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Humanoid Robots and Human Interaction, Psychological Challenges and Psychology behind It

Mohd Naveed Uddin
MSC Applied Psychology, Bharathiar University

Abstract: ***In this study, focus has been laid on psychological aspects of technological innovation, especially androids and Artificial Intelligence (AI). The researcher has speculated the future perspective of interaction in between humanoid robots and real human beings. Robotic technologies starting from initial stages to present situation have been explored as well as assessed in depth in order to come to an ultimate conclusion on androids succeeding in reaching the threshold of indistinguishability. And based on authentic evidence of such, level of sophistication that this android technology is yet to achieve in 20 years from now has been observed and commented. Implication of this innovative interaction on the basis of AI and psychological research works have been taken into account besides revealing set of design-related challenges that might hinder human-android interaction.***

Keywords: ***Humanoids, Human-android interaction, NLP, Artificial Intelligence, Psychological challenges in Human-android interaction,***

I. INTRODUCTION

Technological advancements have succeeded in inventing robots with an aim to increase flexibility along with performing diverse range of tasks and applications. Also, these machines are more accurate, precise and consistent in comparison to humans. This has however, questioned face-to-face interaction with someone who is not even real. Androids-robots are now being designed to act like human beings and with this, it is expected to reach somewhere 100 years from now, when androids would become sophisticated. This threshold of indisguishibility would then lead to a new psychology wherein detailed description of human-android interaction would be highly desirable. Taking these into consideration, this study has hypothesized on (a) evolution of androids 20 years from now on the basis of ongoing technological trajectories, (b) challenges to be addressed for creating realistic androids and (c) psychological implication of human-android interaction in regards to in distinguishability.

A. Androids

Android is referred to as a humanoid robot that is designed exclusively for performing activities similar to that of humans. This concept has been founded in 2003 with an aim to develop smart mobile devices which would keep a track of preference and location of humans. Emergence of androids have completely changed the domain of science fiction and are showcased in Star Trek, Battlestar Galactica and Blade Runner with an aim to make the general public aware of this innovative and artificial social interaction. Inspired by the ideas of Zhao *et al.* (2016), the actual technology is however, beyond these fictions and in turn is progressing at a rapid pace. Latest technical advances in the fields of reasoning, mannerisms, speech synthesis, body movement and facial emotional expression are furthermore, highlighted in news stories. All these together have revolutionized the reality in such a way which would tend humans to assume android as real. Physical features like hair and skin are the things that will help in differentiating the virtual or artificial from the real. Furthermore, it is the simplicity of conversational interactions which would reveal limitations of Artificial Intelligence (AI). A contradicting perspective has however, been forecasted in the fiction, Blade Runner. Androids are exhibited to be fully conscious and highly intellectual individuals with apparent personalities. It has moreover, been added that androids are goal-oriented and have the capacity to recognize intentions, beliefs and motivate others using personal agendas. With this, the gap in between present state-of-art and example set up by this fiction became vast and has furthermore, been highlighted in the next section.

II. EVOLUTION 20 YEARS FROM NOW

A. Locomotion

Emergence of androids has opened up scopes for robotic locomotion and motion control as a result of which, robots are now able to transport from one place to another. Several innovation and advancements in the form of realistic humanoid robots have been analyzed in the past 20 years due to the Japanese technological industry (Ishiguro, 2006; Sakagami *et al.* 2002). At that point of time, it was furthermore, estimated for androids to imitate human-like running and walking. However, this seemed to be obsolete

mostly due to challenges associated with advanced level engineering. In spite of this, widespread scopes and development of commerce have been analyzed which in turn assured addressing of reliability issues with economy of mass production. These together have paved the pathway towards the estimation that androids reach out to service or office settings.

B. Morphology

Technology to be used for creating a realistic look of eyes, hair and skin is supposedly complex. Despite the fact that realistic-looking physical features are promising, difference on the basis of realistic flesh is however, prevalent (Atiyeh, Gunn & Hayek, 2005). Computer graphics or animation on the other hand, has succeeded in portraying an automated realistic human (Brooks, 2001). Taking this advancement into consideration, the distance of indistinguishability is presumed to be negligible in the upcoming fifty years.

C. Facial Emotion

Inspired by the ideas of Breazeal (2002), current Android operating systems have been integrated with the mechanics of human facial muscle action due to which, controlling of discrete facial motion is now possible. However, there was a time when this innovation was highlighted in limited research works. Considering the present scenario and development, it is assumed for androids to detect facial emotion using app 20 years from now. With this come scopes of using Microsoft Emotions API wherein a source code containing XML file would be designed to execute emotion recognition in Android app (Zhao, Adib & Katabi, 2016). Contrarily, limitation of skin technology is likely to be predominant, though to some extent.

