Analysis of Human Machine Interaction Design Perspective - A Comprehensive Literature Review

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Abstract

Human Computer Interaction also refers, as Human Machine Interaction is the most extensive research field of computer science. It defines the behavior between human and machine. The design perspective of human machine interaction helps to interact and how a machine system can operable without potential error and efficiently by human. Many researches have done and also been doing in the field of Human Computer Interaction but the main concern goes to the interaction design methods that would be human understandable and desirable. Several relevant fields have been discussed in this article particularly the interaction methodologies and interaction perspectives. We tried to discuss and summarize the previous important research in this field such as the history of human computer interaction, interaction methods, taxonomy of hci, principles, aspects, and some specific fields of human and machine interaction. A comprehensive literature review has done in this article regarding human machine interaction. The discussion and summery section in this article reviewed the research limitations of the interaction methodologies and design as well as the importance of future interaction methodologies and interaction design aspect for avoid potential error and interact with the machine conveniently by human.

Keywords: Human Machine Interaction, Human Computer Interaction, Interaction Design, Interaction Methodologies.

1. INTRODUCTION

Human computer interaction or Human machine interaction defines the psychology, ergonomics, computer science, behavioral science, cognitive science, media studies and several field of study. The machine interaction technology has been developing since form the last century to find out how human can interact with machine without making any potential error. After 1970's the human machine interaction studies has begun the concentration in researcher and scientist, we can say the revolution takes places in science and technology. Particularly the human machine interaction study was the main concern in computer science due to the computational necessity in modern life, but for the several reasons it has spread almost every fields of science.

Human Computer Interaction is the term that is first used by Stuart, Thomas and Allen [1]. We typically interact with machine for the necessity of multiple purposes. If a machine system is not convenient and effortless to operate then the output can be vary from expected. Several accidents happened in history due to the wrong interaction, command, human error and the failure of the machines. The most influential accident was in March 28, 1979 in reactor number 2 called "*Three Mile Island Accident*" at Nuclear Generating Station in Pennsylvania, United States because of confusion into command on the machine. Though the system was automated but the operator thought there were much coolant water on the reactor system and suddenly he delayed to operate the machine for misunderstand the user interface of the reactor. Another significant accident called "*The Space Shuttle Columbia disaster*" occurred on February 1, 2003 over Texas and Louisiana. The reason of the disaster was caught a piece of foam broke from the external tank and struck the left wing of the orbiter. Without proper interaction methods or proper user interface the system can be complex for an operator, thought the system has automated technology.

In automated systems also can occur such surprising situations if the system has not good interaction model or interface and also cause for wrong input from an operator. Many psychological issues are come in front of us when we consider an accident for human fault. The software bugs are also causes for damages of human life and financial impairment. One of the most recent software bugs accident recorded on March 26 of 2016 in japan [2]. In Japan's Hitomi astronomical satellite was destroyed when a thruster fired on the wrong direction, causing the spacecraft to spin faster instead of stabilize. There are thousands of cases of software errors and interaction errors in the past years which have bought losses in world.

This paper has done a comprehensive literature review on interaction methodologies, interaction design aspect and several related fields of human machine interaction.

Finally has presented and summarized the gaps of human machine interaction design appearance.

2. RELATED WORKS

2.1 Human Computer Interaction (HCI)

We first experienced the name of Human Computer Interaction (HCI) by 'Carlisle' [3]. Though the name of computer interaction but consists several fields of science. One of the most influential books has written by Alan. Dix, et al. that describes in chapter 1, a person's interaction with the outside world through information being received and sent: input and output. In an interaction with computer and user receives and sent to computer and user as vice versa. It also describes the models of interaction in chapter 3. Interaction involves at least two participants; the user and the system. Both are complex, as we have seen, and are very different from each other in the way that they communicate and view the domain and the task. The interface must therefore effectively translate between them to allow the interaction to be successful. This translation can fail at a number of points and for a number of reasons. The use of models of interaction can help us to understand exactly what is going on in the interaction and identify the likely root of difficulties. They also provide us with a framework to compare different interaction styles and to consider interaction problems. The authors also explain the terms of interaction. The purpose of an interactive system is to aid a user in accomplishing goals from some application domain. A domain defines an area of expertise and knowledge in some real-world activity. Some examples of domains are graphic design, authoring and process control in a factory.

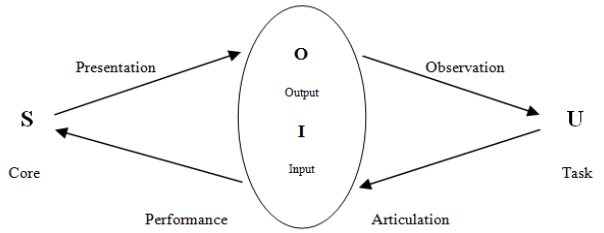

Fig. 1: Four components of interaction, System, User, Input and Output.

Alan, Janet, Gregory and Russell have explained and drawn a diagram which has shown above that there are four components in interaction system: the system, the user, the input and the output [4].

