*Bulletin de la Société Royale des Sciences de Liège, Vol*. 85, 2016, *p*. 446 - 453

# Multimodal User Interface, Enabling of Assistive Robots

Batool MORTAZAVI[1], Nasrin ALISHIRVANI[2]

[1] Payame Noor Faculty Member, b_mortazavi@pnu.ac.ir
[2] Payame Noor Faculty Member, n_alishirvani@pnu.ac.ir

**Abstract**

Multimodal user interface is a kind of user interface which is able to receive various high data and produce various types of output in reaction to it. Though human – robot interaction is based on human and computer interaction, it is more complex than human – computer interaction due to considerable increase in the number of inputs and outputs. Increase in parameters results from mobility of robot and human, interaction of robot and objects and necessity for three-dimensional understanding of the environment. Security is one of the main concerns in human – robot interaction. One of the novel applications of robots is caring for people with physical disability and aged people. Due to some limitations of these patients, simplicity of communication and no need for learning by the clients, in one hand, and presence of various inputs, versatility and automatic adaptation of robot performance and ability to respond to incomplete input, on the other hand, is palpable.

**Keywords**: MultiModal User Interface, Human – Robot Interaction, Human – Computer Interaction, Adaptive Interface, Assistive Robots

## 1. Introduction

Increasing human – robot interaction and attempt for utilizing robots in daily affairs opens new gate for robotic researches. Nowadays in addition to industrial applications, there are other applications for robots including helping disabled and elderly people and generally clients [1-5]. Considering increased number of aged population and getting old of population, need of aged people for caring is not met by young people, and robots can considerably help them in this regards. It should be noted that learning ability is reduced in aged people and sometimes they also suffer from physical disabilities. Thus, Simplicity and ease of communicating with the robot is very important.

One of advantages for simplifying communication with robots is dealing with user interfaces which cover various interaction methods. These interfaces, known as multi-modal user interface, have been considered for the years. In fact, multi-modal user interfaces are used for increasing efficiency and easiness of human – computer interaction in various applications [6-11]. These interfaces can be user-friendly, natural and simple, and considering they use

various methods for data entry and data provision, they are able to different individuals in different conditions. Such variety in interaction ways provides such environment which enables people with motion and physical disabilities and aged people to efficiently communicate with computer [12 - 15].

In order to provide simple and natural communication between human and computer, it is necessary to identify data reception ways by human and ways if affecting environment. Figure 1 indicates different sensory and intellectual aspects of human [6]. Human receives data from environment using different sensors, and performs reactions versus received data using operators, or expresses response of his internal emotions. These reactions can be even behaviors such as frowning, staring, blinking, etc. the important point is that these reactions are appropriate inputs for computer. Thus, if there is suitable perceptual mechanism in the computer, computer can even perceive internal moods of individuals with analysis of human reactions. In order to make human – computer relationship as natural as possible it is necessary that computer is able to interpret natural human behaviors, and there should not be necessity for human too learn and perform specific reactions which are perceivable for computer.

