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Human Activity Recognition Using Smartphone and Smartwatch

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Abstract: ***Human activity recognition has many applications in medicine System of research and surveys among people. The recognition of human action has sparked great interest in both industry and academia in recent years. due to the widespread use of sensors such as accelerometers and gyroscopes in products such as smartphones and smartwatches. Activity recognition is currently used in various areas where it is valuable Information about the person's functional abilities and lifestyle is needed. We can do this using multivariate analysis of covariance (MANCOVA). found a statistically significant difference between the data generated by the sensors integrated into smartphones and smartwatches. This is how we show that smartphones and smartwatches Due to where it is worn, the does not record data in the same way. We have implemented several neurons network architectures that classify 15 different manual and non-manual activities. These models include long-term memory (LSTM), convolution neuron Network (CNN) and Convolutional LSTM (ConvLSTM). The models developed worked better with the watch Data from accelerometer. We also saw that the classification accuracy was achieved with the convolutional input (CNN and ConvLSTM) is found to outperform the full LSTM classifier. Additionally, the watch accelerometer CNN model was able to better classify non-wrist-facing watches. tasks compared to manually executed tasks***

Keywords: Human Activity Recognition (HAR), KNN, CNN, LSTM, EDA, Convolutional LSTM (ConvLSTM), Deep learning algorithm.

I. INTRODUCTION

The demands to understand human activities have increased grew up in healthcare, particularly senior care Support, Rehabilitation, Diabetes and Cognitive Support. Disruptions. A lot of resources can be saved whether sensors can help nurses record and monitor patients constantly and report automatically when there are any Abnormal behaviour was detected. Other applications like the people measurement system and location indicator are all present benefited from the study [1,2,3]. Many studies have been successfully completed very low value activities were identified using wearable sensors Error rate, but most of the above work is done. in laboratories with very limited environmental conditions. Readings multiple sensors attached to the body ensure a low error rate, but its complicated environment is not practical. Human Activity Recognition (HAR) is the challenge of recognition of a physical activity carried out within a environment specified by a person based on a trace of movement. HAR in an automated way is fundamental in many cases ambient intelligence applications such as smart homes, health monitoring, help requests, emergency. services and transportation assistance services. Is predicted that intelligent environments communicate with disabled or elderly people according to their specific needs, will be a corresponding fraction of daily life in the short term. Given this, the global increase in the proportion of older people is certain Significant in, the aging of the site was of utmost importance. The economic consequences of international senility can be was tempered by encouraging surpluses to remain energetic and stable in their homes for many years, where they live freely is more normal and calm. Unfortunately increasing elderly people make it impossible for all households seniors will be assigned a human caregiver if needed. to manage health itself in collaboration with healthcare.

II. LITERATURE REVIEW

Recently, various studies have revealed this information integration strategies integrating different sensor systems or algorithms to increase value, reliability and build trust Measures across different algorithms and reduces problems with identification system to solve the problem connects to each person's proximity sensor and support Total. smart watches became popular market and this trend is expected to continue technological advances. Studies show that more than 80% do. hourly users reported access to better health and medical care service is a significant advantage of wearable technology. There are many studies on HAR in the literature. for mobile phones and more recently for smartwatches. Smartwatch offers a host of features and more is a trusted user because it is usually assigned to the user's security (e.g. In both cases the is worn on the left or right clothing options.

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That's why smartwatches offer: options to securely access performance information You can make mobile phones that you can use people conducted research on motion-sensing smartwatch is the ability to integrate deep learning into wearable devices. Smartwatch shown to be controlled by GPS may be concerned with the implementation of the learning process. The wristwatch system is extremely reliable for normal daily activities such as walking, internal/external and public data sets. The modern way to persuade phone functions and wearable sensors, functions representation technique is used effectively downloads and selections made Effective use of domain expertise. This However, feature extraction is performance-based[9]. It is not transferable in the same way as a or application. Ethics Also well-designed feature vectors Difficult for to analyse data for complex and demanding operations takes a long time to download. in many ways because multimodal integration and mixing decisions are known to achieve different and simple functions Recognition of human activity is recognized in a different way. [10] But problems were related to good coordination The technique still exists and affects overall access and reduces phone processing time, with wear sensor connection.
This section illustrates how the classification process was done. Figure 1 shows the fundamental framework of human activity recognition process.