The principles of HCI describes in the book has written by 'Gerard J Kim'. Good HCI design is generally difficult, mainly because it is a multi-objective task that involves simultaneous consideration of many things, such as the types of users, characteristics of the tasks, capabilities and cost of the devices, lack of objective or exact quantitative evaluation measures, and changing technologies and more. A considerable knowledge in many different fields is required. Over the relatively young history of HCI, researchers and developers in the field have accumulated and established basic principles for good HCI design and the HCI principles are:

- Know Thy User.
- Understand the Task.
- Reduce Memory Load.
- Strive for Consistency.
- Reminds User and Refresh Their Memory.
- Prevent Errors.
- Naturalness.

Above these principles are general, fundamental, commonsensical and applicable to almost any HCI design situation. The author 'Gerard' stated a commonsensical principle is *task* [5]. The term *task* refers the job to be accomplished by the user through the use of the interactive system. The example of *task* model has shown below.

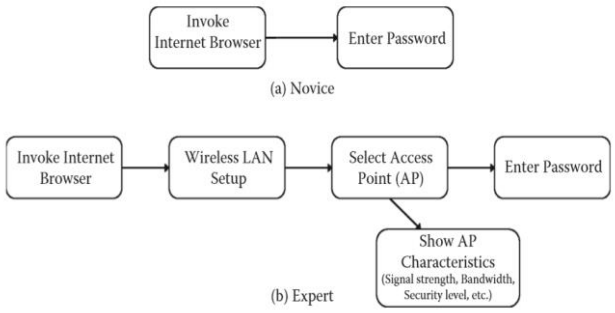

Fig. 2: Two Interactions model for the task.

The Association for Computer Machinery (ACM) defines human-computer interaction as "a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them". It also defines There are other disciplinary points of view that would place the focus of HCI differently than does computer science, just as the focus for a definition of the databases area would be different from a computer science vs. a business perspective. HCI in the large is an interdisciplinary area. It is emerging as a specialty concern within several disciplines, each with different emphases: computer science (application design and engineering of human interfaces), psychology (the application of theories of cognitive processes and the empirical analysis of user behavior), sociology and anthropology (interactions between technology, work, and organization), and industrial design (interactive products). They drew the four development process of HCI.

- Design Approaches.

- Implementation Techniques and Tools.
- Evaluation Techniques.
- Example systems and case studies.

The ACM also expresses of Computer System and Interface Architecture, Machines have specialized components for interacting with humans. Some of these components are basically transducers for moving information physically between human and machine [6]. The components are:

- Input and Output Devices.
- Dialogue Techniques.
- Dialogue Genre.
- Computer Graphics.
- Dialogue Architecture.

The emotion of human being is also important for interacting between human and computer. This term defined broadly by the author Julie, et al. in their Handbook [7]. The literature on emotions and computers has also grown dramatically in the past few years, driven primarily by advances in technology. Inexpensive and effective technologies that enable computers to assess the physiological correlates of emotion, combined with dramatic improvements in the speed and quality of signal processing, now allow even personal computers to make judgments about the user's emotional state in real time" and about human attention defines that, One of the most important effects of emotion lies in its ability to capture attention. Emotions have a way of being completely absorbing. Functionally, they direct and focus our attention on those objects and situations that have been appraised as important to our needs and goals so that we can deal with them appropriately.

2.1.1 Human Machine Interaction (HMI)

Human computer interaction (HCI) refers the name, as Human machine interaction (HMI), is the most important research category of Human computer interaction (HCI). The significant research of layout design have done for a system and the article explicit that the layout problem of human-machine interaction was getting more and more inseparable with artificial intelligence technology. Researchers began to pay attention to various computational intelligence algorithms, such as genetic algorithm, particle swarm optimization algorithm, simulated annealing algorithm, ant colony algorithm, and tabu search. The researchers have drawn an implementation steps as follow.

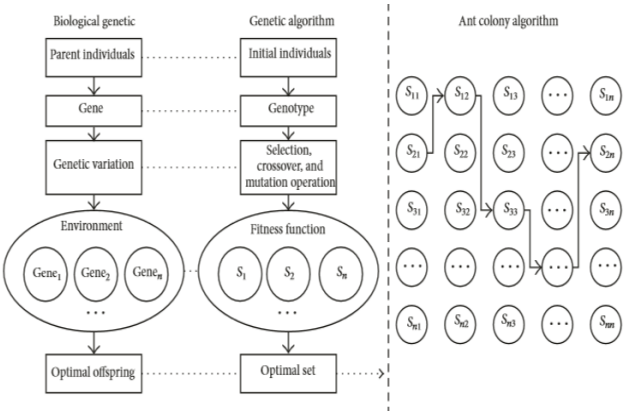

Fig. 3: The Implementation Steps of Layout Design.