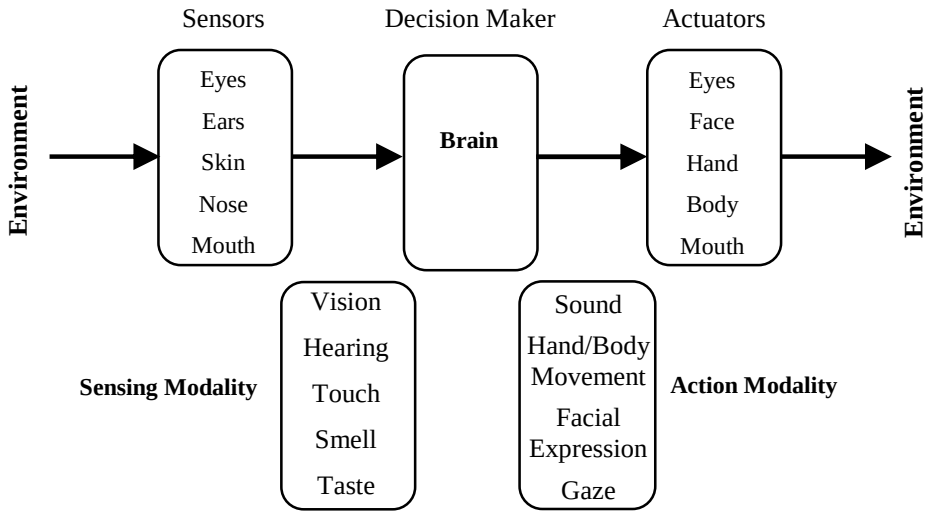


**Figure 1**: Perceptual and practical aspects in human. Human perceives life environments using different sensors and influences it using various operators. [6]

Figure 2 indicates mapping human reactions and actions to computer inputs [6]. As observed, in addition to physical reactions, such as facial expressions, sound, hand pressure etc., which are exchanged in human to human relationship and are perceived by the senses, EEG can also be a computer input. EEG indicates changes in electrical signals from brain activity. It is

clear that capturing and analyzing all human reactions is very complex and time consuming. Thus, based on the expectations from system, inputs will be determined.

On the other hand, for proper understanding of human behaviors, and especially internal states, independent investigation of reactions is not effective in some cases, and computer inputs should be analyzed in an interrelated manner. Different input aspects can have additive or complement aspects [16]. If they have identical data, they are additive. In this case, the purpose is increasing accuracy or reducing probability of lack of data reception. If input aspects contain part of data and the whole message can be achieved by their combination, then input aspects are complement. In addition, multi-modal input minimizes user mistakes.

