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A Survey On Human Identification Using Wi-Fi Signal

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Abstract: Human identification is a main issue for health monitoring systems in home. The common of current systems employ either wearable video or tags cameras to detect numerous residents in home atmosphere. However, because of the inconvenience and inflexibility of wearable devices, and potential intrusiveness of cameras, the adoption charge of those procedures remains lowest. A unique technique for human identification, that leverages Wi-Fi signals to enable on-intrusive human identification in domestic surroundings. It's depend on the surveillance that every person has specific influence patterns to the surrounding Wi-Fi signal while moving inside, regarding their body shape features and activity patterns..
Keywords: human identification; wi-fi; channel state information; device free human detection; frequency diversity

I. INTRODUCTION

For the human identification remains, anything that distinguishes individual person from another, e.g. tattoo, or a variation from normality, converts actual significant to the forensic team, greatly supporting the identification process. The teeth resistance and their supporting tissues, even to fire and decomposition, make them extremely useful for identification purposes. In the scarcity of ante mortem data, the forensic team investigates for alternative sources of reference, e.g. photographs and videotapes for personal features that may be identifiable at the postmortem investigation. Detection thru this technique is depend on the identical of the outline and positional relations among anatomical points on the face, and their locations on the skull [1].Human Computer Interaction (HCI) is a big area that comprise a lot of interested area and one of them is the human activity and gesture recognition. Traditional solutions that utilize human activity based on view analysis in an effort to recognize the movements of human body utilizing machine learning and computer vision approach have their limitations. We utilized two commercial off-the-shelf (COTS) Wi-Fi devices to known the human behavior [2] as demonstrate in Figure. (1).

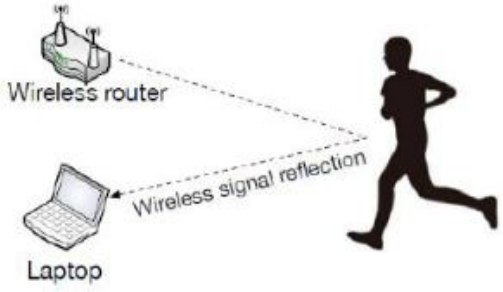

Fig.1 human identification

Human identification is the associating process a human with predefined identity, that's the key problem for a no. of applications, e.g. security, privacy, context- aware services, etc. earlier method comprise the customer inputting passwords or fingerprints to some sensors, or carrying some devices like RFID, or to be captured thru cameras [3]. Furthermore, the proper detection of patients when they walk thru the entry is a major problem today for all the hospitals about the world. Here is a substantial body of knowledge on recognizing subjects by their fingerprint, face, voice, gait, keystroke dynamics, hand, iris, or retina. The need of such features for identification (authentication) or verification purposes has been thoroughly explored in the end 30 years. However, in practice there are other properties that can severely limit the utilize of a special identification method. Over the previous few years, several works have explored the biometric make use of signals that, for different logic, have traditionally received little attention through the security community. Techniques for e.g., normalization, re-sampling or smoothing are commonly utilize measure during the pre-processing step. The general construction of a biometric identification system. The initialphaseinvolves of the data

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acquisition one or more signals take part depending on whether the system is mono-modal or multi-modal, respectively [4].

