

EXPERIMENTAL EVALUATION OF BIOMETRIC IDENTITY BASED ON THE INTRA-BODY COMMUNICATIONS CHANNEL

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ABSTRACT

Wearable sensors as well as methods are quickly being used as ways of augmenting as well as enhancing health care services. To be able to offer a cable free biomedical monitoring system, new wireless technologies connected with sensor apps have been marketed as the following biomedical revolution, promising a major enhancement in the quality of health care programs. Still the size and power needs of wireless sensors that are generally dominated by the RF aisle of the associated transceivers, have limited the adoption of theirs, resulting in increase in Intra Body Communication (IBC) devices where information transmission is actually carried out throughout the body (mostly skin layers), instead of via air.. Radio Frequency (RF) front side ends, because every individual node are actually replaced with simpler interfaces leading to lower energy and decreased area. With this paper, we suggest as well as validate making use of the Intra body communications channel like a biometric identity. Combining experimental measurements collected from 5 subjects as well as 2 multi layer tissue mimicking materials' phantoms, various machine learning algorithms had been utilized as well as compared to evaluate as well as validate making use of the channel qualities as well as functions like a biometric identity for subject identification. An accuracy of 98.5 % was achieved, together with a precision as well as recall of 0.984 as well as 0.984, respectively, when testing the styles against subject identification above outcomes collected from the entire samples. To us a portable and simple setup, this particular effort shows accuracy, reliability, and the feasibility of the suggested biometric identity, allowing for constant identification as well as verification.

Keywords: Body Area Networks; Channel Gain/Attenuation; Channel Modeling; Galvanic Coupling; Intra-Body Communications; Phantoms; Tissue Mimicking Materials; Ultralow Power Systems.

1. INTRODUCTION

1.1 INTRA-BODY COMMUNICATION (IBC)

Intra-body communication (IBC) is actually a technological innovation with the conductive qualities of the body to transmit signals, therefore offering a novel communication technique among wearable sensors in body sensor networks (BSN). In contrast to existing short distance wireless technologies, like Zigbee and Bluetooth, IBC engineering has the positive aspects of higher reliability, high speed, decreased usage, and security. Being a result, real time biomedical monitoring could be attained by surface mounted as

well as implantable biomedical units using IBC know-how. The other crucial program of IBC engineering is the fact that 2 people are able to exchange information by shaking hands with no complex operations. With this application, when 2 people shake hands, one individual can instantly develop the other's energy business cards with the handshake channel. Additionally, IBC technologies likewise can certainly be utilized for transferring multimedia data, creating man ad hoc networks, as well as providing an assistance process for handicapped individuals.

Intrabody communication (IBC) methods make use of the body as being a transmission medium for electric signals to interconnect products in wireless body region networks (WBANs). These units could be both on body and implanted (in body) and speak with one another and with a main unit via lower energy usage as well as minimal data fee body routes. These backlinks connect 2 on body products, 2 in body products, and also an on body with an in body unit, as discussed in Figure one. These units are actually both sensors that history as well as process physiological variables of interest as well as actuators that receive info and produce some response type, for instance, electric drug driving pumps. Te main unit, which coordinates as well as manages the functioning of the network, transmits information with an external long distance link to a medical decision facility for evaluation. This particular link is generally implemented with Wireless Local Area Network (WLAN) requirements, which support larger quantities of information. By doing this, this main gadget acting as an outside gateway supports the bigger transmission energy in the network, therefore reducing the energy usage of the majority of the sensors as well as actuators

Intra-body communications could be classified into 2 primary types; capacitive coupling (near field coupling method) along with galvanic coupling. For capacitive coupling, just the signal electrodes of the receiver and also the transmitter are actually connected to the body as the soil (GND) electrodes are actually left hanging in the air. The conductive body forms the forward path as the signal loop is actually closed from the capacitive return road between the transmitter as well as the receiver's GND electrodes. The next strategy, which is determined by the galvanic coupling principle, utilizes a pair of electrodes for both the receiver as well as the transmitter to propagate the electromagnetic wave. The signal is used more than 2 coupler electrodes as well as obtained by 2 detector electrodes. The coupler establishes a modulated electric area, which is actually sensed by the detector. Thus, a signal transfer is actually started between the coupler as well as detector devices by coupling minute signal currents to the human body. In both solutions, it's been found that the attenuation of the body channel can get so much less than that of the air channel of frequencies up to hundred MHz. An appealing attribute of the galvanic coupling strategy would be that the signal is completely restricted to the body, unlike capacitive coupling in which the signal return path is actually started throughout the air. Galvanic coupled signals encounter little interference from various other electronic devices, enabling secure and robust details exchanges. For that explanation, the galvanic strategy is actually used by

the authors as the technique of preference for applying the proposed system.