D. Emotion Detection

Introduction of Convolutional Neural Network Architecture that is advanced machine learning has diversified the range of facial emotion detection in present time due to the availability of facial expression dataset. There are future prediction and assumption regarding feasibility of visualizing emotion detection. This in turn would form the basis of research emphasizing on linguistics (Shih, 2005: Porter & ten Brinke, 2008). Algorithm-driven android APIs are furthermore, on the verge of making effective utilization of semantic analysis and facial detection. This would then help in interpreting mood from speech, text, videos and pictures in real time.

E. Speech

In-depth research and rapid development in context to speech synthesis and recognition have been analyzed. One such example as observed by Benesty, Sondhi & Hunay (2007) is that speech synthesis from text now consists of prosody and intonation that are almost similar to that of humans. It is the fact that speech recognition has advanced machine learning thereby proving to be beneficial for the past generation. At the same time, it is also argued that this is still lagging behind when it comes to yielding a human-level performance (Maskey & Hirschberg, 2006). However, recent android devices are integrated with advanced voice recognition which in turn is capable of recognizing multiple official languages. Furthermore, fifty years from now, androids are likely to change the voice assistant landscape with aspects of “ambient computing” as set out by Amazon besides using smart speakers which would communicate with humans.

F. Computer Vision

Individuals who are fond of reading printed media that is offline advertisements have a clear perception regarding capability of computer technology to recognize human, their activities, as well as other objects. However, there are certain gaps or differences of the reality from what is forecasted in such advertisements (Barnard *et al.* 2003). Reason behind this is that there is ambiguity in understanding ways with the help of which, common-sense reasoning and theoretical knowledge would be combined together in a system which would interpret visual scenes. This is questioned because of the fact that there was a time when no vision systems were advanced enough to identify a real-time picture of human holding pen to write a letter from a printed picture. However, technological advancements have made it possible for computers to acquire process, analyze as well as understand digital images or high-dimensional data of the real world (Hoiem, 2007). In spite of this innovation, there are several areas that are yet to be explored and developed. This in turn has questioned ability of android to interpret the exact image seen by a human being. As a result of this, there are high chances of androids to turn out to be a significant barrier in the evolution of realistic machine or robot-human interaction. Simultaneously, there are opportunities for this technological innovation to become a major breakthrough wherein computers would be further modified to come up with new solutions of using augmented reality. One of the biggest near-future

advancements in this field would be to train data as there is still requirement for humans to train AI-based computer vision in order to make manually labeled images visible. Additionally, it is assumed for joint human-android teams to efficiently proceed with coordinated activities like that of house painting, fence building or catering a party.

G. Natural Language Processing (NLP)

A meaningful interaction is referred to as the one where there are no barriers in the form misunderstood natural or specific language like that of English. In accordance with the ideas of Reiter & Dale (2000), generation of natural language seems to be quite easier rather than dealing with problems of understanding such. There are a variety of research works of the past 15 years that emphasized on statistical techniques as well as applications to generate messages containing natural language due to widespread use of large databases (Manning & Schütze, 1999; Punyakanok *et al.* 2008). However, recent approaches have succeeded in integrating aspects of complex structure and knowledge with an intention to answer simple human questions (Fortunati, 2017). Nine to ten years back, machines answering questions from text was almost next to possible and was taken into concern for development in the near future. Simultaneously, linguistics proficiency was believed to be remaining out of reach of androids. Impact of this was supposedly being on interaction between humans and androids thereby limiting state-of-mind of listeners.

H. Artificial Intelligence

This is the study of architecture of computational learning, knowledge and reasoning. This is the simulation of human intelligence processes that are demonstrated by machines. In other words, machines, especially computers mimic cognitive human functions like problem solving or learning and is presently in a highest level when it comes to intelligent routing of content delivery, automated delivery cars and human speech recognition (Amir & Maynard-Zhang, 2004; de Salvo Braz, Amir & Roth, 2007). Nevertheless, this concept was once depicted to be limited in terms of reaching the desired threshold of indistinguishability. It was then challenging to determine the connecting knowledge in between high-level knowledge and low-level knowledge and to succeed in processing both (Shirazi, & Amir, 2008). Ensuring effective understanding of self-directed robots with use of relevant models was prioritized in research works some 10 years back. Those studies however, become backdated with time specifically by connecting reasoning with the real world. In regards to this, opportunities of AI to flourish in upcoming years seemed to be limiting with further conclusion on more complex conversational capacity of AI in comparison to automatic telephone services. Esque androids with personal agendas as depicted in the Blade Runner was however, termed to be the centre of attraction in science fiction only. The present situation is analyzed to be contradictory due to the fact that AI has continued to undergo massive transformation and development thereby overcoming complexity of converting “small talk” into a natural language which in turn is understandable by all.

