

## **Analysis of Decision Fusion Detection in Wireless Sensor Network**

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**Abstract:** The emerging technology of embedded system and internet of things crack great potential of the wireless sensor network. The deployment and feasibility of wireless sensor network applied underdisciplined process of the task. The major issue of sensor node deployment is an energy factor. The life of energy depends on the strength of signals during transmission and sensing of the sensor node. The major factor to impact the sensor node's life is a distance of target node, signal attenuation and model of propagation model. The continuous efforts of various authors proposed various models and system level algorithms for the efficient utilization of energy in a large number of sensor node deployment cases in case of random and knew sensor node environments. This paper presents the analysis of distributed detection of energy based on decision fusion factor based on different constraints function. Most algorithms applied the process of probability function to estimate the energy function in terms of detection and false detection. This paper focuses on already developed methods of detection elaborate in the survey. The validation of algorithms designs a wireless sensor network environment in MATLAB software and standard measure parameters and analysed algorithms' behaviours. Also, the study of comparative performance of all presented algorithms.

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**Keywords:** - WSN, Data Fusion, Distributed, Detection, Probability, Energy Efficient, Sensing, MATLAB

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### **Introduction**

The capability of a wireless sensor network brings the attention of emerging and embedded technology of communication. the sensor node is capable to communicate other sensor node and fusion sensor node for the processing of data. the deployments of sensors node depend with different topological represents. The main distribution of sensor node is flat and hierarchical topology, the distribution of sensors node focus on three parameters such as distance, signal attenuation and propagation model of signal. The sensor node deploys in large scale on large area, it maximizes the distance point of sensor node with sink and fusion node. The large distance takes more signal strength for the propagation of sensors node. The too much time of sensing needs more energy and the life of sensors node compromised. The compromised sensor node impacts the performance and stability of wireless sensor network. Many authors [1,2,4,5] applied energy efficient protocol for the transmission of data in from of data aggression. The most popular protocol of wireless sensor network is LEACH protocol. The main contribution and features of LEACH protocol are low energy and low bandwidth. The most of authors derived various modified protocol of LEACH to enhance the energy capacity of sensors node. The meaning of capacity enhancement is the limit the energy utilization and increase the life of sensor nodes. Now a day's wireless sensor network applied in many areas such as security surveillance, battle field of war and many agriculture industries. Such area needs large deployments of sensors node in form of information collector and target detection of sensor node. The target detection of sensor node applied various protocol such as distributed detection, counting role, voting process and many more algorithms[3, 4]. In early of sensor node detection, many researchers use the rule of counting of transmitted data in terms of probability. The age of detection is increase now detect in mode of passive in large area of sensor nodes. The flexibility of probability-based methods to detect the location and signal strength of fusion node. The data fusion Are aggressive methods of wireless sensor network for gathering of information and transmission. The process of fusion stored the signal binary value 0 and 1[6, 7]. The center of fusion received the value 1, that means the data are received and the value of 0 indicates the data are not received on fusion center. The collection of fusion data node based on the know scenario of sensor network and dynamic network the value of selection threshold plays a vital role for the formation of data node and shrink node. Some authors [12,1,4,18] applied the methods of compression sensing methods for the process of fusion of data. the methods of compression sensing are good in terms of only data received, if data is compressed, otherwise data not received. The process of methodology describes in manners of hypothesis and estimated error of probability. The analysis of parallel sensor network based on distributed detection for signal detection with 1 bit's data. in paralle sensor network the FC act as global decision factor for the processing of signals and gathering of information[8,

9, 10]. The main contribution of this paper is analysis of distributed detection methods in wireless sensor network. The second contribution is formulated the fusion state of detection. The rest of paper organized as in section II. Describe the related work in the area of distributed detection. In section III. Describe the methods of detections. In section IV describe the simulation and experimental results and finally conclude in section V.

### II. Related Work

Lu, Feng Et al. [11] A tale DEKF is created, and self-tuning cushion technique of recursive combination assessment is consolidated to the DEKF to shape the SDEKF calculation for improving state assessment execution. The lengths of information cradle bank identified with the nearby filters of SDEKF are unique, and they are autonomously versatile to the data misfortune level and neighborhood assessment precision. Neighborhood states are determined utilizing the estimations gathered at the most recent strides in self-tuning cradle banks, and afterward shipped off ace filter to yield worldwide state and covariance by combination assessment. The commitment of this examination is to talked about a novel EKF calculation for state assessment in the dispersed system with sensor combination vulnerability, and it accomplishes better compromise between the assessment precision and computational endeavors. Jing, Ming Et al. [12] D-S hypothesis is applied to deal with unsure data in various situations. Another bBPA strategy is examined to deal with the likely clash before information combination. Rather than appointing introductory conviction overall force set space, the new technique allots the base conviction to fundamental occasions in the edge of insight. Thus, the bBPA is reliable with the old-style likelihood hypothesis. A few mathematical models are embraced to confirm the dependability and exactness of the technique in preparing profoundly clashing information. The informational indexes in the UCI Machine Learning Repository are utilized to verify the accessibility of the new technique in characterization issue. Xiao, Fuyuan Et al. [13] A progression of ideas for the evidential validity measure are first introduced, including the nearby believability degree, worldwide validity degree, evidential believability assessment and validity prospect esteem capacity to completely portray the honor and rebuff grades regarding trustworthy proof and unimaginable proof, individually. In light of the above explores, a proper load for each proof can be acquired. Eventually, the heaviness of each proof is utilized to correct the crude confirmations prior to directing DCR.