The effect of the algorithm in different applications was different so, according to the characteristics of the cabin, solving algorithm should be suitable for the layout problem [8]. HMI is mostly applicable in Aircraft also; by following the HMI methodologies the aviation system is very adaptable nowadays. In this field the researchers have shown a new HMI design methodology supporting the specification and evaluation of a new automation concept, both will be functional and operational perspective. The advanced models for safety aircraft name as (A-PiMod) project funded by the European Commission. The A-PiMod project goal is to improve flight safety in a time of increasing levels of performance, automation and information provision to the flight deck. The automation concepts of three hybrid elements [9] are:

1. Multi-Modal Pilot Interaction.
2. Operator Modeling.
3. Real-Time Risk Assessment.

In recent years one of the significant researches has done and funded by the Takes-Finish Funding Agency for Innovation and VTT. They used Virtual Prototyping in Human Machine Interaction design and demonstrate a Framework for HMI is a combination of Human, Interface and System Model Elements. The human interact with the system model through the interface. It shows Virtual Prototyping in design review and some objectives [10].
The HMI also applicable in Intuitive Programming of Assembly Tasks and the research have done by three researchers 'Sven, Johannes and Sigrid' [11], they demonstrated an article at the conference is Association for Robots in Architecture works on making robotics accessible to the creative community. An approach that had significant success was the combination of graphical programming of parametric geometries with robotics, allowing for parametric robot control and mass customization and have given some points are, Robot in Construction Industry and Parametric Robot Control, Adapting to Assembly in Unstructured Environments, Teaching Process and Analysis of Generalization. Three researchers 'Cheng, Liu and Meng' explained in their

journal the Visual Analysis of Cognitive Structure based on HMI [12]. The authors explain the cognitive manifolds in the brain are mapped to the information manifolds by the coupling situation of human-machine interaction, which can be named as "cognitive high-dimensional manifold observation method in cognitive coupling states of man-machine interaction", The architecture of BSM observation platform - a local structure of a high dimensional manifold is mapped to a low dimensional cognitive manifold and Category-theory-based cognition observation in BSM. High-dimensional cognitive objects are induced by the coupling situation. The cognitive information is collected through man machine interaction. Modulated by computers, the coupling situation can perform more collection interaction for the controllability of cognition observation.

2.2 Research of HMI

There have various field researches in HMI. One researcher article explained the Designing methods for Autonomous Vehicles [13]. Authors are stated that, it is a formative constraint-based approach, consisting of five successive stages: Work Domain Analysis, Control Task Analysis, Strategies Analysis, Social Organization and Cooperation Analysis, and Worker Competencies Analysis. Two of these stages are presented and used in their paper: Work Domain Analysis (WDA) and Control Task Analysis (ConTA). One researcher 'Stefanie' have carried out the improvements in HMI by using a Conversational interface Design, a Spoken Dialogue system (SDS) [14].

A doctoral thesis about SDS has done by 'Stefanie L Tomko', explains speech could be considered an ideal medium for human-computer interaction. Speech is natural and the vast majority of humans are already fluent in using it for interpersonal communication. Speech is portable, it supports hands-free interaction, and its use is not limited by the form factor of speech-enabled devices. The author took a Speech Graffiti approach which aims to reduce the negative effects of variability system complexity. The Speech Graffiti also approaches to dialog systems is built on the principles of portability, universality, flexibility, and transparency, and as such offers a system-level attempt at increasing interaction efficiency. In that research studied Three Case Study and proved the human interaction via 'Shaping'.

Two researchers 'Bogdan and Andreas' demonstrated in their article included recognition of the user's facial expression which has done by a camera and emotion recognition within speech [15].

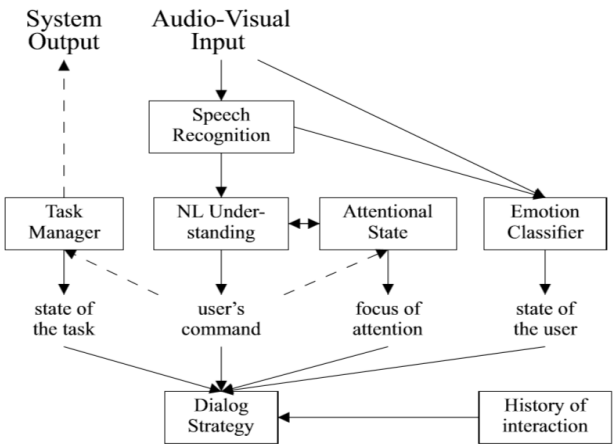

Fig. 4: Processing user's input.

Emotions are then classified into one of two emotion classes (neutral and anger). The history of the previous system-user interaction intentions, are classified such as cooperative, explorative or destructive.

In another article the authors Raquel, et al. considered that SDS describes to enable people to interact with Robots or in general by using spoken language in natural way [16]. They consist of a human-machine interface that can recognize and understand a speech request uttered by the speaker and provide an output an answer. In this process different modules are involved in order to recognize the speech input, understand their meaning, manage the dialogue and provide the speech output. Two different kinds of SDS were considered in the work:

- Informants: Systems providing some piece of information to the user.
- Actuators: Systems that have to carry out some action.