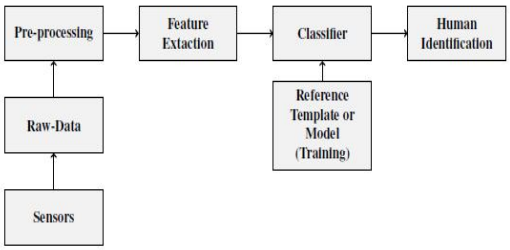

Fig.2 general structure of a biometric identification system

II. WI-FI

Wirelessly devices are everywhere - our homes, offices, shops restaurants and virtually entirely of our urban spaces. They invisibly fill the air with a range of Radio Frequency (RF) signals. While a person gaits through these spaces, they create a perturbation in this RF field. By closely examining these perturbations using the Channel State Information (CSI), it is possible to classify basic human activities for example standing, sitting, walking and running and even hand gestures and keystrokes typed on a keyboard. Everyone's natural walking style (i.e. gait) is unique which is characterized thru the changes in the limb (hand and feet) movement shapes and velocity. These patterns are also highly repetitive. We hypothesis is that an individual's step will thus create a unique perturbation in the Wi-Fi spectrum. Fig. 3 shows the spectrogram of the CSI data for two people walking through the same corridor (scenario depicted at the top of Fig. 3).

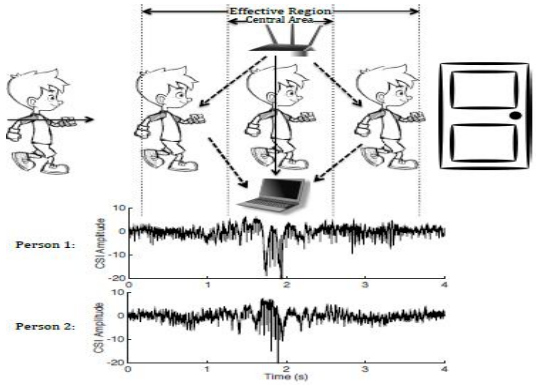

Fig.3 operational scenario for Wi-Fi id

The device-free and non-intrusive environment of this approach makes it an attractive substitute to traditional authentication approach i.e., cameras, microphones. Biometrics or physical objects (swipe cards, wearable tags, etc.). While a person walks, gait their impacts the atmosphere in a unique manner, which changes the result of these phenomena on the Wi-Fi signal [5].

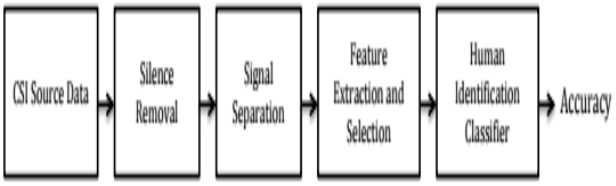

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Fig.4 overview of wi-fi-id system

High-resolution mobility of individuals and entire social systems can be captured thru a sensors multitude existing on phones, include GPS and sensing of close by Wi-Fi APs (access points or routers) and cell towers. Furthermore, large companies like as Google, Apple, Microsoft, combine Wi-Fi access ideas by GPS records to positioning, a practice known as `war driving'. As a consequence, it is usually not well-known how Wi-Fi networks can be utilize for mobility sensing on a societal scale; this information is exclusive to big companies. Here, we demonstration that a time series of Wi-Fi access ideas is successfully identical

to location records. Specifically, having collected both GPS and Wi-Fi data with high temporal resolution in a large study, we use six months of data for 63 participants to model how lowering the amount of position sampling influences the capability to infer mobility. By mapping the Wi-Fi records, we are capable to measure details of Wi-Fi-based position tracking, which are typically not available to the general public [6].

III. CHANNEL STATE INFORMATION

We our system uses metrics that are showing through Wi-Fi chipsets as part of normal operation and do not need any hardware changes, or changes in router-software. Wi-Fi communicates using Orthogonal Frequency Division Multiplexing (OFDM), meaning that it broadcasts on numerous closely separated at the same time subcarriers to increase data rate.

A. Wi-fi channel state information (CSI)

CSI denotes to channel state properties in wireless communications. CSI defines exactly how a sign propagates from the transmitter to receiver, and exposes a set of channel dimensions depicting the amplitudes and stages of each subcarrier as shown in equation (1):

$$H(f_k)\|e^{jsin(<H)} \quad (1)$$

Where H (fk) is the CSI value at the subcarrier with central frequency of fk, and $\angle H$ is the phase. In general, the receiver quantities and evaluates CSI, then makes feedback to the sender (a time-division duplex system often needs reverse evaluation). In actual application, CSI can be parts into instantaneous CSI and statistical CSI. Also, there is another classification as the CSI in the transmitter (SCIT) and receiver (CSIR).