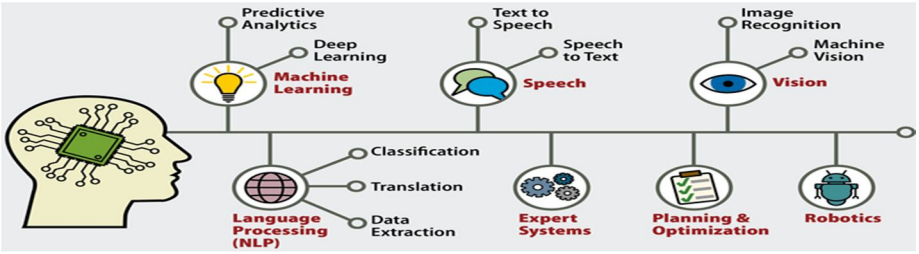

Figure 1: Advancement in the fields of AI
(Source: Inspired by the ideas of Zhao *et al.* 2017, p.772)

It is now possible to process variables in a programmable way although, 20 years from now, it would be feasible for machines to perform activities within scientific realm of statistics. This would then assure much accuracy.

I. Free will

Soon after the emergence of androids, immediate adoption or implementation of this concept seemed to be limiting. For instance, majority of individuals preferred machines like devices used for regulate television to be under human control rather than predicting human preferences (McCarthy, 2000). However, technological advancement has changed this perception and human beings are now willing to rely or depend on operations of android robots. This image is furthermore, assumed to be continuing with machines with easing complexities. Considering the above discussions and predictions, the biggest concern is what it will take for androids to achieve the anticipated indistinguishability threshold.

III. CHALLENGES RELATED TO DESIGN AS SUGGESTED BY PSYCHOLOGICAL SCIENCE

This section has focused varying findings of psychological research works in order to identify list of challenges which might make it difficult for roboticists to design androids in a more realistic way.

A. Eye Gaze

Human beings have sensible eye gaze especially when it comes to other individuals or animal staring at them (Calder *et al.* 2002). It is the eye contact that reflects a complex social interaction or signaling the intent, power or status to recognize. The journey of evolution of androids has therefore, made it a mandate for this technology to regulate direction of gaze of human beings with exquisite subtlety. In simple words, androids are now taken into consideration to gather adequate evidence regarding feasibility of robots to make a realistic eye contact by looking back-and-forth thereby unfolding an effective social interaction (Minato *et al.* 2005). However, this concept of gaze or responding to gaze is one of the challenging innovations yet to be implemented or designed in robots. This in turn has depicted a technology-centered loophole that needs to be explored in order to improve human-android interaction.

B. Body Language

Human beings have the ability to move own body into different positions based on circumstances or requirements and is therefore, considered to be an important signal required for a successful communication (de Paulo, 1992). However, it is the fact that information in this type of communication is less accurate as in symbolic languages. With this, engineering challenges seemed to be simpler when compared with interaction via natural language. Even after technological advancements, there are numerous body movements that are yet to be implemented as motion control in these robots. However, there is almost limiting scopes of this due to no approved or justified evidence on android body language.

C. Personal Space

According to the ideas of Middlemist, Knowles & Matter (1976), face-to-face interaction from an interpersonal distance tends to reflect cultural norms wherein it is essential for one person to stay at a distance which is neither too far or too near. This therefore, requires effective utilization of sensors to detect the location that is the “personal space” and accordingly, regulate body positioning. This has subsequently raised concern about flexibility.

D. Theory of Mind

Human beings are advanced enough to understand speech, underlying motives, emotional states, liking and actions of others to some extent. This is emphasized on findings of Carruthers & Smith (1996) and is termed as “theory of mind”. It is the brain of human beings that is responsible for regulating behavior of mind that is psychology. This has also been verified by social cognition theorists who separated sequence of cognitive mechanisms from the concept of computational mechanisms. However, the best way to integrate psychological-based studies with that of AI-based research is challenging.

IV. PSYCHOLOGY BEHIND HUMAN-ANDROID INTERACTION

Prior to proceeding with this section, it has been assumed that above-mentioned engineering challenges have been addressed and as a result of which, realistic androids have become an inevitable part of everyday life. In order to deal with psychological implications, the reality of sentient robots has been prioritized (Libin & Libin, 2004).