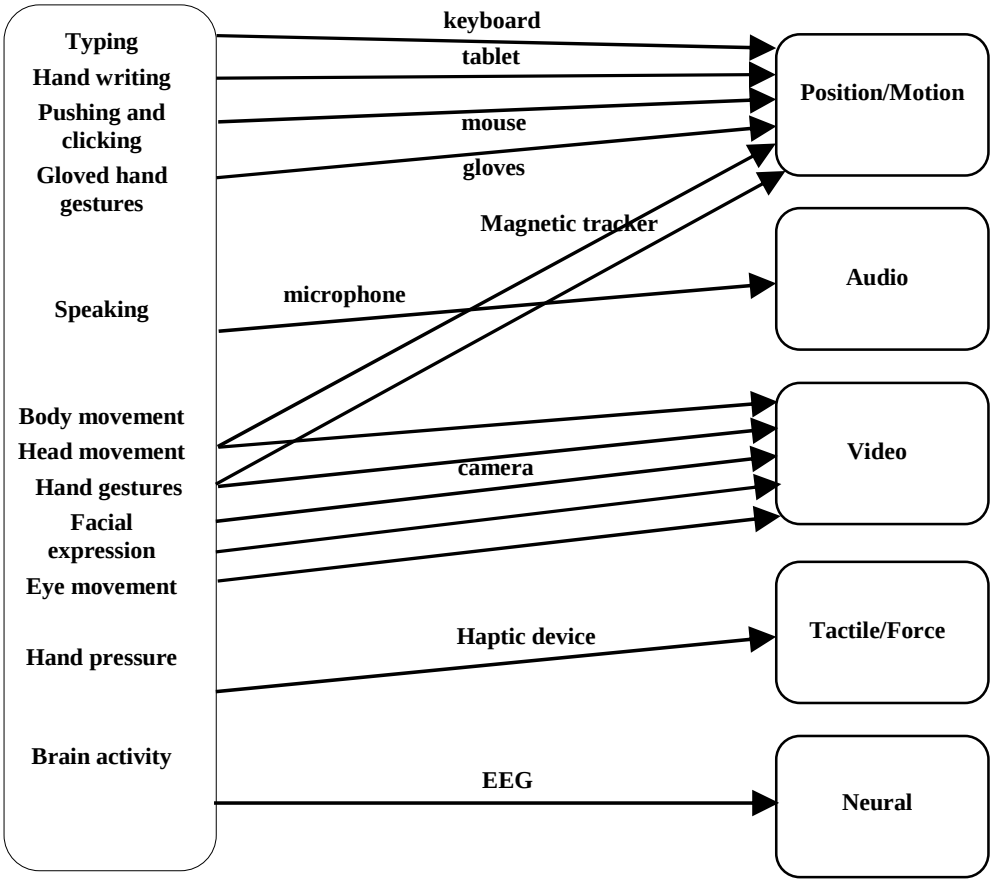


**Figure 2**: Mapping Human practical aspects to computer perceptual aspects. Several functions can be extracted with a perceived sensor and different data. [6]

In people with physical disability and elderly people, considering the disability, some input aspects do not provide data for the computer [12, 13, 14]. For example, a physically disabled person cannot type input data, or a person may not be able to speak. Regarding aged people reduced accuracy in data entry and need for simplicity of communication should be considered [17]. For example, instead of expecting user to adopt himself with needs of

system, it should be done automatically based on user behavior and reactions. Or considering the pressure and duration of holing hand on key and using terms bank and commands, appropriate delay for letter detection and proper decision making is specified.

Adapting system with user needs is done by intelligent user interfaces, and intelligent agents are responsible for identifying user behavior and habits for system learning and adaptation. As a result of such process, system complexity refers to its design and implementation. But users can communicate computer without need for learning complex functions. Such flexibility causes that individuals with different levels of knowledge and capability are able to interact and use computer, and at the same time, interaction type is close to their natural behavior, and there is no need for complicated trainings.

## 2. Human – robot interaction

Human – robot interaction is essentially based on human – computer interaction, with this difference that considering expectations from robot, robot environment is more complex. Robot interaction with objects, three-dimensional perception of environment and ability to communicate and interact while robot and user are factors which increase complexity and create new challenges [18, 19, 20]. For creating quasi-human relationship, it is necessary that interaction is developed based in dialogue in natural language, facial expressions and body gestures and touches.

Considering motion for individual and robot develops relationship from a stop interaction to field interaction, leading to increased complexity. In this case, high adaptability is required so that robot can properly find expected input among different inputs, and reacts properly in case of absence of some inputs in addition to adopting appropriate decision. In addition, it should be able to infer and extract facts from inputs which even part of which may be incorrect. Above cases require rich sources of data.

Figure 3 indicates situation of robot, human and environment in relation with each other, and clarifies different situations which should be taken into account.

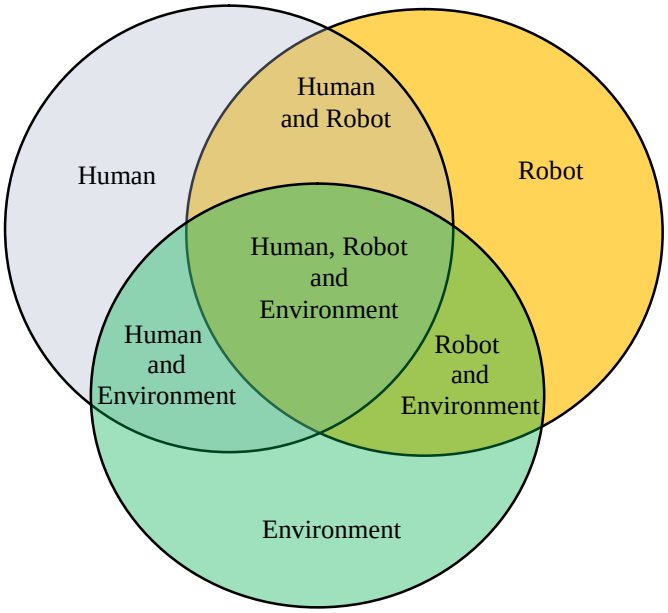


**Figure 3**: Three-way interaction among human, robot and environment

As observed, the most complicated conditions occur in three-way interaction among robot, human and environment, and considerable part of interaction occur in this section. Since robot is often mobile, in addition to various inputs received from human, which is mainly inputs shown in Figure 2, it also receives high number of inputs from environment, and considerably affects the environment. Hence, the number of inputs versus human – computer interaction is significantly increased. In addition, robot function is beyond informing, advising, or dialogue, and it leads to increased number of operators.