Wi-Fi continuously monitors differences in the wireless network using CSI, which characterizes the response of the wireless frequency channel. Let X (f, t) and Y (f, t) are the frequency domain representations of transmitted and received signals, respectively, with carrier frequency f. The two signs are associated by the expression:

Y (f, t) = H (f, t) ×X (f, t), where H (f, t) is the complex valued channel frequency response (CFR) for carrier frequency f measured at time t. CSI dimensions basically these CFR values. Let NTx and NRx represent the no. of transmitting and receiving antennas, respectively. As CSI is measured on 30 selected OFDM subcarriers for a received 802.11 frame, each CSI contain 30 matrices with dimensions NTx× NRx. Each entry is a CFR value in any matrix b/w an antenna pair at a certain OFDM subcarrier freq. by an actual time. Therefore, the time-series of CFR values for a given antenna pair and OFDM subcarrier is called CSI stream. Thus, there are30 × NTx × NRx CSI streams in a time-series of CSI values.

B. Applications of Wi-Fi CSI:

Channel State Information (CSI) of the commercial devices are available in many wireless signal i.e., Intel 5300 and the Atheros 9390 n/w interface cards (NIC).This information has a big range of utilizations and applications in several regions such that the usage of CSI in the human activity recognition.CSI also utilize in indoor localization, human activity of falling, and the recognition of the existence of human in a room or building and even in the application of counting the no. of persons in a crowd. Other types of activity recognition applications by using particular directional antennas contain distinguishing the spoken words to attain the necessary CSI variations produced by lips movements during speaking. CSI can also be utilizing to identify in home daily activities by the E-eye system as example. Wiley, Wi-Vi, Wither, and Windrow are all just other examples of the versatile applications that make use of the CSI [7].

IV. DEVICE FREE HUMAN DETECTION

By the popularity of Wi-Fi, here are more and more applications developed using Wi-Fi signals, for example gesture and activity detection indoor localization, falling detection lips identification, and human detection. Wi-Fi signals based on channel state information (CSI) are considered for detecting human. CSI provides the channel response, including the magnitude and phase, for every subcarrier of a trans-receiver pair [8].

Beyond end-user-oriented fundamental access services, a noticeable growing trend from the literatures can be experimental that Wi-Fi signals begin to be deeply analyzed and exploited via extracting a sequence of features from signal measurements. The conventional Wi-Fi signal features include power, time and angle information [9].

Device-free sensing using Wi-Fi has exposed great potential in such scenarios; however, a fundamental question of human identification has remained unsolved. We evaluate with using tests at multiple locations with a total of 20 volunteers, and demonstration that it can detect a person with average accuracy of 92% to 80% from a group of 2 to 6 people respectively. In most cases walking as rare as 2-3 meters is sufficient to recognize a person's gait and detect the person. We discuss the potential and

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tasks of Wi-Fi-based human identification with respect to smart space applications**.** Human identification using Wi-Fi is areally challenging problem. Our objective in this work is to utilize the existing Wi-Fi infrastructure to allow pervasive, low-cost deployment of smart spaces. It also provides privacy compared to improved identification through audio/video monitoring which can also track other private activities of the person.

We believe that such accuracy is reasonable for smart space applications (homes and offices) where primary purposes of identification are convenience and entertainment. We provide measurement-based evidence that channel state information between two Wi-Fi who can identify a person with average accuracy of 92% to 80% from a group size of 2 to 6 people respectively. In most cases, it only requires a person to walk for less than 2-3 meters in order to get identified based on the gait analysis. We discuss the potential and limitations of such Wi-Fi based person identification from the perspective of smart space applications.Fi endpoints can be used to detect walking steps of a (device-free) person. Recent works have established that step can be used as a biometric signature for person identification. In authors usage video cameras to record people walking and extract gait information from the video record [10].