A. Sentience Ambiguity

Emergence of unrealistic or virtual technology has made it important for human beings to determine whether interaction or argument with an airline agent over cancellation of flights is even with the real person. During exchange of information especially at the time of complaint, it is the psychology of individuals to follow certain social scripts based on whether the receiver is real or just an automated technology. Despite current advancement of android technology, it would be difficult for a human to identify realistic of the receiver at the very first observation. This momentary feeling of “ambiguity” can therefore be one of the significant disquiets. In addition to this, it is the fact that any sort of uncertainties turns out to be unpleasant for people due to which, they take initiatives to reduce such. For this, they form several explanations (de Paulo, 1992). With time the android technology has undergone massive transformation and is now considered to be the most user-friendly operating system. Despite this, there is a major ambiguity related to overheating of smart phones due to running of several apps in the background (Zhao *et al.* 2016).

B. *Mindless Acceptance*

Inspired by the ideas of Minato *et al.* (2005), several social interactions of today's world are scripted wherein careful attention seems to be unnecessary and can therefore, be considered to be reflexively "mindless" interaction. Some of the most common examples include interaction at coffee counter, toll booths and even at playgrounds. In context to this, it is assumed that in case android exceeds the threshold of indistinguishability, human psychology would once again become blasé to interact with such. This is due to the fact that human observers require a wide and accurate image of whether the other person is artificial or real.

C. *Turing Anger*

Human psychology is such that one ends up in relieving sentience ambiguity with anger. And in such an instance, whether AI has progressed to permit small talk conversation is of least importance. Angry verbal attack is one of the simplest ways to reveal the status of an ineffective or disappointing interaction. The Turing Test comes into play in such a situation where a verbal interaction is designed to reveal the reality of the unseen speaker (Turing, 1950). However, almost every depictions of this test are centered to semantic memory. The Turing Test needs to be such that would produce swifter results of emotional content regardless of any complexity, which once seemed to be one of the highest hurdles of AI. It was then believed for this Turing Test to result in a culture filled with innovative and advanced level androids. This is now an inquiry method which makes effective utilization of AI to determine whether machines like computers are capable of thinking in a similar way to that of human beings.

D. *Caricatures*

One of the biggest questions lies on the ambiguity whether human beings as a whole are willing to see androids as truly realistic. Some prefer this technology as a deviation from humanity like that of cartoon characters or caricatures. "The uncanny valley" is a widely discussed phenomenon in the fields of roboticists where a highly sensible and realistic robot comes in human form. This however, is full of discrepancies and subtle flaws thereby leading to an unreal feeling (Zettlemoyer & Collins, 2005). Malle (2004) further referred highly pragmatic androids as not-quite-perfect and further added this technology to turn out to be unsettlingly creepy. And in order to avoid this, it has become essential for android designers to focus on deliberate caricatures. This problem of uncanny valley is however, likely to get resolved only in case androids succeeds in surpassing the approach of indistinguishability despite the fact that there are individuals who prefer caricatures like cartoon robots. This concept in the form of C-3PO was showcased in one of the most popular fiction films, the Star Wars.

E. *New Out Group and old Stereotyping*

Looking upon outside groups with disrespect comes under one of the most common tendencies of human psychology (Dastani, Hulstijn & van der Torre, 2005). This mechanics of categorization that is segmenting the world into two halves besides aspects of self-enhancement and self-protection altogether lead to establishment of a negative stereotype about these out-groups. These in turn are likely to have a detrimental or adverse impact on social interaction thereby resulting in suboptimal outcomes by promoting or fostering discrimination. Androids are compared to constitute social groups as a result of which, similar mechanisms of stereotype formation were estimated to prevail. Androids on the other hand, are exempted from such a feeling of anger due to discrimination unless they are designed or programmed so (Pious, 2003). Therefore, stereotypes are less likely to impact or rather hamper the extent of interaction with human beings. Advertising benefits of any upgraded versions of android are however, estimated to be difficult in comparison to that of computers or newer models of car. Reason behind this is viewing this innovative technology through the lens of social stereotyping. This subsequently raised the question regarding the time when androids and human beings would interact to one another at much ease thereby considering this to be a major part of their own group.