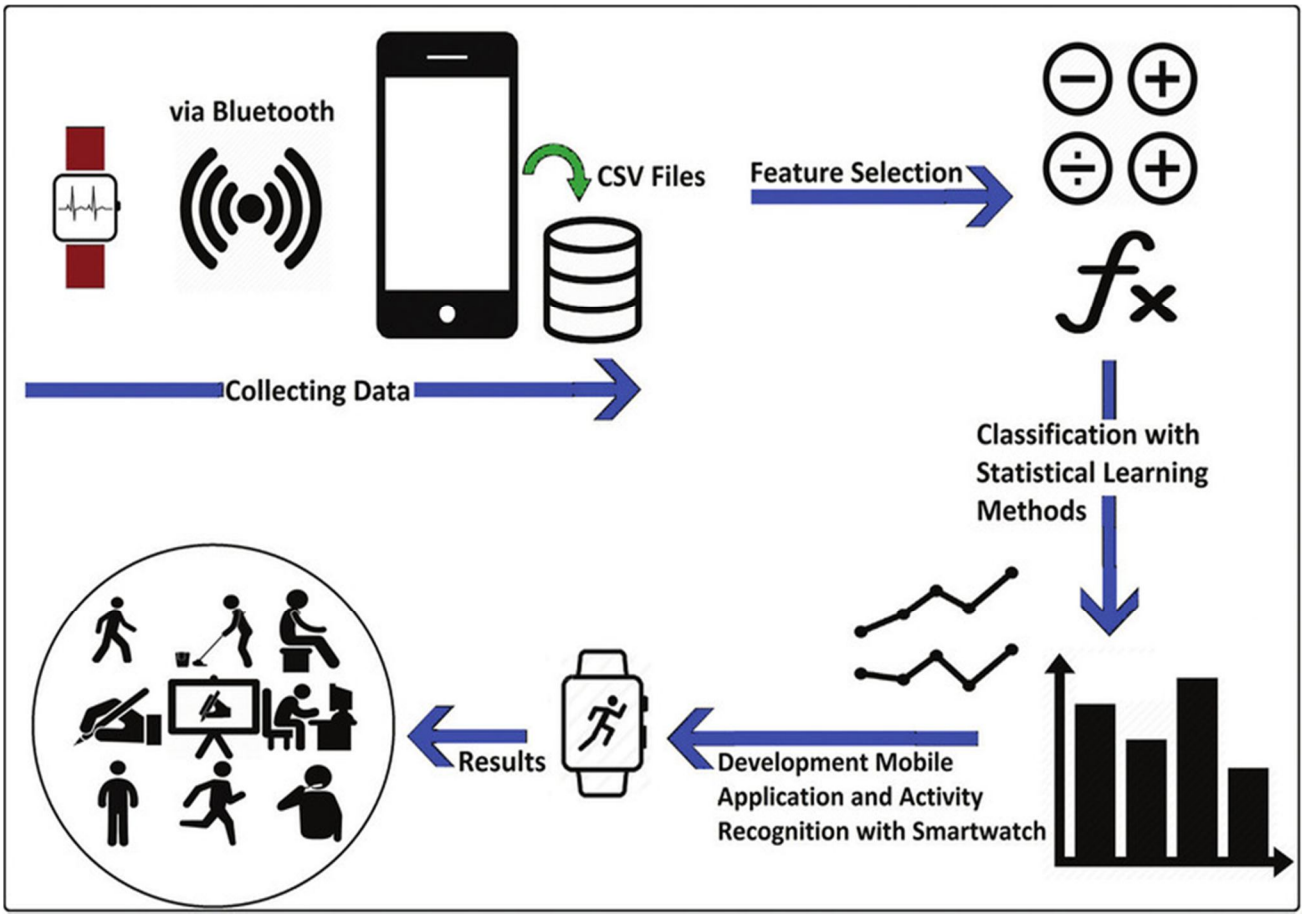


Fig. 1 Basic Structure of human activity recognition process.[13]