V. FREQUENCY DIVERSITY

In wireless communications, multipath propagation reasons frequency-selective fading of wideband signals. Various forms of frequency diversity can be utilized to battle this effect. For instance, by means of coded orthogonal frequency-division multiplexing (OFDM) an error-correction code effectively averages over strong and weak sub channels. These frequency diversity effects are numerically studied in this paper. The difference between the average capacity and the outage capacity is originate to decrease with the square-root of a diversity order that is given approximately in the ratio of the signal bandwidth to the coherence bandwidth of the capacity [11].

Basically, the main purpose of using diversity is to improve the reliability of the analogue or digital message content in radio connections. To attain this there are several methods to distinguish between the multi-path signals. Common base of the concepts is too distinct the multi-path signals as individual channels experience different levels of fading and interference [12].

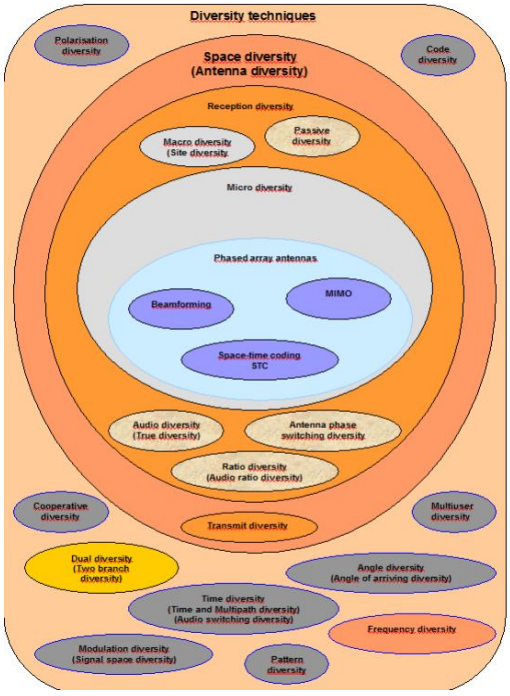

Fig.4 frequency diversity techniques

Diversity schemes offers two or more inputs at the receiver such that the fading phenomena among these inputs are uncorrelated If one radio path undergoes deep fade at a particular point in time, another independent (or at least highly uncorrelated) path may have a strong signal at that input If probability of a deep fade in one channel is p, then the probability for N channels is pN [13].

VI. LITERATURE SURVEY

Nawaf Y. Almudhahka (2016) et al., they define human identification utilize comparative facial soft biometrics on a larger and extra realistic scale using 4038 subject from the View 1 subset of the LFW database. Furthermore, they define a novel set of proportional facial soft biometrics and examine the effect on these identification and verification performance. Our experiments demonstrate that by use only 24 features and 10 comparisons, a rank-10 identification rate of 96.98% and a verification accuracy of 93.66% can be achieve [14].

Tong Xing (2016) et al., in this paper, they suggest an original method for person detection, which leverages Wi-Fi signs to allow non-intrusive human detection in domestic environments. It is situated on the examination that every human has specific influence patterns to the surrounding Wi-Fi signal as moving indoors, regarding their body shape individuality and movement patterns. The power can be captured thru the Channel State Information (CSI) time sequence of Wi-Fi. Specifically, a mixture of Principal Component Analysis (PCA), Discrete Wavelet Transform (DWT) and Dynamic Time Warping (DTW) approaches utilize for CSI waveform-based human identification. They implemented the system in a 6m*5mhome recruited and environment9 users for data collection and evaluation. Experimental results demonstrate that the identification efficiency is approximately 88.9% to 94.5% when the candidate customer set modify from 6 to 2, showing that the defined human detection technique is effective in home environments [15].