1.2 IBC AS A BIOMETRIC IDENTITY

In this product, the arm was simplified to the 5 major layers earlier mentioned: bone marrow, cortical bone, skin, fat, and muscle. The unit took into account system components, as the electrodes utilized, and also biological elements, as the age as well as body mass. Since the gain profile obtained utilizing the unit showed excellent fit with experimental outcomes previously reported in the literature, the authors adopted the product for the gain/attenuation computations. Outcomes based on such calculations show the way the body's actions as being a signal transmission channel depends on various characteristics, both geometrical and biological, and it is hence unique to each individual. A benefit for making use of this suggested biometric with the traditional biometrics presently used, as the fingerprints, is the fact that it is able to offer continuous and periodic identification/authorization without any essential attempt from the individual and the 2 nodes are able to communicate for re authorization seamlessly and periodically to the user.

1.3 INTRA-BODY COMMUNICATION METHODS

- **Radio Frequency (RF)** We 1st discuss the salient characteristics of narrowband (NB) and ultra wideband (UWB) channels. At this point, the RF transceivers, in the type of implanted sensors, speak by emitting electromagnetic waves in frequencies that are different,
- **Ultrasound** Mechanical waves that propagate in frequencies above twenty KHz (the top limit of human hearing) are also referred to as ultrasound waves [twenty six]. Ultrasound has been utilized extensively for underwater communications as a result of effective propagation through press composed of mainly water. Because of this, advocates the usage of ultrasound for IBC since the human body consists of sixty five % water.
- **Capacitive Coupling** Coupling techniques in common are actually based upon the big energy transfer between a set of receivers as well as transmitters to create an electric signal that propagates from the human body.
- **Galvanic Coupling** Like capacitive coupling, galvanic coupling is actually a technique which uses the human body as a channel to propagate the power signal developed by a pair of coupled electrodes. The distinction between this

strategy and CC, would be that the alternating current is coupled within the body rather than in between the environment as well as the body.

- **Resonant Coupling** Resonant Coupling utilizes the attributes of electromagnetic resonance to make a magnetic field throughout the body. RC is used to produce a near field wireless transmission of electric power between 2 coils wrapped around areas of the body, operating the area propagation. The possible advantages of its develop from very low energy requirement.

1. LITERATURE REVIEW

Khorshid, A. E., Alquaydheb, ET AL (2020) - With this paper, we suggest as well as validate making use of the Intra body communications channel like a biometric identity. Combining experimental measurements collected from 5 subjects as well as 2 multi layer tissue mimicking materials' phantoms, various machine learning algorithms had been utilized as well as compared to evaluate as well as validate making use of the channel qualities as well as functions like a biometric identity for subject identification. An accuracy of 98.5 % was achieved, together with a precision as well as recall of 0.984 as well as 0.984, respectively, when testing the styles against subject identification above outcomes collected from the entire samples. To us a portable and simple setup, this particular effort shows accuracy, reliability, and the feasibility of the suggested biometric identity, allowing for constant identification as well as verification.

David Naranjo-Hernández, et al (2018) - Intrabody communication (IBC) is actually a wireless communication technology through the body to build up body region networks (BANs) for ubiquitous and remote monitoring. IBC uses living tissues as a transmission medium, achieving miniaturized and power-saving transceivers, making communications much more powerful against outside interference and attacks on the privacy of transmitted information. As a result of these benefits, IBC has been incorporated as a third bodily level in the IEEE 802.15.6 standard for wireless body region networks (WBANs) designated as Human Body Communication (HBC). Further analysis is actually necessary to evaluate both techniques with respect to the qualities of IBC program. Challenges remain for an optimum deployment of IBC technology, like the effect of long term use in the human body, communication seo through much more reasonable versions, the influence of both anthropometric qualities as well as the subject's action on the transmission efficiency, standardization of communications, and

improvement of energy efficient prototypes and small size with improved information rate. Te goal of this particular effort is providing an indepth introduction to future challenges and the latest developments in man body/intrabody communication for mobile computing and wireless communications