In their work proposed to improve the performance of an ASR (Automatic Speech Recognition) system with dialog system taking into account LM (Language Modelling) one hand and the other hand AM (Acoustic Modeling). They showed the impact of two aspects of the system and proved that are semantically meaningful are advanced.

The recent research of SDS for improving Human Machine Interactions has done by 'Raveesh' in his Doctoral dissertation. Explained the objective is to enable human users to interact with computers in a human-like manner, and spoken human–computer interaction has the potential of offering natural and effortless interactive experiences with computers. Spoken dialogue systems are inherently complex and comprise of various speech and language processing components that perform automatic speech recognition, natural language understanding, dialogue management, natural language generation, and speech synthesis. Presented a data-driven approach for detecting suitable response locations in user speech and used human–computer interaction data that collected using a fully automated dialogue system that can perform the Map

Task with the user. The author trained three models for error detection: the Early Model the Late Model and the Offline Model. The three models are work differently, first the Early Model have relied on using feature that contribute to the assessment of user turn, such as the position in dialogue, Late Model benefits from addition inputs from user response and the Offline Model closely similar to the Late Model, but additionally uses manual features [17].

2.3 HMI Methodologies

Several relevant researchers have done in the field of HMI by following the Methodologies to develop the interaction between human and machine. One of the very important research found that has done by 'Sébastien' in his Doctoral dissertation. The researcher has followed the Formal methods to develop the interactions between human and machine. The research has flooded many important factors and task of human machine interactions fields. In the context essential research factors will be discussed and analyzed regarding to the importance and priority for this research. The main categories have used in the research of formal methods to analyze the HMI, Model Checking Algorithm, discussed Automatic Generation of User Interfaces, Integrated user's task into the interaction analysis, the discussion of Human-Machine system and demonstrates a Safe minimal mental model, Interaction Model and Enriched Model, The potential automation surprises, The Full-control property, Full-control Conceptual Models, the case study of Autopilot model and Reducing the model, Discovered Full-control modes, the First Conceptual model and Analyzed the Mode Confusion, Task Model Completion [18]. Firstly we will discuss the Formal method to analyze the HMI, The Model Checking Algorithm, Interaction model and the Full Control Conceptual model.
Formal Methods use for different purposes and the classified three main categories are according to the investigation of the researcher:

- Systems can be modelled formally so that rigorous and systematic analysis can be performed on them. Given a formal model, systems can be characterized and compared. For example, measures for the level of usability or complexity can be computed.
- Properties can be expressed formally and verified against systems. Such verifications can be mainly done with either model checkers or theorem provers. For example, a system can be proved to have no deadlocks or it can be checked that some actions are always undoable by the operator.
- Finally, by using formal methods to model HMI, it is also possible to use algorithms that are able to generate artefacts, such as user manuals, other models, alternative system models and user procedures, satisfying some precise and well-defined properties. For example, a user manual covering all the behavior of a system can be automatically generated.

The two researcher groups Matthew, et al. [19] and Alan [20] have done a research for apply the formal methods to analyze the human machine interaction before.
The second important discussion for the research is Model Checking Algorithm; this algorithm exhaustively checks the model of a system that meets the specification. Here the researchers have given a model for the algorithm:

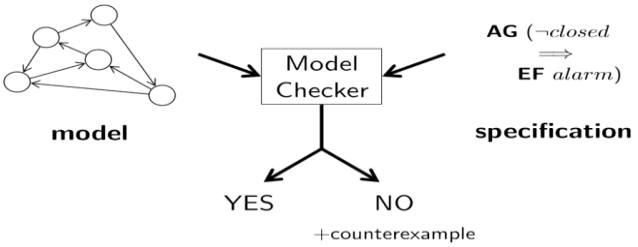

Fig. 5: Model Checking Algorithm.

A specification is a set of desired properties each of which representing an element of the specification. Satisfying the specification means satisfying all of its properties. If M denotes a model and S a specification, the notation M |= S means that the model satisfies the specification. Model checker can be checked different kind of specifications. Firstly verified the properties in a given logic, for example Computation Tree Logic (CTL) defined by Edmund, et al. [21].
The third one is Interaction model, here is an example expressed by the researcher. A vending machine system modelled with a HMI-LTS (Labelled Transition System). The system is left side and the operator is right side which represents the mental model of the user that thinks the coffee will deliver on the right side. The coin commands the machine that customer inserted coins and do the next step, after that the observation ends and the machine delivering the coffee.

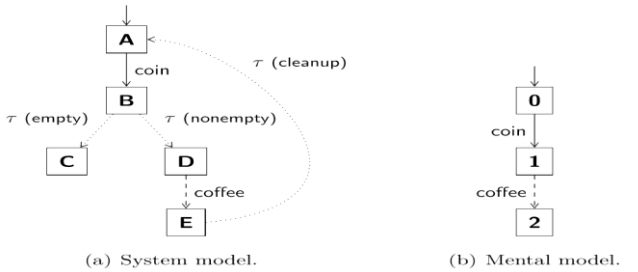

Fig. 6: A vending system interaction between human and Machine.