III. SYSTEM APPROACH

To the best of scientific knowledge modern methods developed in this section, for inertial sensors to reach people Disclosure of Activity. The important contribution of this activity is an integrated smart android watch. Additionally, system components are also used. For convenience the is connected to a phone results for recognition of human activity, The biggest obstacle is availability System: Perfect personal phone repair body. This is actually not a practical solution as a user. sometimes wants to work on the phone means you will answer the phone from different locations and was made on a grand tour. This manoeuvres affecting the inertial sensor matching measurements can then be produced results for reporting inappropriate activity. effect, distributed systems are integrated using smart watches The phone is attached by placing the on the user's leg, and the user in any location and orientation.

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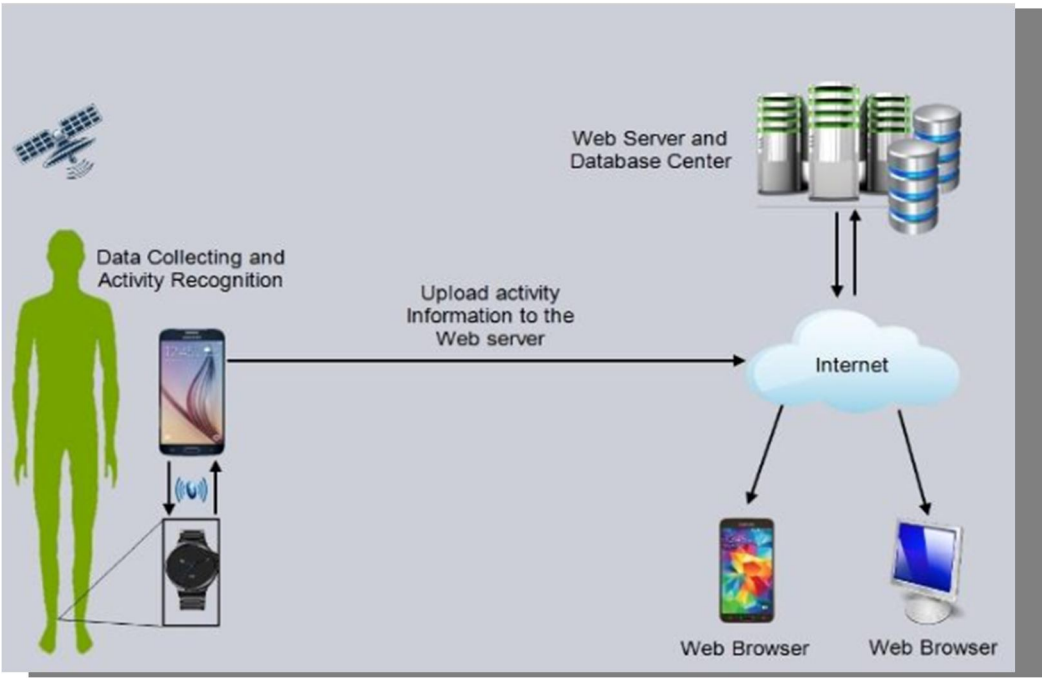


Fig. 2 Overall system structure

IV. DATA COLLECTION

Collection of data component integrated into smartwatch and smartphone in smartwatch to collect data from the smartwatch's sensors while you are indoors phone to collect GPS data. Smart watch is being collected data comes from its sensors every 20 ms. Then sample parameters were selected to perform many different research tests times to get the best clarity suits all applications to achieve minimum throughput load and deflection/general factors.