Ahmed Khorshid, et al (2018) - This paper provides techniques to building tissue mimicking components which may be utilized as phantoms for evaluating the overall performance of Body Area Networks (BAN). The primary objective of the paper is actually describing a methodology to produce a repeatable experimental BAN platform which could be customized according to the BAN situation under test. Comparisons between various content compositions and proportions are actually found, together with the resulting electric qualities of every blend with the frequency range of interest for intra body communications; hundred KHz to hundred MHz. Test results on a composite multi layer sample are actually given verifying the efficacy of the suggested methodology. To date, this's the very first paper which offers guidance regarding how to decide on focus levels of ingredients, based on the actual frequency range of operation, as well as the desired matched electric qualities (conductivity vs. permittivity), to create multi layer phantoms for intra body communication apps.

Maoyuan Li, et al (2017) - Intra body communication (IBC) is actually a technological innovation with the conductive qualities of the body to transmit information interaction, and signal by handshake is actually viewed as among the vital uses of IBC. In this particular paper, a way for modeling the galvanic coupling intra body communication by handshake channel is actually suggested, even though the corresponding parameters are actually talked about. Meanwhile, the mathematical model of this particular sort of IBC is actually designed. Lastly, the validity of the evolved design continues to be verified by measurements. Additionally, its characteristics are talked about as well as in contrast to that of the IBC through individual body channel. Our results suggest that the proposed strategy will lay a foundation for the theoretical analysis as well as application of the IBC by handshake channel.

Keisuke Hachisuka, ET AL (2003) - The private area network (PAN) benefits from a wireless communication system for exchanging several information types through wearable electrical products. Intra-body communication utilizing the human body as the transmission medium allows for wireless communication without the usage of airborne radio waves. This particular paper covers the outcomes of

many experiments on intra body communication. We discovered that the maximum frequency for intra body communication is actually five MHz. We additionally discovered that different the distance between electrodes, varying the kind of electrode metal, as well as the absence of electrode paste didn't considerably impact impedance fluctuation. In order to evaluate the outcomes of ours, we created an intra body, 10.7 MHz frequency modulation (FM) transmitter as well as receiver with stainless steel electrodes to transmit heartbeats. Results indicate this sound frequency signals could be properly transmitted via human systems making use of these products, even in the presence of too much outside noise.

3. PROPOSED METHOD

The proposed structure uses the methodology discussed below:

- ✓ An electrical power signal is actually coupled into the body at the transmitter (TX) node, then picked up at the receiver nodes (RX), the place that the signal is actually transmitted from the body following the galvanic coupling IBC method, since both electrodes at each node are actually linked to the body.
- ✓ The received signal includes info regarding the channel which it had been transmitted through - the body in this instance - which is different for each individual and will therefore be utilized as a biometric identifier. This particular info is primarily depending on the channel effect (channel transfer function) which is actually driven primarily by the gain/attenuation channel profile which is actually created because of the body's distinctive biological as well as geometrical capabilities.
- ✓ The above process will be repeated instantly n times for the calibration of the ca, in which n is actually a method parameter. Calibration is actually necessary to draw out your own options to have the ability to effectively determine topics, as well as to help at normalizing the functions against outside elements whose outcome shouldn't influence the last special biometrics, such as: temperature, illumination, posture, wind, etc.
- ✓ Once the method is actually calibrated the person's identity will therefore be saved,

however, nevertheless is going to be relevant and unique to the particular method (hardware) used, including an additional level of protection.

- ✓ Continuous authentication/identification/authorization could then take place, in which a predefined signal is then transmitted from the TX node, every particular time interval. This's additionally among the main benefits of following the suggested biometrics, the place that the identification/authentication procedure is actually done conveniently and automatically, without demand for any physical actions to be taken on the user's part, rather than various other methods like using finger prints.
- ✓ The received signal is actually picked up at the RX node and even further processed by machine learning algorithms to finish the identification progression and confirm the identity of the subject matter, after comparing the received signal with previously captured identifiers which are distinctive for that subject.

