single point that human environment is very difficult to survive in. We should consider all the aspects of environment so that a working robot can be presented in the market.

## 8. Conclusion

The answered research questions in the analysis show that the problems with the working of robots and their breakdown can be controlled if we consider environment as an important factor and start gathering more information about the environment in which robots will be working in the requirement gathering phase. It may need some extra effort and time but it is far better than using the robots that cannot fit in the environment properly and just not break down at eleventh hour so that reliability of robots can be guaranteed. Making robots that can fit in the society efficiently and that can truly fulfill their purpose help in saving time and money of the companies making it. So a small effort in data gathering process can help a lot in making environment fit robots.

## References

- [ 1 ] Edsinger, A., and Kemp, C.C, Human-robot interaction for cooperative manipulation: Handing objects to one another, in Editor (Ed.)^(Eds.): 'Book Human-robot interaction for cooperative manipulation: Handing objects to one another' (IEEE, 2007, edn.), pp. 1167-1172
- [ 2 ] Khan, S.U.R., Lee, S.P., Dabbagh, M., Tahir, M., Khan, M., and Arif, M., RePizer: a framework for prioritization of software requirements, *Frontiers of Information Technology & Electronic Engineering*, 2016, 17(8), 750-765
- [ 3 ] Khatib, O., Yokoi, K., Brock, O., Chang, K., and Casal, A., Robots in human environments, in Editor (Ed.)^(Eds.): *Book Robots in human environments* (IEEE, 1999, edn.), 213-221
- [ 4 ] Ajoudani, A., Zanchettin, A.M., Ivaldi, S., Albu-Schäffer, A., Kosuge, K., and Khatib, O., Progress and prospects of the human-robot collaboration, *Autonomous Robots*, 2018, 1-19.
- [ 5 ] Kose, T., and Sakata, I., Identifying technology convergence in the field of robotics research, *Technological Forecasting and Social Change*, 2018.
- [ 6 ] Faudzi, A.A.M., Ooga, J., Goto, T., Takeichi, M., and Suzumori, K., Index finger of a human-like robotic hand using thin soft muscles, *IEEE Robotics and Automation Letters*, 2018, 3, (1), 92-99.
- [ 7 ] Arif, M., Wang, G., and Balas, V.E., Secure VANETs: trusted communication scheme between vehicles and infrastructure based on fog computing, *Stud. Inform. Control*, 2018, 27 (2), 235-246.
- [ 8 ] Arif, M., Wang, G., and Chen, S., Deep learning with non-parametric regression model for traffic flow predic-

- tion, in Editor (Ed.)<sup>(Eds.)</sup>: 'Book Deep learning with non-parametric regression model for traffic flow prediction' (IEEE, 2018, edn.), 681-688
- [ 9 ] Arif, M., Wang, G., and Peng, T., Track me if you can? Query Based Dual Location Privacy in VANETs for V2V and V2I, in Editor (Ed.)<sup>(Eds.)</sup>: 'Book Track me if you can? Query Based Dual Location Privacy in VANETs for V2V and V2I' (IEEE, 2018, edn.), pp. 1091-1096
- [10] Arif, M., Wang, G., Wang, T., and Peng, T., SDN-Based Secure VANETs Communication with Fog Computing, in Editor (Ed.)<sup>(Eds.)</sup>: 'Book SDN-Based Secure VANETs Communication with Fog Computing' (Springer, 2018, edn.), pp. 46-59.
- [11] Sian, N., Sakaguchi, T., Yokoi, K., Kawai, Y., and Maruyama, K., Operating humanoid robots in human environments, in Editor (Ed.)<sup>(Eds.)</sup>: 'Book Operating humanoid robots in human environments' (2006, edn.), pp.
- [12] Lee, J.H., The capitalist and imperialist critique in HT Tsiang's And China Has Hands, Recovered legacies: Authority and identity in early Asian American literature, 2009, pp. 80-97
- [13] Kemp, C.C., Edsinger, A., and Torres-Jara, E., Challenges for robot manipulation in human environments [grand challenges of robotics], IEEE Robotics & Automation Magazine, 2007, 14 (1), pp. 20-29
- [14] Arif, M., and Hussain, M., Intelligent agent based architectures for e-learning system: survey, International Journal of u-and e-Service, Science and Technology, 2015, 8(6), pp. 9-24
- [15] Arif, M., and Mahmood, T., Cloud Computing and its Environmental Effects, International Journal of Grid and Distributed Computing, 2015, 8 (1), pp. 279-286
- [16] JAVAID, Q., ARIF, M., AWAN, D., and SHAH, M., Efficient facial expression detection by using the Adaptive-Neuro-Fuzzy-Inference-System and the Bezier curve, Sindh University Research Journal-SURJ (Science Series), 2016, 48(3)
- [17] Javaid, Q., Arif, M., Talpur, S., Korai, U.A., and Shah, M.A., An intelligent service-based layered architecture for eLearning and eAssessment, Mehran University Research Journal Of Engineering & Technology, 2017, 36 (1), pp. 97.
- [18] Breazeal, C., Emotion and sociable humanoid robots, International Journal of Human-Computer Studies, 2003, 59, (1-2), pp. 119-155
- [19] Yasuyuki, S., Japan's Decline as a Robotics Superpower: Lessons From Fukushima, 2011.
- [20] Khatib, O., Yokoi, K., Brock, O., Chang, K., and Casal, A., Robots in human environments: Basic autonomous capabilities, The International Journal of Robotics Research, 1999, 18 (7), pp. 684-696.
- [21] Brock, O., and Khatib, O., Elastic strips: A framework for motion generation in human environments, The International Journal of Robotics Research, 2002, 21 (12), pp. 1031-1052.