The τ's internal actions empty and nonempty correspond to the check of the stock level of coffee and the τ internal action cleanup corresponds to the machine resetting to the initial state after a clean-up.
The Full Control Conceptual model is very important for our research due to the importance of automated system

model research purpose which is one of the topics of our research background. The researcher proved that by making opstate state-variable visible possible to reduce the system model into a smaller full controlled conceptual model which is shown in figure 7. The model has reduced to a two-state model.

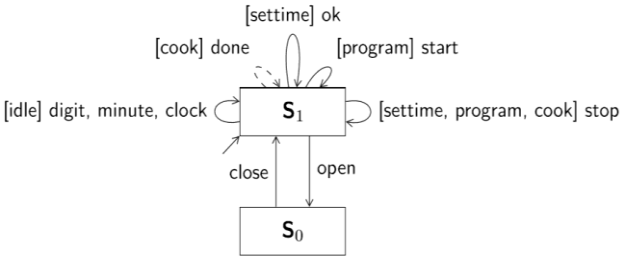

Fig. 7: Microwave oven Full control Conceptual model.

The **S_0** state showing on the figure meaning is door open command and the **S_1** for the operational mode of the system.

We have known that HCI is a multidisciplinary field and the Ambient Intelligence (AMI) is one of them. In AMI there are various uses of HCI and 'MIT' has started the first Ambient Intelligence research group at their Media Lab as 'Fluid Interface Group' [24]. According to the research of 'Massimiliano' HCI has many interesting challenges for Ambient Intelligence [25]:

- Multimodal Interaction.
- New Interaction Vocabulary and grammar.
- New Metaphor that may suite the new scenarios.
- New input/output devices that may catch implicit/explicit user interaction and communication to all his/her senses.

The Ambient Intelligence paradigm is closely related to the HCI for human-centric computer interaction design and is characterized by technologies and systems [22].

The researches Diane, et al. in AMI expected some features; sensitive, responsive, adaptive, transparent, ubiquitous and intelligent. From these definitions, and the features that characterize Ambient Intelligence, we can see how the discipline compares and contrasts with fields such as pervasive computing, ubiquitous computing, and artificial intelligence [23].

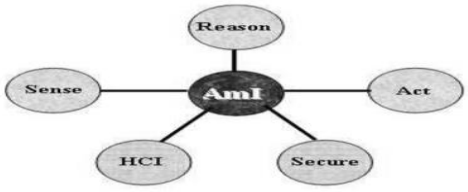

Fig. 8: Relations between AMI and Technologies.

- Sensing: Ami is designed for real world, effective use of sensors is vital. The key that link computational power with physical applications. Sensors designed for detection of chemicals, humidity, light, temperature, sound, strain, pressure, velocity and position.
- Reasoning: Sensing and acting provide links between intelligent algorithms and the real world in which they operate. In order to make such algorithms responsive, adaptive and beneficial to users, a number of types of reasoning must take place.
- Acting: AMI systems tie reasoning to the real world through sensing and acting. Intelligent and assistive devices provide a mechanism by which AMI systems can executive actions and affect the system users.
- Human Computer Interaction: Through HCI the AMI to made easy to live with and defines human-centric computer interfaces that are context aware and natural.
- Security Challenges: Users customizing their environments and unobtrusively meets their needs.

The fact of AMI systems must be sensitive, responsive and adaptive which highlights the dependence that AMI research has on context-aware computing.

Ambient Intelligence paradigms radically changes between human and technological relation. These changes the classical HCI paradigms used for years with personal computers. Technology cannot improve human physical and cognitive abilities but can help them to reach their goals. Indeed technology changes the task that the user has to perform, with simpler and more affordable ones. The researcher 'Massimiliano' also explained the essentiality of designing the Usable UIs and mentioned the complexity relation between user interface level and degree of automation, levels of workload and operator performance. As we know the three fundamentals variable in human computer interaction: the user, the task and the context of use. The researcher has used in Interaction style to interact with the interface a touchless paradigm name 'WiiMote tacking'. This features have, Infrared camera with object tracking, Accelerometers, Buttons, Vibration Motor, Speaker. The device communicates with Bluetooth connection being recognized as a Human Interface Device for easy connection with computers.

2.3.1 Activity Theory

In Human computer interaction or human machine interaction diverse methodologies are used, but some methods have used vastly one of them is 'Activity Theory'. It first pioneered in 1987 at Russia by 'Lev Vygotsky, Alexei Leont'ev and Sergei Rubinstein'. The goal of Activity theory is understand the mental capability of a single individual. It has six elements that take the actions to analyze something. The elements are Subject, Object, Community, Tools, Division of Labor and Rules.

Figure 9 is showing the theory model and their six elements.