Jin Zhang (2016) et al., We present Wi-Fi-ID, a device-free system that uses off-the-shelf equipment to exclusively identify persons as they walk through urban spaces that are filled with Wi-Fi transmission. Our system exploits the detail that every individual has a unique walking style which causes unique disturbances within the Wi-Fi signals. Wi-Fi-ID analysis the Channel State Information and extracts exclusive features that permit us to identify individuals. We resolve show a performance model of our system and use conference attendees as test subjects [16].

Minh-Tuan Nguyen, Guo Shiang Lin - (2016) in this paper, they proposed a vision-based human detection technique for unconstrained images. The proposed way is composed of two parts: feature extraction and person identification classifier. After human detection, color and shape information is adopted for person identification. The main color characteristic is to measure the color information from some interesting points within the moving person. The directional swing distance is used to measure the change of body shape while walking. A SVM classifier with these features is trained to recognize persons. The experimental results show that the proposed system can achieve person identification well [17].

Assadi, A. Charef (2015) et al., The aim of this paper is to present a person identification method and frequency features of the QRS complex with sometime of the ECG signal. They features are extracted from a fractional order representation of the freq. content of the QRS complex besides of its temporal area. The K-Nearest Neighbors (KNN) classifier is used for person identification by the proposed clustering features. Tests of Series have been achieved to assess the proposed identification algorithm using 20 subjects from the MIT-BIH arrhythmia database [18].

Qiang Lin, Yuan Yue (2015) In this paper, they afford a review of existing works that were done for detecting human motion indoor thru classifying these research efforts into these categories according to the used of wireless signal features. Specifically, they define the Wi-Fi signal features that are frequently intended for device-free detection of person mobility in indoor environments, including RSSI, CSI and TOF. They can separate existing work into three categories according to these wireless signal features. A fixed of potential applications that can be achieved within this new open research area of device-free passive human mobility detection will be proposed. Finally, they discourse existing research tasks and point out possible research directions [19].

Bo Tan (2015) et al., This paper presents a Wi-Fi signal based wireless sensing system that has the ability to detect diverse passives indoor human movements, from entire body motions to limb movements and breathing movements of the chest. The actual time signal processing is utilize for human body motion software and sensing, defined radio system are described and verified demo in practical experiments scenarios, they include recognition of through-wall human body movement, hand gesture or tremor, and even respiration. The experimentation results offer potential for promising healthcare applications by means of Wi-Fi passive sensing to monitor daily activities, in the home together data health and detect emergency situations [20].

Weijun Qin(2013) et al., In this paper, they suggests an enhanced Wi- Fi channel detection and selection method to switch the best channels automatically to aggregate the Wi-Fi messages based on channel data transmission weights, and human presence activity classification method built on the features of person dwell duration sequence in order to approximation the user engagement index. By organizing in the real-world office environment, they create that the performance of Wi-Fi messages aggregation of CAOCA and

CACFA algorithms is over 3.8 times than the worst channel of FCA algorithms and approximately 76% than the best channel of FCA algorithms, and the human presence detection rate reaches 87.4% [21].

Mikkel Baun Kjærgaard (2012) et al., This paper addresses the combined identification of the movement indoors of multiple persons forming a cohesive whole - exactly flocks – with clustering methods operating on three different feature sets resulting from Wi-Fi signals which are comparatively analyzed. Automatic detection of flocks has several important applications, including social and psychological sensing and emergency research studies. We usage a dataset comprising 16 subjects forming one to four flocks walking in a building on single and multiple floors. For the detection of flocks they accomplished an average F-measure accuracy of up to 85 percent. They report on the advantages and drawbacks of the three different types of feature sets considering their suitability for usage "in the wild" or in well-defined environments [22].

VII. CONCLUSION

Human identification plays a significant role in human-computer communication. There have been many techniques for human identification (e.g., gait recognition, face\ recognition, etc.). While this technique could be very helpful under dissimilar circumstances, they also suffer from some shortcomings (e.g., customer privacy, sensing coverage range). We utilizing Wi-Fi signals to detect some human mobility behaviors e.g. walking, stationary, or running. The main aim is to successfully detect these activities for the individuals and depend on that enable detection of the crowd's overall mobility performance.