V. CONCLUSION

This is considered to be the era of machine-initiated transformation of both employment as well as labor. However, the scenario in the 1950s was somewhat different with massive use of electronic computers allowed human beings to shift from manual-compiled paper spreadsheets of long arrays of financial figures. 1980s furthermore, turned out to be somewhat similar for assembly line workers who were being replaced with industrial robots. This instigated a majority of workers from industries to switch for new employment in the service sector. Further innovation and advancement in the form of androids have resulted in an equivalent situation with machines performing tasks or activities of human workers with much more precision and accuracy. This era is ought to be the third machine transformation which is in the verge of successfully replacing previous two transformations. It can furthermore be concluded that the threshold of indistinguishability would be achieved the moment technology would succeed in

designing android which would be identical or similar to that of humans. It is suspected for androids to turn out to be sophisticated enough so as to get fully involved in the process of everyday social interaction. Machines or rather robots solving or managing equations of mathematics were once an imagination however, evolvement and technological innovation has converted this into reality. Advent of AI is anticipated to be calculating statistical significance which is also the foundation of machine learning. This in turn would turn out to be beneficial for mankind to check and forecast weather patterns, playing intellectual games and also in the fields of medicine. Despite all these, it is of utmost importance to stick to the fact that software used for accurate functioning of android robots is designed by humans.

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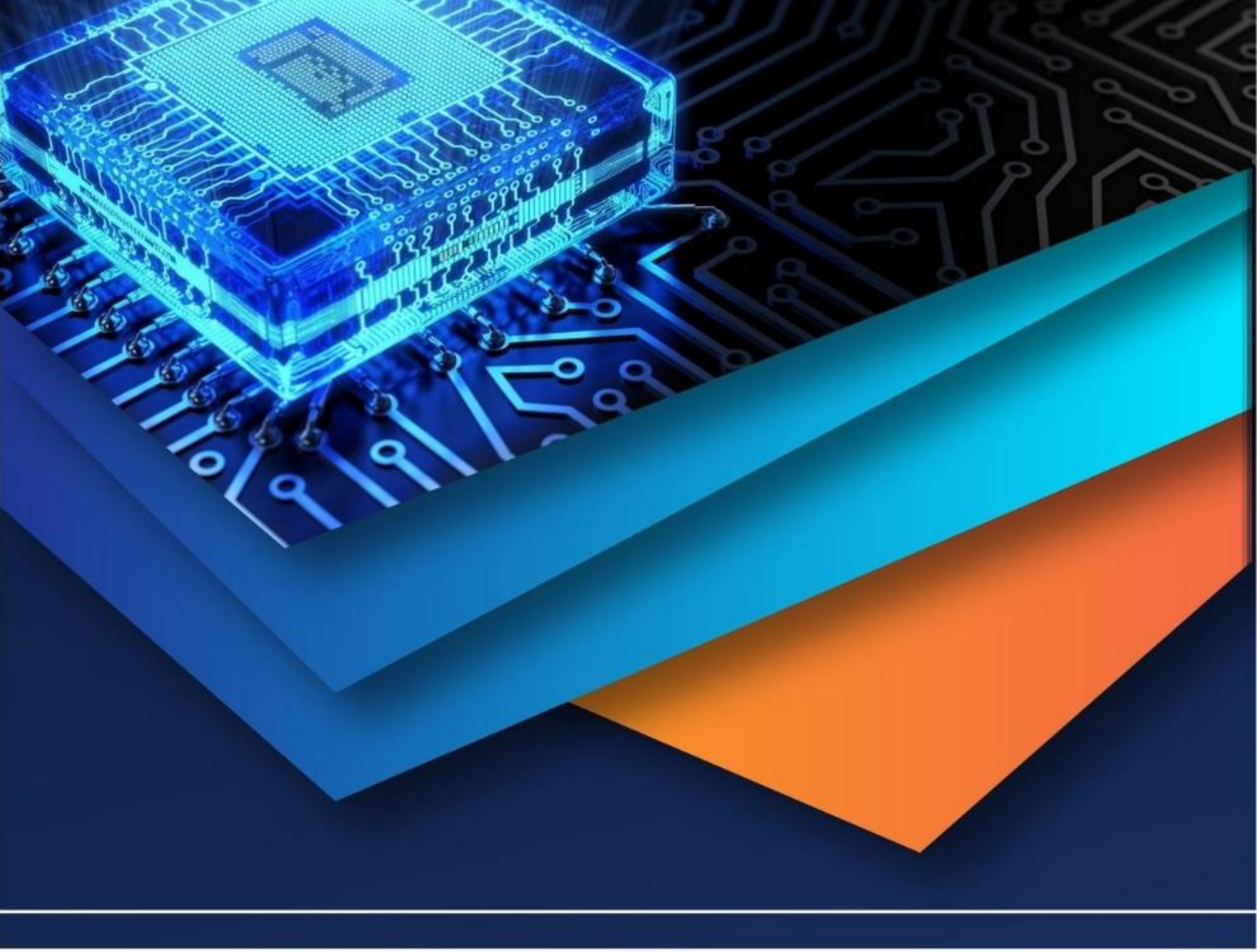

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