3.1 EXPERIMENTAL SETUP

Testing was carried out utilizing the miniVNA Pro, that is a hand-held, portable Vector Network Analyzer that covers the frequency range of hundred kHz to 200 MHz. The miniVNA belongs to the TX/RX nodes that have been talked about earlier, in which a signal is actually transmitted at the TX node (port in this particular case) with the IBC galvanic strategy, travels with the body and it is formed from the particular individual's channel qualities as well as profile, then picked up at the RX node (port). The test setup is actually shown in Figure one, the place that the VNA was utilized to measure the S parameters, particularly S21, representing the channel gain. The optimum RF paper power used was zero dBm, therefore sticking with the well being security limits. At first, the setup was tested on phantoms as shown in Figure two, before human testing. Phantoms are actual physical five layer design built using tissue mimicking components which were designed. These supplies accurately mimic the dielectric qualities of the tissues; specifically the permittivity and conductivity, that are primarily in charge of deciding the transmission attributes for the IBC channel. The 5 layers that the phantom design mimics are bone marrow, cortical bone, fat, muscle, and the skin. 2 phantoms had been designed as well as utilized for testing. Identical testing methods were then carried

out on 5 actual subjects (human beings), making the entire number of tested subjects to 7 unique ones (two phantoms as well as 5 humans). Testing was carried out at room temperature, over skin that is dry. Distinct postures had been analyzed, standing as well as sitting, though no significant effect was noticed, therefore the remaining of the assessment methods have been carried out for the sitting posture. Dimensions had been completed about noon time. Outcomes received from testing on phantoms are actually accurate and precise adequate to be utilized in comparison with outcomes

collected from genuine topics, as shown in Figure three, which even further improves the last results obtained from the evolved machine learning models. Figure three shows measurements' outcomes for 3 scenarios in which the distance between RX and TX had been varied between ten, fifteen as well as twenty cm, even though the separation between electrodes of the identical node are kept regular at five cm. Over 150 measurement instances have been carried out, with 632 measurement point every instance.

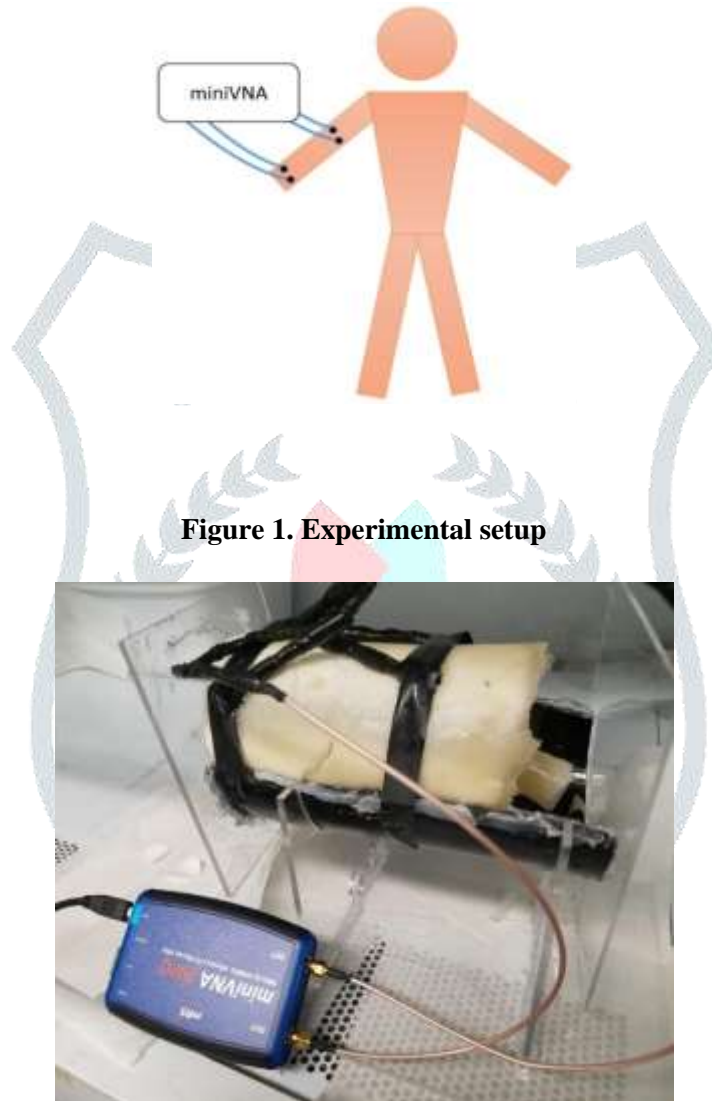


Figure 1. Experimental setup

Figure 2 The constructed five-tissue layers arm phantom model in a measurement's setup scenario (connected to the miniVNA).