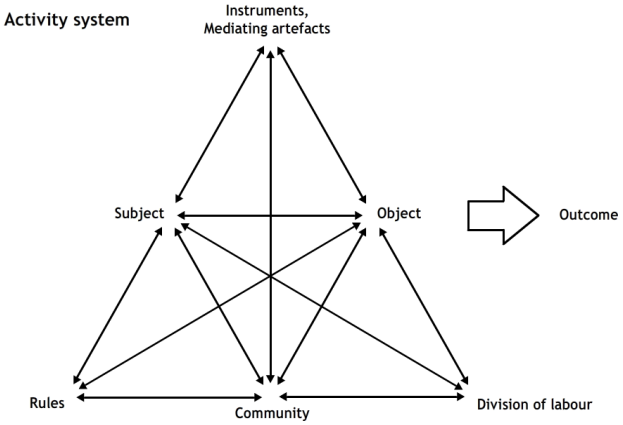

Fig. 9: Activity theory model.

There are various uses and researches have been done by using Activity Theory. In the 'Journal of Academic Writing' the researcher 'Marie. C. Paretti' used the activity theory to analyze two different portfolio approaches as tools for programmatic assessment of Integrated Content and Language (ICL) programs. Stated Activity theory provides a tool to explore what these models can offer in terms of an assessment of the integration of content and language in disciplinary contexts, where texts serve to mediate the ongoing work of a discipline. The researcher done two case studies one of them is 'The Design portfolio-longitudinal view of one activity system'. That focused on a single system in which texts mediated students' work on an authentic, open-ended project in the field. The portfolio consisted of artifacts created during a year-long design project: a written proposal and presentation; intermediate written progress reports each with a corresponding presentation; and a final written report and presentation [32].

Another significant research has done by 'Hasan. Helen, et al. that expressed the human activity as:

Subject ⇐⇒ Object ⇐⇒ Outcomes

In Activity Theory the *subject* is (human doer) and *object* is (thing being done). The *outcomes* of an activity can intend ones but there can be also that are unintended. They mentioned by using the Activity theory provides a language and set of frameworks for making sense of what is discovered through interviews, observations and other methods. By analyzing the real world stated the lens of Activity Theory precedes some steps as follows:

Step 1. Identify the significant activities of the system to be investigated together with each activity's subject(s), object and purpose.

Step 2. Identify the actions and mediating tools of the activity or activities, where tools can be primary, secondary or tertiary.

Step 3. Identify the dynamics and tensions within and between the identified activities.

By following these steps will provide a holistic and meaningful mechanism under a situation for researcher and what is being researched [33].

A couple of researchers have published an article together that presented a conceptual model called Activity Theory-based Model of Serious Games (ATMSG). Their model is considering for complex and dynamic system purposes. Regarding their research has three activities, the gaming activity, the learning activity and the instructional activity. Every activity is takes different actions. According to their research the learning activity and instructional activity is important. The instructional activity is subdivided by two activities: intrinsic instruction that is performed design decision made when creating the game or game assessment and feedback mechanism and the extrinsic instruction performed of how the instructor uses the game [34].

Activity Theory also uses for designing and developing in interactive Media Art. In practical Hyunil.C. Kim, et al. Jung on their article stated Activiti Theory as effective and clarified tool for designing and planning computer-based media art. The theory is not also psychological but also a relation between a person and an artifact. It helps to analyze the situation. They analyzed in their research Projection Mapping and used Activity theory for designing their project that has three types of interaction interfaces: Body interaction, Hand interaction and Phone interaction [35]. Their main concern was to Activity theory as a base structure to evaluate how the technology and art works message are communicated and implemented. A researcher has proposed a 4th generation Activity Theory Model against on founded some limitations by the previous researchers done research of Activity Theory. In the research has drawn a theory model and added three terms for developing the old model: Motivations, Barriers and Awareness. All the terms are effect in human activities on the model. The researcher also discussed the unclear arrows on the previous Activity Theory Model and added the terms on the new model [36].

2.3.2 User Centered Design

User Centered Design is the second method or process that uses severely in HCI. Several researches have done in HCI by following the User Centered Design methods. According to the definition of HCI and this methodology various fields of science are uses to develop by these methods. For developing Sign Language a research has done by Julie. Fisher, et al. (2013). Their research explored the designing and building of a system to teach parents of deaf children and others SL (Sign Language) providing meaningful, real time feedbacks using a UCD approach. They designed a MIAC using an avatar displays a sign to the user, the user makes the sign which is captured and the image is compared with the stored version of how the sign is made. If the user's depiction of the sign is incorrect the system highlights visually the mistakes made. The process

is repeated until the sign is correctly made. They have done the two important parts in their research as follows:

- Designing the Avatar.
- Alternative views for signs.