## 3. Assistive robot should be to eliminate which needs?

Physically disabled people and aged individuals have various needs which are classified into physical needs and psychological needs. It is clear that robot is not ever considered as replacement for human, but the aim is that robots help in meeting basic needs of clients. Some needs of clients are described in the following:

### 3.1 Physical needs

- Monitoring vital signs: clients need to be monitored in terms of vital signs and treated if needed. If the worker robots are equipped with appropriate sensors, they can do this.

- Initial vital behaviors: some clients are not able to perform personal affairs alone like eating. Although it does not seem that robots can be easily used in this regards, and they cannot easily replace human. But robots can examine needs and warm if necessary, prepare reports of initial behaviors and provide necessary devices.
- Client movement: motion and displacement are cases which client may have problem in them. Robots with specific architecture can be used for movement. In addition, robots can play role as guide for directing and locating.
- Movement of objects: one of the basic needs of most clients is displacement of objects. To this end, robot can have many abilities including the ability to detect needs, clarify and detect objects and move and carry them.
- Explaining existing conditions: clients which have motion or vision problems tend to obtain data from their environment. Robots can collect these data somehow from the surrounding environment and provide as text or speech for clients.
- Environmental condition management: assistive robot can help client in management of environmental conditions such as temperature, light, and other cases.

### 3.2 Mental needs

Many of elderly people suffer from loneness and need companion. The point is that natural speech and behavior for robot is more important. Facial expression and logical speech is more important regarding psychological needs. Proper eliminating of psychological needs has considerable impact on physical improvement and refreshment and hope of clients. Empathy and interaction with client is also important. Robot should detect that when client needs communication and which behaviors are suitable for him. Robot can read book for client, tell story, talk with him, download news, and provide for him, show film, play intellectual games, like chess and similar activities.

## 4. Conclusion

After penetration of computer in all aspects of human life, nowadays robots gradually are taking important status among human beings. Helping increasing life quality of clients such as physically disabled people and old people is one of robot applications. Although robots never can fill stats of human for other human beings, their utilization seems inevitable considering demographic changes and changes in life styles. Robot- human interaction is possible through multi-modal user interface. Increasing number of input aspects increases complexity, but it causes that communication is more natural. Robot should be able to receive

reactions obtained from different operators and detect the existing status following analysis, and offer appropriate function. Such robot should be able eliminate physical and even psychological needs of client.

**Refrences**


[1] Uradiles, C., Collaborative Assistive Robot for Mobility Enhancement (Carmen), The Bare Necessities: Assisted Wheelchair Navigation and Beyond, Springer-Verlag Berlin Heidelberg, 2012.

[2] Mayer, P. and Panek, P., "*Towards a Multi-modal User Interface for an Affordable Assistive Robot*", 8th International Conference, Universal Access in Human-Computer Interaction. Aging and Assistive Environments, Springer International Publishing Switzerland, Part III, pp. 680-691, 2014.

[3] Cherubini, A. , Oriolo, G. , Macri, F. , Aloise, F. , Cincotti, F. , and Mattia, D., "*A vision-based path planner/follower for an assistive robotics project*", IEEE International Conference on Robotics and Automation, Spain, 2007.

[4] Dautenhahn, K., Human-Robot Interaction. In: Soegaard, Mads and Dam, Rikke Friis (eds.). "*The Encyclopedia of Human-Computer Interaction*", 2nd Ed", Aarhus, Denmark: The Interaction Design Foundation. Available online at https://www.interaction-design.org/encyclopedia/human-robot_interaction.html, 2014.

[5] Katyal, K.D., Johannes, M.S., McGee, T.G., Harris, A.J., Armiger, R.S., Firpi, A.H., McMullen, D., Hotson, G., Fifer, M.S., Crone, N.E., Vogelstein, R.J., Wester, B.A., "*HARMONIE: A multimodal control framework for human assistive robotics*", 6th International IEEE/EMBS Conference on Neural Engineering (NER), pp.1274-1278, 2013.