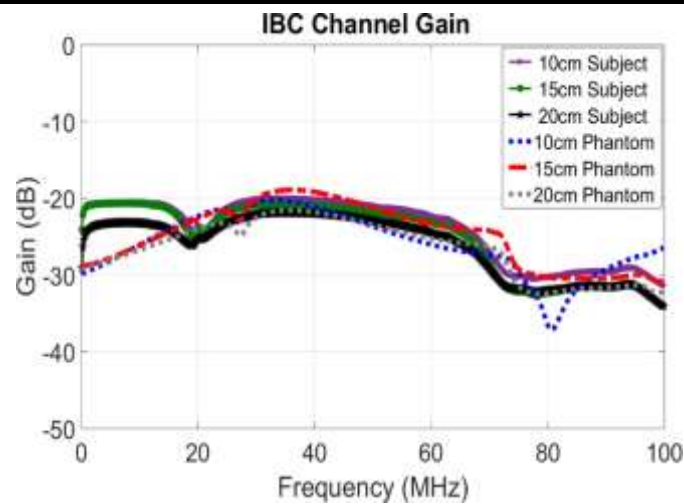


Figure 3 IBC channel gain, for a human subject vs for a phantom.

To learn the various characteristics that may be utilized for subject identification, we explored different approaches:

- Using the amplitude of the galvanic channel gain at frequencies that are various immediately as the functions, over the entire frequency range, at each TX RX separation distance individually. Put simply, the channel gain/attenuation profile across the galvanic coupling frequency range is actually utilized straight to get the special capabilities determining the biometric identity of every person, however, each set of the characteristics are actually analyzed individually against each separation distance.

Use the identical strategy as one however when wearing all of the information for the various TX RX separations, as various cases; like various instances with the same special identifiers (for instance the channel effect magnitude at ten MHz is actually utilized when the same special identifier, regardless of what the separation is actually) thus raising the number of instances which could be utilized for instruction as well as tests the machine learning models by 3× times.

- Same as technique one, but when incorporating the dimensions for those TX RX separation measurements, not as test instances, but as attributes (channel reply magnitude at ten MHz for the ten cm is actually utilized as a feature, even though the magnitude at ten MHz for the fifteen cm is actually used as a distinct feature, therefore for every measurement situation, the 3 separations are actually mixed as a single training/testing instance). In other terminology, functions received from the channel profile whenever the separation distance for the

experimental setup is actually ten cm, are actually used all along with attributes produced in case of fifteen cm as well as twenty cm at exactly the same time to teach as well as test the identification machine learning models, to determine if incorporating these kinds of variations would improve the product accuracy & performance, through including more special as well as identifiable info.

- Divide the frequency spectrum into bins/segments of identical sizes (example: one MHz bin, five MHz bin), compute the entire power spectral density for the channel effect for the frequency parts inside each bin, then simply make use of this value as a single special feature.

MATLAB was employed for signal processing, also to calculate the noted characteristics. These features were therefore shipped to WEKA, a collection of machine learning program created in Java, created at the Faculty of Waikato, New Zealand underneath the GNU General Public License, for implementing various machine learning algorithms for instruction as well as tests the information, as well as getting performance metrics for comparison between various methods in feature choice along with comparing various machine learning algorithms.

4. RESULTS AND DISCUSSIONS

With this section, outcomes for testing the usage of IBC channel attributes like a biometric identity for identification programs, the place that the function of the biometric classifier is actually determining to which user a particular measurement sample belongs to, are actually presented. The fundamental performance metrics, specifically, the accuracy, precision, recall, as well as F measure are actually revealed in Tables 1?6, because the various machine learning algorithms used