Meraner, Andrea Et al. [14] a profound leftover neural organization engineering is intended to eliminate mists from multispectral Sentinel-2 symbolism. SAR-optical information combination is utilized to abuse the synergistic properties of the 2 imaging frameworks to manage the picture remaking. Akbar, Adnan Et al. [15] authors broaden cutting edge occasion preparing utilizing BNs to consider vulnerability while recognizing complex occasions. analysts execute their talked about arrangement utilizing opensource parts enhanced for huge scope applications. specialists show their answer on genuine use-case in the space of ITS where analysts investigated traffic, climate and web-based media information streams from Madrid city to foresee likelihood of clog progressively. Diez-Olivan, Alberto Et al. [16] information driven forecast is progressively acquiring consideration in various mechanical areas. This work gives a complete review of the new improvements in information combination and AI for modern guess, setting an accentuation on the distinguishing proof of examination patterns, specialties of chance and neglected difficulties. To this end, a principled classification of the used component extraction strategies and AI techniques will be given based on its proposed reason: examine what caused the disappointment, decide when the observed resource will fizzle or choose what to do as such as to limit its effect on the current business.

Bai, Xingzhen Et al. [17] analysts have managed the information combination issue of WSNs for the nursery ecological observing framework. Considering the attribute of the nursery environmental change and the necessity for the efficient information combination of WSNs, the progressive construction of WSNs has been talked about for the nursery observing framework, which is supportive of improving the combination execution and the energy efficiency of sensors. At that point, the two-stage combination conspire has been planned with regards to the highlights of neighborhood consistency and moderate difference in the nursery natural data. Dey, Saurabh Et al. [18] a writing audit on the chose uses of inexhaustible asset and force determining models to encourage the ideal mix of RE in power frameworks. This survey is drafted based on the chose top notch research distributions from the previous decade. Albeit the improvement of figure models for RE age, i.e., wind and sun powered energy, is a well-informed region. The application-arranged audit on these fundamental territories can be utilized by the force area for acclimation with the new patterns and for dissecting the effect of gauging enhancement for ideal force framework plan and activity. Dutta, Palash Et al. [19] an effort has been made to talked about a way to deal with measure vulnerability that engaged with huge information and a combination rule of conflict confirmations of huge information. At last, mathematical models are represented under these settings and results are contrasted and existing methodologies.

Eleftheroglou, Nick Et al. [20] An epic structure to intertwine SHM information from various in-situ checking strategies is talked about planning to build up a hyper-include towards more successful prognostics. A cutting edge NHHS MM is used to demonstrate the harm collection of composite constructions, exposed to exhaustion stacking, and gauge the RUL utilizing customary just as melded SHM information. Ngadi, Md A. Et al. [21] a novel powerful grouping-based energy efficient and QoS-mindful steering convention, which is motivated by the

genuine conduct of the BMO, has been talked about. The talked about appropriated conspire improves network dependability significantly and lessens unreasonable parcels retransmissions for WSN-based SG applications. Execution results show that the examined convention has effectively diminished the start to finish delay and has improved parcel conveyance proportion, memory usage, leftover energy, and throughput. Goyal, Nitin Et al. [22] UWSN innovation is broadly utilized in different submerged checking and investigation applications and has demonstrated its high height. Since numerous years different UWSN proto-cols have been planned or existing conventions are extemporized for viable and subjective exploration investigation. The information collection is one of the plans that is generally been utilized alongside UWSN conventions to accomplish better outcomes. Haque, Md, Md Asikuzzaman Et al. [23] A SHM framework is a methodology for distinguishing the harms caused to different sorts of constructions utilizing diverse framework works and giving the important input about design's conditions. As common designs are the foundation of their general public, to decide its everyday activities is a vital issue. The presentation estimation of those constructions is manual while a PC based checking framework could naturally survey the primary harms and distinguish its precise area. As of late, WSNs have pulled in a lot of consideration for far off detecting applications because of adaptability to proportion of different movement of enormous scope organization. Since innovation is propelling step by step, the general expense of an observing framework is likewise diminished.