V. CLASSIFICATION

As a result of its use, a smart watch is placed on the person. legs of the body to see the differences and differences basic information about smart electronics, categories A boundary-based approach was used in this study describes human activities. so download the content class separates the main features of each window according to the approved program of each class human activities. Items are removed from every window The amount of (for smart watch) was sent to the phone via. Bluetooth, targeted application. The known human activities for this activity are: Walking (slow, normal and fast), jogging, running (slow, fast and run), walk up and down, up and below, seated (full or semi-fixed), Seated or Standing (fully or partially standing) and Horizontal of them (left, right, abdomen and back) actually because paper borders, examples of human action categories are discussed and analysed in detail next section. recommended

VI. DEEP LEARNING ALGORITHMS

Deep learning algorithms like Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN) are commonly used in smartwatches for human activity recognition. These algorithms can learn complex patterns and features from the data collected by the smartwatch sensors. Decision Trees: Decision trees are also used in smartwatches to predict human activity. Decision trees can classify activities based on the features extracted from the sensor data. They can handle both numerical and categorical data and are relatively easy to interpret. Random forests are an ensemble of decision trees that can improve the accuracy of the classification. They can handle a large number of features and are less prone to overfitting.

VII. SUPPORT VECTOR MACHINE ALGORITHM

Support vector machines are very simple and powerful prefers algorithm because it offers more and less accuracy COMPUTING power. Support vector machine algorithm the goal is to define the hyperplane in N-level space. (N number of functions) different practical information.

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The data was first divided into training and testing data, 70% of the data was used for training, 30% for the rest was used for testing. Finally, the SVM model was created. Since that time SVM is a binary algorithm,[8] which is one of the strategies used to reduce the problem of classifying many classes into many classes binary sorting problems, one against each strategy. This skill involves learning one lesson per class. and grade level are good examples and The remains a bad example. Condition allows are field classified to provide real-time results for their results certification rather than just a class label. Bayesian distribution was used to develop SVM classifier using Fitcsvm function and Optimize Hyper parameter name-value pair.

VIII. K-NEAREST NEIGHBOUR ALGORITHM

KNN is a powerful technique that can be used for replication There are simple actions. KNN is a classification tool works as a direct sorting method but this is not the case It accepts working methods. KNN takes it into the unknown something calculates number based on k value immediate neighbour. KNN algorithm works concept of convergence (gap) in education Classification of datasets and new samples. Distance of the test neighbours were identified by location similar performance data such as distance Euclidean functions. An anonymous sample will be classified is the most common class in the immediate area. [11]Open first the data is divided by 70% as in the pre-training part data and 30% tests, then the KNN algorithm was created to apply the new observations from the tests Value k was one.

IX. WALK, JOG AND RUN

Smart watch with accelerometer and gyroscope sensors used to organize walking, jogging and jogging activities other functions like scroll up/downward static, as follows: 1-The diagram shows the basic information of the smart watch the has a flexible three-axis transmission window size function. Shown when the velocity of the x-axis is perpendicular to the Earth. and the user's foot is on the ground, so the x-axis The value of acceleration is approximately 9.8 m/s2. (±0.7 more or less than 9.8 m/s2) shown for the first time Periods 1 to 10 in the diagram are Periods 11 to 10 are 50 users got off their feet for this reason is represented by distinguishing marks approximately 4 m/s2 to 20 m/s2. Currently. [12]The axis is no longer perpendicular to the Earth, and User lifts his feet off the ground gives different values on the x axis depending on x axis angle to ground and line acceleration of the user's foot. In successive cases from 51 to 66 and 67 to 108, almost the same the mentioned above is repeated while on the user's foot down is when the user lifts their foot From places. This method was used to differentiate in this study. the user's foot is lowered or raised. Another Signal separations on y-axis and z-axis do not provide correct interpretation system is enough to use It reported reporting activities. Because, achieves high accuracy in centre discrimination Walking, jogging, jogging and other activities goes up/down, it really does unique and distinctive features Time is the time when the user lifts his foot lands.