They explained on designing of MIAC using User Centered Design has given them the opportunity to explore the effectiveness of taking a UCD approach in the context of the development of a real system [37].
We are trying to explain and demonstrate the various uses of User Centered Design approaches. A European Journal a research article has been published by 'Carsten Röcker' about UCD in Ambient Assisted Living System. In the article described the User Centered Design for Medical Usefulness, also Compared to traditional desktop-based computer systems, which rely nearly completely on explicit user input, Ambient Assisted Living systems are often envisioned as autonomous helpers. The author paid attention that when designing AAL systems, special attention should be paid to intuitive control and feedback mechanisms for enabling user centered patient monitoring. Good design does not only refer to the aesthetic qualities of a system, but also includes a visual appearance, which does not contribute to the stigmatization of its user [38].
User Centered Design method is uses in designing for Driving Simulators. The researcher Ghasan. Bhatti, et al. (2014) has developed an user centered architecture for driving simulators. They used User-Centered (UCD) approaches for the model scenarios and have built prototype software. They made clear that the design and execution of the scenario needs three main roles: the end-user (e.g. researcher, trainer, etc.), the technical team and the experiment operator. They used an interactive prototype tool name "Justinmind prototyper" to build prototype [39]. Their prototype was evaluated on an unskilled and low skilled end user, showing good result in term of completion rate.
A significant research has done by 'Ishrat. Begum' regarding the emphasis of good User Interface Design with applying the User Centered Design method. In the article demonstrated the two terms that are important to HCI are functionality and usability. Cited some reasons for poor interface design:

- Lack of HCI based training of people developing interfaces.
- A range of knowledge is required to design good interfaces.
- Rapid technological advances are required to design.
- Companies reluctant to commit resources.
- Poor management-where programmers are not thinking and designing as users.
- Lack of interaction and involvement of users.

The author mentioned the conventional four stages User Centered Design model is:

➔ Study ➔ Design ➔ Build ➔ Evaluate ➔

However, the researcher extended the four stages conventional model into five stages user centered new model.

➔ Understand ➔ Study ➔ Design ➔ Build ➔ Evaluate ➔

That has added conceptual analysis or 'understanding' stage to understand user's domain, environments and cultures [40]. According to the researcher, the new method must complement the existing methods of designing and stress on usability between prototypes and engineered solutions.
A Case study has been done with the method or process by 'W.V. Siricharoen' in 2014 for the development of Navigation map of MRT (Mass Rapid Transit: Underground Train) at Bangkok. The researcher applied the user-centered design methodology to create the interactive route navigation map. So the primary problem specification is to refer to any technological system which requires interaction with user, such as how can they design an interactive MRT and BTS map by integrating the user center design method, which is both convenient and informative. Interaction design aims to reduce the learning curve and to increase accuracy and efficiency of a task without diminishing usefulness. Also stated UCD forces designers to be explicit about decisions made, reviewing them through prototype and storyboards with the team and potential users. Designers need ways of sharing design thinking by producing physical representations of design ideas. These could be working computer-bases prototypes or as simple as a paper sketch. In that research has broken the UCD process into four phases: ***Analysis, Design, Implementation and Deployment***. User-centered design is not just about the user interface and the screen layout, colors, and buttons. It is much more, to come to a good user interface design at the end, it is essential to lay the foundation in the beginning. This foundation is an understanding of what end users really need and want "the user requirement" [41].
A researcher 'Z. Yovcheva' has described UCD is one of the major concepts that emerged from early HCI research, describing an approach (and methodology) to design in which the end-users of a product shape out its final outlook. Design knowledge within HCI is, therefore, expressed as design principles, heuristics and checklists based on kernel (relevant) theories and empirical observations. One of the most tangible results from UCD is the compilation of design guidelines, heuristics and checklists based on extensive empirical user research [42].
By following UCD method one related article has been published in 2016 by 'A. Giardi'. In the article mentioned that using the User-Centered Design methodology, 20 university students were involved in a participatory planning whose objective was the design and implementation of a "mobile course model". A preliminary

part of the activity, but crucial to the course design, was aimed to the analysis of the models, used by major universities present in iTunesU platform. The objective of the experimentations was to engage students in a participatory planning to define through iterative refining of the developed prototype modules - mobile model course: how today's students organize a course for students of tomorrow [43]. At the same year a field research has done by S. Büttner, et al. with applying UCD method in the industry. They proposed a conceptual design and prototype which has mainly done by three phases: Sketching Workshop, Development of a Low-Fidelity Prototype and Development of the Interactive Prototype. When applied User Centered Design process were presented some challenges during development of the system: Limited Access to Users, Confidentiality during the Development, Bias towards Lab Studies and Conflict of Interests between Management and User. Though have some challenges but also presented some opportunities in the industrial context: *Complex Connected Machines Require Excellent Usability, Usability Issues Inexcusable due to Long Product Life Cycles, Usability Issues Inexcusable due to Long Product Life Cycles, Methods Available and Applicable (With Modifications) and New Interaction Technologies in Industry* [44].

2.4 Interaction Design

Interaction design is the most important fragment for a system to interact with machines properly. It studies from many years, but the term was first coined by B. Moggridge, et al. in 1980. Another 10 years before it discovered by Cooper, et al. and started the concept [26]. Researchers are tried to find the methodology of interaction design and authors are publishing modern books and research articles in these fields. The authors Jenifer, et al. first edition in their book mentioned the process of interaction design have four activities:

- Identifying needs and establishing requirements.
- Developing alternative designs that meet those requirements.
- Building interactive versions of the designs so that they can be communicated and assessed.
- Evaluating what is being built throughout the process.