Himeur, Yassine Et al. [24] Researchers explore their conceptualizations, benefits, difficulties and disadvantages, just as playing out a scientific categorization of existing information combination methodologies and other contributing elements. Following, a far-reaching examination of the best-in-class information combination-based energy efficiency systems is led utilizing different boundaries, including information combination level, information combination procedures, social change influencer, conduct change motivating force, recorded information, stage design, IoT innovation and application situation. Huang, Min Et al. [25] the multi-source detecting information combination models and combination calculations are examined and talked about. The JDL combination model and the Hierarchical combination model are com-pared and examined. Kang, Kai Et al. [26] A tale conveyed molecule channel calculation is introduced, called DHLB-PF. The DHLB-PF is intended to conquer the decline issue by utilizing a staggered MCMC strategy after the resampling step of molecule separating. Khan, Tayyab Et al. [27] scientists talked about a novel and exhaustive LTS for enormous scope WSN that utilizes bunching to improve collaboration, dependability, and security by distinguishing malevolent sensor hubs with decreased asset utilization. The talked about conspire works on two levels, to be specific, intra-group and between bunch alongside circulated approach and concentrated methodology, individually, to settle on precise trust choice of sensor hubs with least overheads. Li, Guoquan Et al. [28] scientists center around DF methods for network interruption recognition and talked about a particular definition to depict it. specialists survey the new advances of DF procedures and talked about a progression of rules to look at their exhibition.

Majumder, Sagardip Et al. [29] Sensory information are for the most part connected with imprecision and vulnerability, and subsequently, it becomes difficult to extricate valuable data from them. The issue turns out to be significantly more difficult to deal with, when the information are gathered utilizing various sensors. Understanding the capacity of fluffy sets to manage imprecision and vulnerability, a multi-sensors information combination strategy was created in this investigation by utilizing fluffy grouping and prescient devices. The information were first grouped dependent on their likeness utilizing an entropy-based fluffy C-implies bunching strategy and the acquired groups were used to build up a fluffy thinking based prescient instrument. The curiosity of this examination lies with the use of a grouping calculation, which can guarantee both minimization and peculiarity of the created bunches, and improvement of a thinking instrument using the data of acquired bunches. Manogaran, Gunasekaran Et al. [30] The IoMT is worldwide foundation comprising of the assortment of clinical gadgets and applications that are interconnected through data and correspondence advances. Muduli, Lalatendu Et al. [31] a methodical writing audit on the best in class investigates on use of WSN in underground coal mineshafts and to recognize the hazy situations requiring more consideration for wide utilization of WSN procedure. Progressed search is directed on different advanced libraries for separating important investigations for the audit. The inquiry procedure identified 762 examinations, among which 52 important investigations are chosen for intensive survey. Utilization of WSN for checking of ecological boundaries and different viewpoints in underground coal mineshafts, like mine gases, temperature and stickiness, dust, fire, rooftop fall, and so on are talked about. Muzammal, Muhammad Et al. [32] Day by day visual information is acquired from an assortment of sensors which is combined to produce great action information. The intertwined information is subsequently contribution to an Ensemble classifier for early coronary illness expectation. The gatherings are facilitated in a Fog processing climate and the forecast calculations are acted in a decentralized way.

Nguyen, Trong-The Et al. [33] The course of action of hubs impacts the nature of network and energy utilization in WSN for drawing out the lifetime. Nweke, Henry Friday Et al. [34] Activity discovery and characterization utilizing diverse sensor modalities have arisen as progressive innovation for constant and self-ruling checking in conduct examination, surrounding helped living, ADL, old consideration, recoveries, excitements and observation in savvy home conditions. Morshedizadeh, Majid Et al. [35] head segment examination is utilized to extricate boundaries with power creation impact dependent on all accessible signs in the SCADA information. Ruben, Cody

Et al. [36] This investigation presents a crossover information driven material science model-based structure for ongoing observing in shrewd lattices. As the force network changes to the utilization of keen framework innovation, it's constant observing turns out to be more defenseless against digital assaults like FDI. Albeit keen lattices digital actual security has a broad extension, this examination centers around FDI assaults, which are displayed as terrible information. Soltani, Mohammad Mostafa Et al. [37] The use of CV in development projects has been examined for a long time, bringing about a few progressed calculations and strategies. The earthmover is one of the exceptionally utilized bits of hardware on building locales that should be observed to assess both security and efficiency. Knowing the efficiency of tractors assists with arranging the removal interaction all the more precisely. A long line of trucks sitting tight for the tractor implies paying more cash while the trucks are not being stacked.