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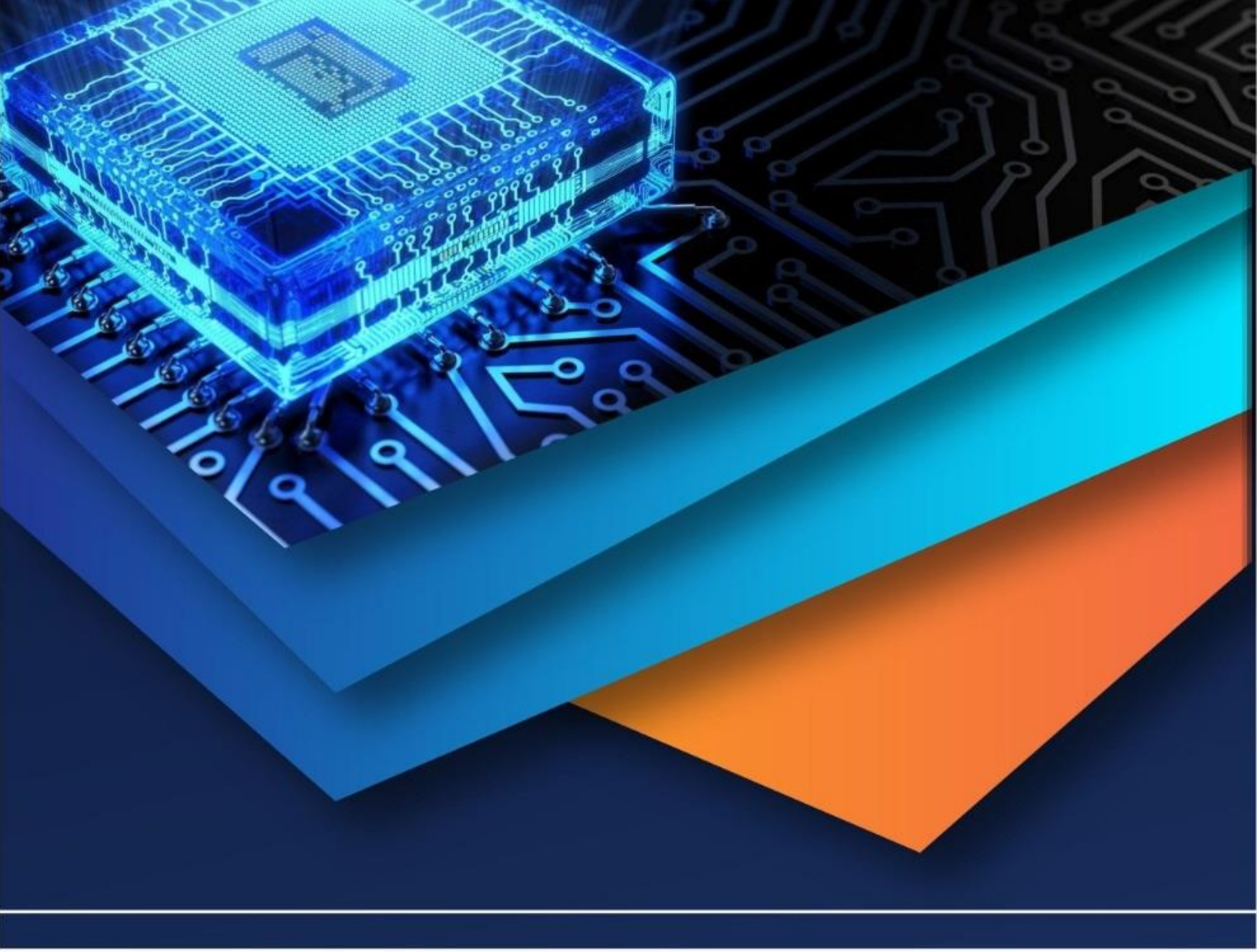

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