[6] Sharma, R.; Pavlovic, V.I.; Huang, T.S., *"Toward multimodal human-computer interface"*, Proceedings of the IEEE , vol.86, no.5, pp.853,869, 1998.

[7] Bellik, Y. and Teil, D., *"A Multimodal Dialogue Controller for Multimodal User Interface Management Systems. Application: a Multimodal Window Manager"*. In Proc. INTERCHI'93, New York, ACM Press, 1993.

[8] Clerckx, T., Vandervelpen, C., Coninx, K., *"Task-Based Design and Runtime Support for Multimodal User Interface Distribution"*, Springer, Engineering Interactive Systems: Lecture Notes in Computer Science, vol. 4940, pp. 89-105, 2008.

[9] Luperfoy, S., *"The Representation of Multimodal User Interface Dialogues Using Discourse Pegs"*, In Proc. of the 30th Annual Meeting *of the Association for Computational Linguistics*, pp. 22–31, 1992.

[10] Reitter, D., Panttaja, E., Cummins, F., "*UI on the fly*: *Generating a multimodal user interface*", in Proc. of Human Language Technology HLT-NAACL-2004, Boston, Massachusetts, USA, 2004.

[11] Taib,R., Shi, Y., Choi, E., Chen1, F., Sladescu, M., Phung, N., *"Multimodal User Interface Facilitating Critical Data Entry for Traffic Incident", proc. of conf. Research and Practice in Information Technology, vol. 57. P.5, 2006.*

[12] Argyropoulos, S., Moustakas, K., Karpov, A.A., Aran, O., Tzovaras, D., Tsakiris, T., Varni, G., and Kwon, B., "Multimodal user interface for the communication of the disabled", Journal on Multimodal User Interfaces, vol. 2, pp. 105–116, 2008.

[13] Teixeira, V., Pires, C., Pinto, F., Freitas, J., Sales Dias, M. and Mendes Rodrigues, E., Towards Elderly Social Integration using a Multimodal Human-computer Interface. Proc. of the 2nd International Living Usability Lab Workshop on AAL Latest Solutions, Trends and Applications, AAL 2012, Jan. 2012.

[14] Rodrigues, E., Carreira, M., Goncalves, D., "*Developing a Multimodal Interface for the Elderly*", 5th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-exclusion, pp. 359-368, 2013.

[15] Su, H., Wang, T., Tokhi, M., Virk, G. S., Assistive Robotics, Proceedings of 18th International Conference on Climbing and Walking Robots and the Support Technologies for Mobile Machines, 2015.

[16] Dumas, B., Lalanne, D., and Oviatt, S., "Multimodal interfaces: a survey of principles, models and frameworks," Human Machine Interaction, pp. 3–26, 2009.

[17] Jameson, A., "*Adaptive interfaces and agents*", *he human-computer interaction handbook: Fundamentals, evolving technologies and emerging applications*, 2nd ed., pp. 433–458, Boca Raton, FL: CRC Press. 2008.

[18] Tapus, A., Mataric, M.J. and Scassellati, B., "*The Grand Challenges in Socially Assistive Robotics*", IEEE Robotics & Automation Magazine, IEEE, Volume:14, Issue:1, pp. 35 – 42, 2007.

[19] Di Nuovo, A., Broz, F., Belpaeme, T., Cangelosi, A., Cavallo, F., Esposito, R., Dario, P., "*A web based Multi-Modal Interface for elderly users of the Robot-Era multi-robot services*", IEEE International Conference on Systems, Man and Cybernetics (SMC), pp.2186,2191, 2014

[20] Mayer, P. Beck, C. , Panek, P., "*Examples of multimodal user interfaces for socially assistive robots in Ambient Assisted Living environments*", IEEE 3rd International Conference on Cognitive Infocommunications (CogInfoCom), pp. 401-406, 2012.