in this specific study; Nave Bayes, SVM, KNN, Random Forest, and J48. Results are actually found for the 4 distinct procedures followed for selecting the ample functions that wouldn't complicate the product a lot of (not adding more unneeded characteristics, to save computational time and power), but protecting the model's performance and accuracy for doing its primary job - determining the person based on his/her IBC channel characteristics' biometrics. Inside Tables 1?3, outcomes because implementing various machine learning algorithms, making use of the WEKA program, are actually shown, exactly where the conventional performance metrics are actually reported, for the results if the very first strategy (the gain at each frequency component is actually utilized as a feature), for every one of the TX?RX separations of ten, fifteen, and twenty cm. Total amount of characteristics employed for every situation is 632 feature, along with a cross validation of 10 fold method can be used for training/testing. As can be viewed out of the results, and it is anticipated also, when working with dimensions received from the ten cm separation, outcomes are better, reaching an identification accuracy of 98%?100 %. Still the accuracy drops, because the exact same classifiers, when working with information for bigger separations (fifteen as well as twenty cm). Once more, such findings are actually expected, since the signal suffers a lesser amount of attenuation for smaller

separation between the communicating nodes, still as the splitting up increases, the attenuation increases. For technique 2, results from all TX?RX (Transmitter?Receiver) separations are actually utilized in a single training/test run, which means that test trials are all utilized as train/test instances, yet each is actually viewed as a distinct situation. Total amount of characteristics a case remains exactly the same, at 632. With this situation, the product is taught using the ten as well as fifteen cm cases and it is tested on the twenty cm situations. Results are revealed in Table four. Despite the reality that the qualities as well as geometry changes, the performance gets to an accuracy of eighty nine % for the KNN classifier, which is nonetheless an acceptable consequence, provided this instruction as well as tests are actually carried out for various TX?RX separation situations. Nevertheless, this kind of fall of accuracy is expected. As found from outcomes provided in Table one, Table two, and Table three, features obtained from the channel attributes are definitely more effective in determining a specific specific (distinguishable and unique more) whenever the separation distance is less (ten cm yields the very best outcomes of that case), since the channel attenuation increases with distance, therefore the received signal power is actually cut down considerably with raising the separation between the RX and TX nodes.

Table 1 Performance metrics for TX–RX (Transmitter–Receiver) of 10 cm features (632 features per case)

Classifier	Accuracy	Precision	Recall	F-Measure
Naïve Bayes	98.8372%	0.989	0.988	0.988
SVM	95.5%	0.962	0.955	0.955
KNN	100%	1	1	1
Random Forest	96%	0.962	0.960	0.959
J48	92%	0.939	0.920	0.923

Table 2 Performance metrics for TX–RX of 15 cm features (632 features per case).

Classifier	Accuracy	Precision	Recall	F-Measure
Naïve Bayes	91.9811%	0.920	0.920	0.920
SVM	90.566%	0.909	0.906	0.907
KNN	91.9811%	0.921	0.920	0.920
Random Forest	91.9811%	0.921	0.920	0.920
J48	81.6038%	0.827	0.816	0.818

Table 3 Performance metrics for TX–RX of 20 cm features (632 features per case).

Classifier	Accuracy	Precision	Recall	F-Measure
Naïve Bayes	71.6102%	0.740	0.716	0.691
SVM	80.5085%	0.838	0.805	0.812
KNN	83.8983%	0.750	0.581	0.655
Random Forest	79.661%	0.793	0.797	0.782

J48	78.3898%	0.606	0.645	0.625
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Table 4 Performance metrics for all TX–RX as different cases (632 features per case)

Classifier	Accuracy	Precision	Recall	F-Measure
Naïve Bayes	85.9756%	0.844	0.609	0.708
SVM	–	--	--	--
KNN	89.4817%	0.894	0.895	0.894
Random Forest	87.0427%	0.870	0.870	0.868
J48	82.3171%	0.833	0.823	0.826

Table 5 Performance metrics for all TX–RX as different cases (1896 features per case)

Classifier	Accuracy	Precision	Recall	F-Measure
Naïve Bayes	97.9695%	0.981	0.980	0.980
SVM	--	-	-	-
KNN	96.9543%	0.970	0.970	0.970
Random Forest	97.9695%	0.981	0.980	0.980
J48	92.3858%	0.941	0.924	0.926

Table 6. Performance metrics for the power bin approach (0.5 MHz bin size).