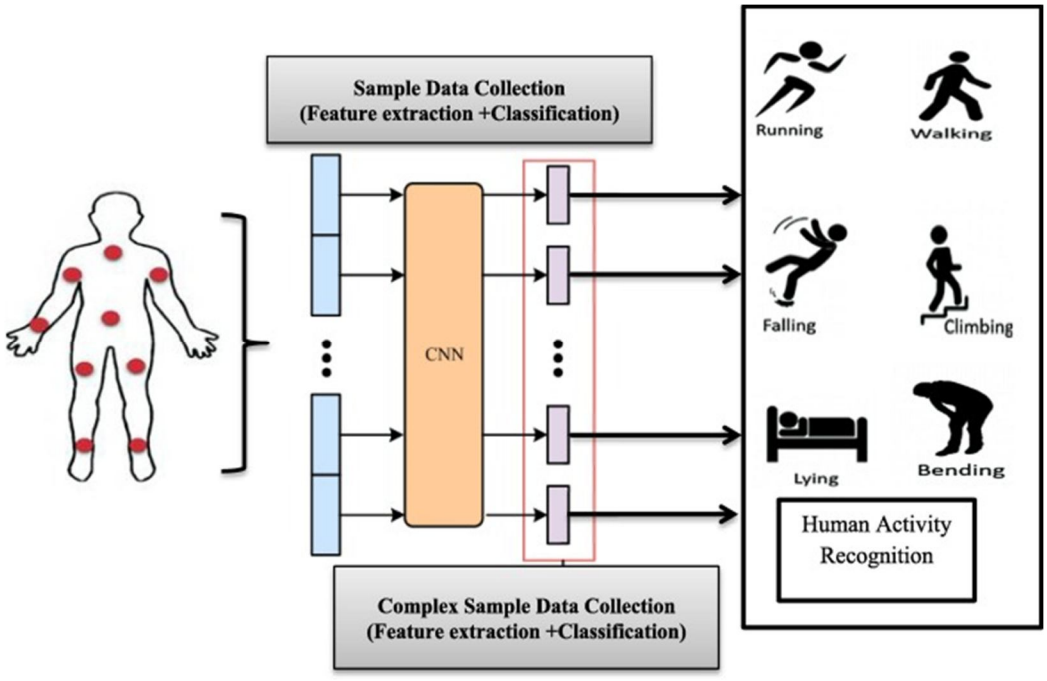


Fig. 3 How system apply algorithm after data collection

X. SMARTWATCH ROLE

In fact, most of the work is done in this area, to disclose human activities and approved procedures with single phone or combination phone external sensors. This method covers: difficulties and obstacles that hinder them access to a simple and comprehensive system. This issues were analysed and justified as follows:

1) Identification of human activities due to the change of nature and direction of the phone system does not work properly when I try smartphone is held freely in the user's hand or There is in the bag, as many women do.
2) Finding it somewhat different hallmarks of smartphones, all connected vacant positions published bans phones from being brought into a setting fixed positions in the human body, e.g. in your pocket or on your chest. This The limitation also has the following disadvantages flaws: a- Sometimes the user wants to use phone number for calling, delivery internet, social media, social media, weather detection, camera and more transfer Smartphone is installed from the first position Misinterpretation of phone sensor connections due to phone changes locations and directions. b- There is no smartphone in the pocket silent and some changes aspect due to type differences outfits. Moreover, most bags is too small to avoid The smartphone will change the location and user time tips.
3) Activity reporting system does not work is good and solid for one job one people unintentionally turn off their phones is usually on the table when it comes to scuffle Make it or Break it Main contribution of this study Within the scope of Android smart watch installation System components. A practical test shows that this is the case found a smartwatch implanted in someone's leg. Theis an excellent outdoor vehicle to use. For convenience the is connected to a phone results for human activity recognition. Reason: good reasons to use a smartwatch as part of the proposed system for comparison for a standalone phone or extension phone unique sensors discussed below:1- Smartwatch contains some hardware is not available on most phones like sensors barometer sensor used in this process upward mobility and downstairs, and heart rate sensor that can be used for heart rate checking. [13,14,15]