They discussed the goals of interaction design and it states a design a very efficient system that allows users to highly productive in their work or will be challenging and motivating so that it supports effective learning. The usability goals also defined by the authors: effectiveness to use, efficient to use, easy to learn and easy to remember how to use [27]. A simple interaction design model defined by the authors:

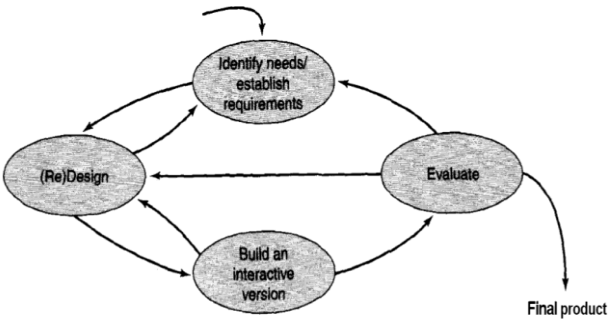

Fig. 10: A simple interaction design model.

Another significant book has been written by ‘Don’ and discussed the design about everyday things. The author defines seven questions for valuable design tool.

1. What do I want to accomplish?
2. What are the alternative action sequences?
3. What action can I do now?
4. How do I do it?
5. What happened?
6. What does it mean?
7. Is this okay? Have I accomplished my goal?

And the seven questions insights seven principles of design:

1. Discoverability
2. Feedback
3. Conceptual model
4. Affordances
5. Signifiers
6. Mappings
7. Constraints

In the book it has also mentioned four different human-centered design processes:

- Observation
- Idea generation (ideation)
- Prototyping
- Testing

These four activities have iterated, they are repeated over and over [28]. In interaction design the researchers John, et al. have proposed at conference a set of criteria or four lenses for evaluating interaction design contributions [29]:

- Process: The critical elements for judging the quality of an interaction design research contribution is the process.

- Invention: In interaction design, research must constitute a significant invention and demonstrates that have a novel integration of various matters to address a specific situation.
- Relevance: Every scientific research should have a focus on validity.
- Extensibility: The final criteria of successful design research are extensibility. It defines the ability to build on the result outcomes of the interaction design research.

The researchers Elizabeth, et al. have published an article on ACM conference that has discussed the research of interaction and interaction design. They mentioned that growing body of research has begun to produce a more practice-based perspective on design. Drawing on their own practice and on observation of others, researchers have described design as resting on a form of knowledge that differs from conventional notions of science. In this approach, successful designers often in practice value reflexivity, interpretation, and judgment. Explicit the complexity of interaction design for consultancies and corporations have separated from software and hardware implementation [30].

The interaction design is one of the major concerns in human-automation systems. The researchers Hwisoo, et al. published an article where they worked an interaction design for adaptive cruise control system of ground vehicle. They discussed that an airplane can operable by directly pilots or it can be automatically by the system, but automation surprises can occur due to human operator may not fully understand the automation process sufficiently. This confusion can happen from the automated function changes or command the automated system by the operator in unexpected manner and incorrect operations. Therefore, it is essential to develop a holistic design approach of user interfaces for the automated system. The human machine interaction is described and analyzed by four elements, they are; the machine, the user tasks, the user interface and the user model of the machine [31]. They proposed a methodology for interaction design and verification of user interfaces expressed two criteria for analyzing and evaluating the correctness of analyzed model.

3. DISCUSSION AND SUMMERY

In this article it is clearly demonstrated that HCI methodologies particularly Activity Theory and User-Centered Design are the most extensive and applied methods for developing and establishing of Interaction design and User interface design perspectives. Regarding the research has to clear the importance of Interaction and Interface design aspect in Human Computer Interaction. Several researches have done of human machine interaction since last century. For proper interaction design and user interface design those methods are apply in the development stage. The methods Activity theory and User-Centered Design both are necessary in HCI. We have noticed these two theories have several stages or actions that take during development on a system and every actions or stages perform different task due to the role of the methods and the necessity.

Activity Theory and User-Centered Design methods are using on diverse fields notably in HCI. Activity Theory acts as cultural and technical aspects of human actions. Six actions are performing in the model of Activity Theory but some researchers are arguments the actions of objects and outcomes. On the other hand User Centered Design has four actions or stages but some of the researches are arguments against the four actions and broke into five or more extended stages. Those two methods actions have been applying from several years but sometimes these fall complication during different role for different activities. For those issues researchers are trying to extend or develop the two methods for future integrations but it is not until specified the final methods of the two models, which will be the role model in Human Computer Interaction design.

4. CONCLUSION

There are no limitations or ending points of technological view. We always try to understand and build our surrounding environment with technologies. We create something and then modify and modify. The process will be carried out until we found our desired expectations. In this article, we tried to explain and demonstrate the essential part of Human Computer Interaction in science. Human Computer Interaction motivates and develops by some criteria and methods, which are, apply in development process when building some physical and virtual systems. We tried to illustrate the role of two vastly used methods Activity theory and User Centered Design for developing and establishing Human Computer Interaction. We also demonstrated the two methods argumentations and the complexity have explained by researcher and further development and extension of the two methods.

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