Classifier	Accuracy	Precision	Recall	F-Measure
Naïve Bayes	98.4127%	0.984	0.984	0.984
SVM	94.9206%	0.963	0.949	0.952
KNN	97.7778%	0.978	0.978	0.978
Random Forest	87.619%	0.892	0.876	0.863
J48	47.9365%	0.750	0.479	0.512

This explains why strategy two yields much worse outcomes than technique one (in the ten cm separation case), in which additional knowledge as well as tests cases are actually added but with less impressive features, which caused far more confusion to the models when attempting to calculate the greatest features to exclusively determine a person from the suggested characteristics, therefore the complete models' ability and accuracy power to exactly determine the individual's identity had been somewhat decreased. In technique 3, each frequency part has 3 diverse capabilities (gain at ten, fifteen, and twenty cm). Outcomes because of this situation are actually revealed in Table five the place that the performance remains at a very good degree of ~98 %, since even more features are actually added to the product. The SVM classifier didn't converge for both instances. Small changes in several of the models' performance (for the Random Forest and also the J48 algorithms) are actually found, still at the price of additional complexity, the place that the amount of functions are actually enhanced by three, which suggests the models' complexity is actually improved, much more computing resources are essential and much more memory for saving the

product parameters is necessary, which may not be the right option then for the majority of the IBC as well as wearables' programs, when such methods are actually scarce on strength & region budgets. The last approach attempted was dividing the spectrum into energy bins of the same sizes (example: one MHz bin as well as five MHz bin), compute the entire energy for the frequency parts inside each bin, then make sure you use it a single feature. This particular method is much more resilient to sound & system/environment changes, as it computes the feature as the common energy inside a range of frequencies, not simply from an individual relative one, therefore has higher capacity to eliminate noise as well as unusual differences. In Table six, we clearly show the performance metrics for the situation whenever the spectrum is actually split into bins of size 0.5 MHz each. The overall performance shown in Table six is better to other approaches & hence will be used when the technique of choice.

5. IMPACT OF BIN SIZE

This particular aisle investigates the overall performance of the energy binning strategy as opposed to the dimensions of the energy bin. By referring back again

to Figure three, one can see that the gain drops for frequencies more than fifty MHz. This happens because of to various reasons; body antenna result, causing power leakage in addition to signal interference, as well as the attenuation introduced by body cells. This's additionally established in [twenty three], the place that the frequency band of under sixty MHz showed better benefits. As a result, to bring down the amount of characteristics, we consider frequencies between hundred KHz as well as fifty MHz. Results are actually plotted in Figure four leading the tradeoff among accuracy as well as bin size in which the identification accuracy drops as the strength bin size increases (as the number of characteristics decreases). Figure five shows the tradeoff between the number and also the accuracy of characteristics, in which accuracy advances considerably with raising the number of characteristics well then saturates past a particular benefit, after which adding far more features doesn't add a lot to the identification procedure. By the results we concluded that the averaged power bin strategy is best, with bin size of 0.5 MHz, with the frequency range of hundred KHz to fifty MHz, with both the KNN or maybe Naïve Bayes classifiers.

The results indicate which features obtained from the IBC channel attributes could be correctly used as identity biometrics. Nevertheless, which use to be utilized in choosing the functions, and also, which machine learning algorithm to be selected, will rely on the application at hand. If the performance metrics of the machine learning models, like the accuracy or maybe precision, are actually the primary concern, then

the fourth and first methods could be utilized for choosing the proper characteristics, with the Naïve Bayes or maybe the KNN algorithms as the algorithm of choice. Method one (for the ten cm separation case) is significantly simpler compared to technique 4, since little computation is actually required for feature preprocessing, as the channel effect at various frequency instances are exclusively utilized as the capabilities. While, in technique 4, additional steps are essential to calculate the strength spectral density for every bin. Nevertheless, strategy 4 shows far better resilience to changes in outside factors as well as biological variations like other factors and moisture. Strategy 2 showed much worse general performance benefits, and it requires very experimental setup (different separation distances), therefore it's not really a preferred method. Last but not least, strategy 3 shows small improvement for the arbitrary forest as well as J48 algorithms, still at a higher computational price, therefore not an extremely appealing method for wearables & ultralow run biomedical uses. To summarize, approach one for characteristics choice when using the Naïve Bayes or maybe the KNN version, gives results that are good, with the easiest style and least computational energy budget. Approach 4 with the Naïve Bayes design gives results that are good also, and it is a lot more resilient to variants and noise in outside factors still calls for more computational actions, therefore, a greater energy budget. The decision hence is determined by the application at hand: the computational budget versus unit accuracy and resiliency. Findings are actually summarized in Table seven.