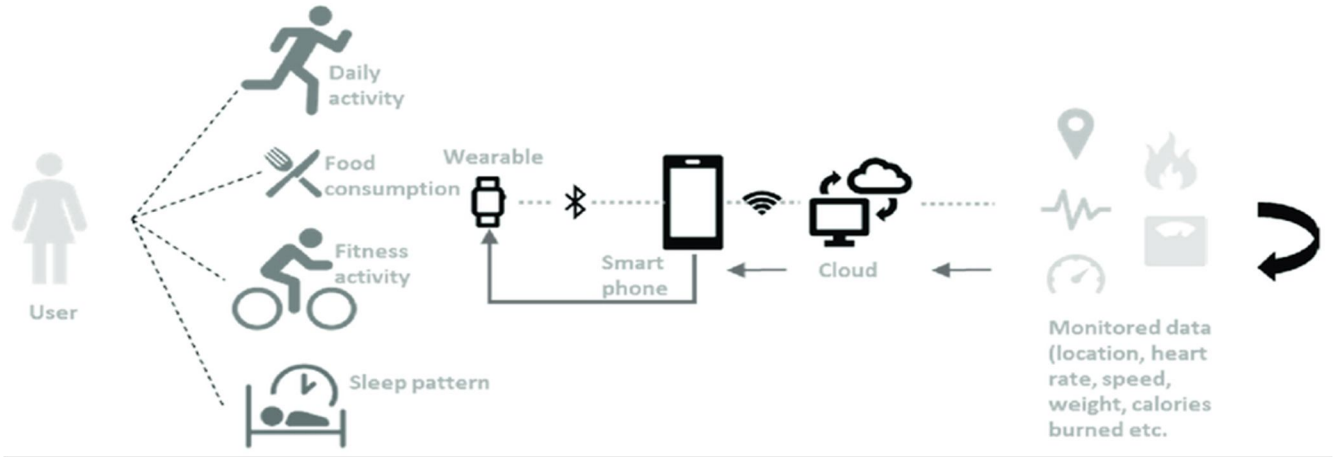


Fig. 4 Proposed System Design

XI. CHALLENGES

During system analysis and solutions control of human activity identification system, The has some unexpected features occurs during recognition. In addition, also has other features such as window size and sample rate that also affects a person's beliefs Reporting system. These are things is explained below:

1) Effect of category human activities are the completion of activities views in one window. That part happens of the operating system is found in a specific window Another item is available in the next window. Inside In other words, it is not necessary for the action to begin starts of each window. For example exercise activities, a small selection of exercise activities There are currently different signals available in the current window Below is most of the signal separation window where the user starts navigating high performance. Therefore, due to the consequences movement signs are different, last window can be removed misquoted as movements. That's why sometimes it's very difficult to reach 100%. Although is different and separate, it can be ordered easily features were found in the sensor. Actually it is impossible to match the beginning and end of each activity durations and the start and end of each window Size Again when the user switches between There will be different functions, then it is possible for reduced class classification.

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2) Select the area suitable for the window size is an important issue because there are many pros and cons when increasing or decreasing its duration window size:

a) Change of action in a short time times (below window size) The 's ability to conduct such operations has been reduced or vice versa when you increase the window size.

b) Facts about human actions will be possible increases as you increase the time window Size as it will be sufficient and clear is available and vice versa.

c) The number of storage units will decrease and when increasing the time window size level-3 Heading: A level-3 heading must be indented, in Italic and numbered with an Arabic numeral followed by a right parenthesis. The level-3 heading must end with a colon. The body of the level-3 section immediately follows the level-3 heading in the same paragraph. For example, this paragraph begins with a level-3 heading.[16,17]

XII. CONCLUSION

Human activity recognition has a wide range of applications medical research and human research systems. In this project, we created a phone recognition system. knows five human activities: walking, limping, running, goes up and down. System compiled the series has a built-in high speed motor function in both time and domain fields Reduced the size of features to improve functions. Trained and tested using functional data 4 fast learning methods: quadratic classifier, k-approximation neighbours' algorithm, support vector machine and artificial intelligence channels.

During the study and development of human activities Many points were also taken into account in their cognition system found:

1) It was observed that the system would work and it was concluded. Necessary and mandatory to do well to see the characters of different characters of phone sensor is 3-axisgears and gyroscope. As an answer, all comparable systems banned phones are processed in the human body.

2) It is not permissible to place the phone on the human body. Theis practical and not a definitive solution for this system performance is also often a moving part may affect the signal different phone sensors.