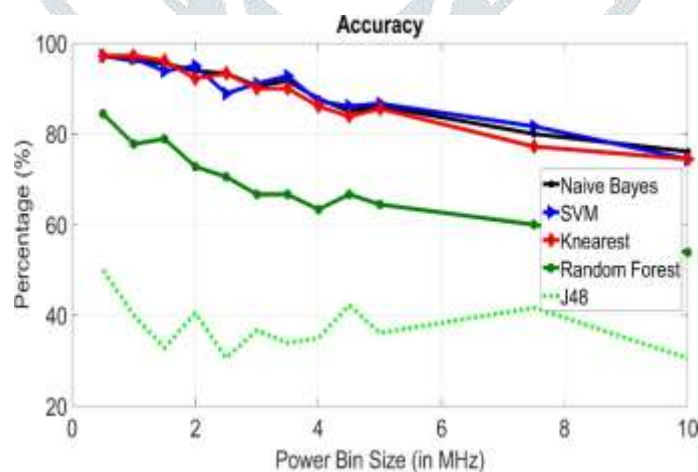


Figure 4. Accuracy for different classifiers versus power bin size.

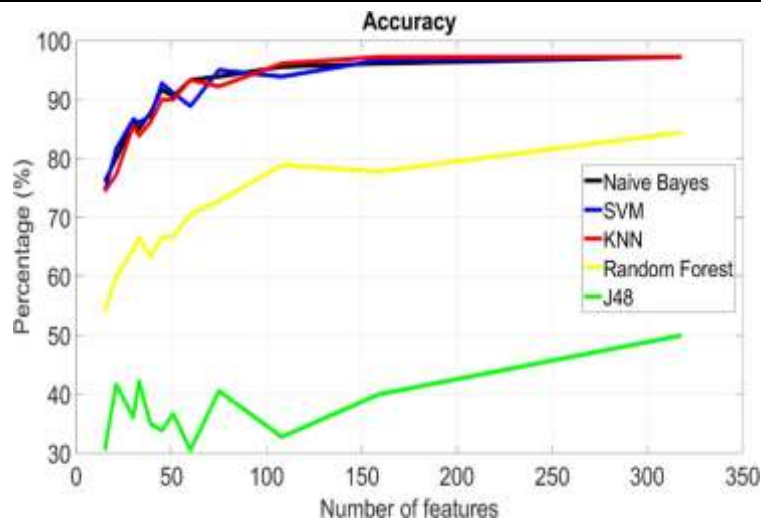


Figure 5. Accuracy for different classifiers versus the number of features

6. CONCLUSIONS

With this paper, the qualities of the Intra Body Communications channel, produced from the channels' gain/attenuation profile, is actually utilized as a biometric identity for subject identification. Along with 5 actual subjects (humans), 2 multi layer bodily phantom models are actually created as well as utilized also, to diversify and further validates the feasibility of the study. Channel attributes received from the experimental measurements collected are actually further processed for feature extraction, in which various procedures had been in comparison to figure out the distinguishable and unique most functions for the channel attributes. Utilizing frequency bins of 0.5 MHz wide each, as well as covering the frequency spectrum from hundred kHz to fifty MHz, the extracted functions were in that case utilized to compare between the accuracy as well as productivity of various machine learning algorithms, in which tradeoffs among accuracy, selection of options, and computing resources have been studied as well as presented also. By the study, the greatest performance was obtained using the Nave Bayes algorithm, with an identification accuracy of 98.5 % and recall and precision of 0.984 as well as 0.984, respectively. The k nearest neighbors (KNN) yielded the next best results, with identification accuracy of 97.8 % and recall and precision of 0.978 as well as 0.978, respectively. By the results, it's proved that the IBC channel attributes could be correctly used as a biometric identity, where a portable and simple setup may be utilized for that purpose. Technology that is This kind of could be utilized for security uses in

common, and as security level for body region networks especially, for securing information transmission between various nodes & receptors in and on the body. Future work is going to focus on testing for more IBC channel connected functions along with test the usage of the IBC channel functions for biometric authentication systems.

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