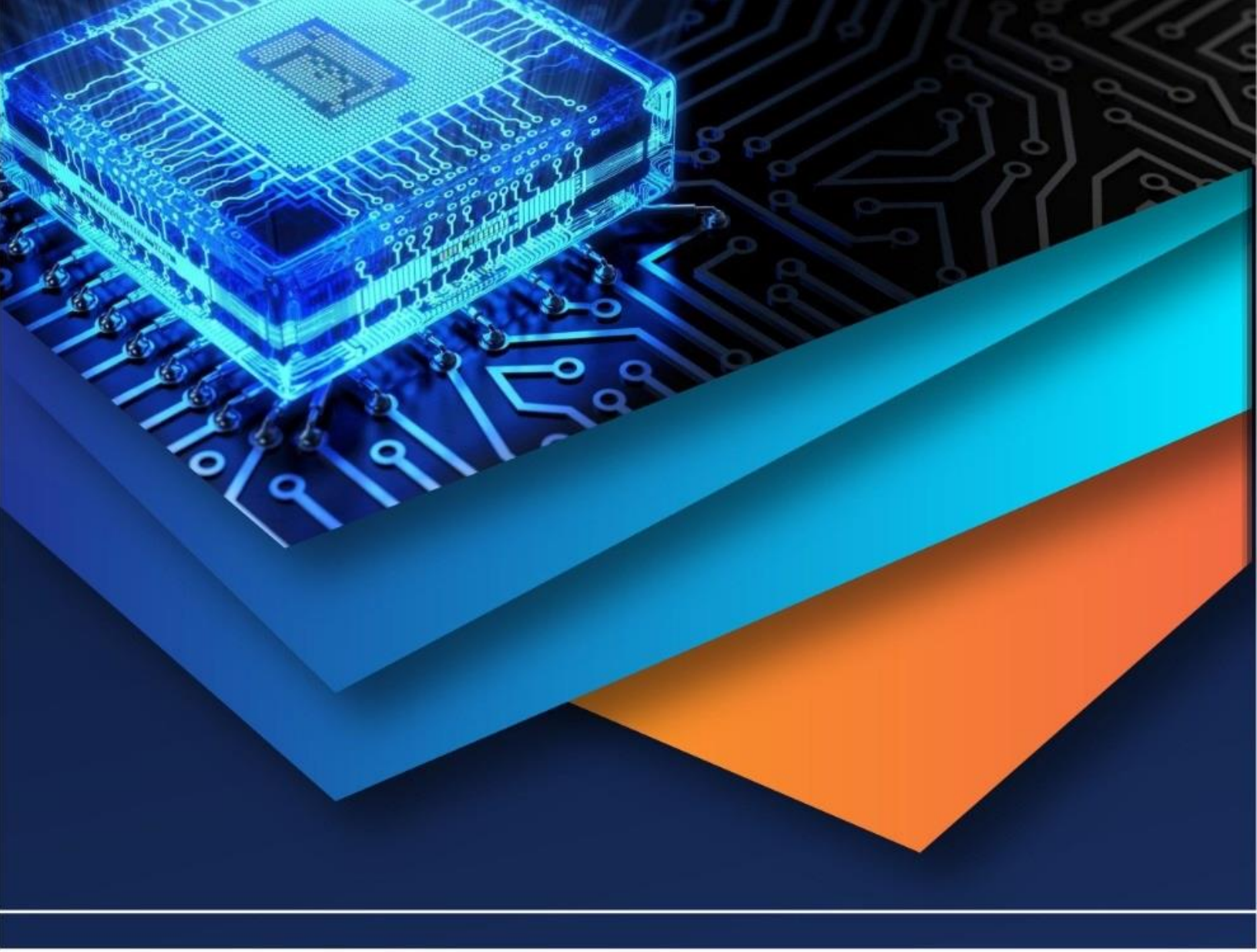
3) Therefore, connect the smart watch (fixed)posted on personal lines) and phone numbers as the main reason for public access is a separate article for a wide range command with high accuracy.

4) Defeat evil for future actions constants derived using a variable window size the size of can be examined and taken into account Such a system prevents double interference functions in window size.

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