Tune, Yutong Et al. [38] another difference proportion of BPA is examined dependent on mathematical mean of Deng relative entropy. The heaviness of each proof is controlled by the examined difference measure and data volume. Contrasted and the current conviction Jensen–Shannon disparity, the examined technique has a superior exhibition in the assembly to the right objective. Wang, Jin Et al. [39] analysts present an insightful information gathering pattern with information combination called IDGS-DF. Yu, Xiuwu Et al. [40] Sampling information is thought about against the set edge, and the hubs enter the significant state just when there is strange datum; now, group development starts. All group individuals fuse a neighborhood sending history to conclude whether to advance or to drop ongoing inspecting information. Dempster–Shafer proof hypothesis is misused to deal with the information. The essential conviction task work, with which the yield of each bunch part is described as a weighted-proof, is developed.

**III. Methodology of Distributed Detection**

The detection of the target node in a wireless sensor network depends on the network's topology, the strength of energy, sensing capacity, detection rule, noise and interference, attenuation of the signal source to the target node[1,12]. This section describes the various methods applied for detecting target node with the help of decision fusion methods.

1. System model

Consider total N sensors are deployed randomly in the area of  $a^2$ . The location of target node is unknow in WSN, but the process of distribution follows independently identically distributed (i.i.d) in area of network.

$$f(x_i, y_i) = \frac{1}{a^2} \left( -\frac{a}{2} \leq x_i, y_i \leq \frac{a}{2} \right) \dots \dots \dots (1)$$

Here  $i=1,2,\dots,\dots,N$  where  $(x_i,y_i)$  are the location coordinates of sensors  $i$ .

The distribution of local sensor are i.i.d and follow the standard gaussian distribution

$$n_i \sim N(0,1) \dots \dots \dots (2)$$

The hypothesis of problem defines as

$$H_1 : s_i = a_i + n_i \dots \dots \dots (3)$$

$$H_0 : s_i = n_i$$

Here  $s_i$  is received signal and  $a_i$  is the amplitude of signal.

Now the model of power attenuation

$$a_i^2 = \frac{P_0}{1 + \alpha d_i^n} \dots \dots \dots (4)$$

Here  $P_0$  is the signal power emitted by the target at distance zero,  $d_i$  is the distance between target and local sensor  $i$ :

$$d_i = \sqrt{(x_i - x_t)^2 + (y_i - y_t)^2} \dots \dots \dots (5)$$

2. Decision fusion Rule

The estimation of distance of local sensors is very complex issue. The fusion centre forced to treat every sensor are equally distributed. The system level decision made by local sensors and then match with a value of threshold  $T$ [20, 21].

$$A = \sum_{i=1}^N I_i H_1 > T \dots \dots \dots (6)$$

$$A = \sum_{i=1}^N I_i H_0 < T \dots \dots \dots (7)$$

Here  $I_i=\{0,1\}$  is the local decision made by sensor  $i$ .

3. Generalized like hood Ratio Test (GLRT)

The GLRT methods efficiently detect the target node using the fusion centre function describe as

$$A^{GLRT} = \sum_{s=1}^N I_s \log \frac{P_{ds}(x_t, y_t)}{P_{fa}} + (1 - I_s) \log \frac{1 - P_{ds}(x_t, y_t)}{1 - P_{fa}} \dots \dots \dots (8)$$

here Pfa is probability of false detection and GLRT is hypothesis of detection.

4. Bayesian approach

Bayesian is another approach to detection of target node in scenario of distributed sensor network. Now following prior target position

$$f(X_t, Y_t) = \begin{cases} \frac{1}{A^2} & 0 \leq x_s, y_s \leq A \dots \dots \dots (9) \\ 0 & \text{otherwise} \end{cases}$$

5. Chair-Varshney rule

The chair-Varshney rule based on local decision of sensor node I. the fusion centre FC decide the final decision about presence of target node. The rule of fusion describe as

$$A_0^{opt} = \log \frac{P(I|H1)}{P(I|H0)} = \sum_{s=1}^N I_s \log \frac{P_{ds}(x_t, y_t)}{P_{fa}} + (1 - I_s) \log \frac{1 - P_{ds}(x_t, y_t)}{1 - P_{fa}} \dots \dots \dots (10)$$

The above optimal set of rules decide by log-like hood ratio.

**IV. Experimental Result Analysis**

To evaluate the performance of different fusion center for the detection of unknow target. The process of simulation done in MATLAB software with version R2014a. MATLAB provides various function and script of sensor network. The total number of sensors node is N=1000 and other different variable parameters change according to their probability density function (Pdf). The simulation process measure mainly two parameters probability of false alarm (Pfa) and probability of detection (Pd)[7, 8, 12, 15].

$$Pfa = \Pr \{A2 = \sum_{i=1}^N I_i \geq T | H_0\} \dots \dots \dots (11)$$

$$Pd = \frac{1}{a^2} \int_{-\frac{a}{2}}^{\frac{a}{2}} \int_{-\frac{a}{2}}^{\frac{a}{2}} Pd(x_t, y_t) dx_t dy_t \dots \dots \dots (12)$$

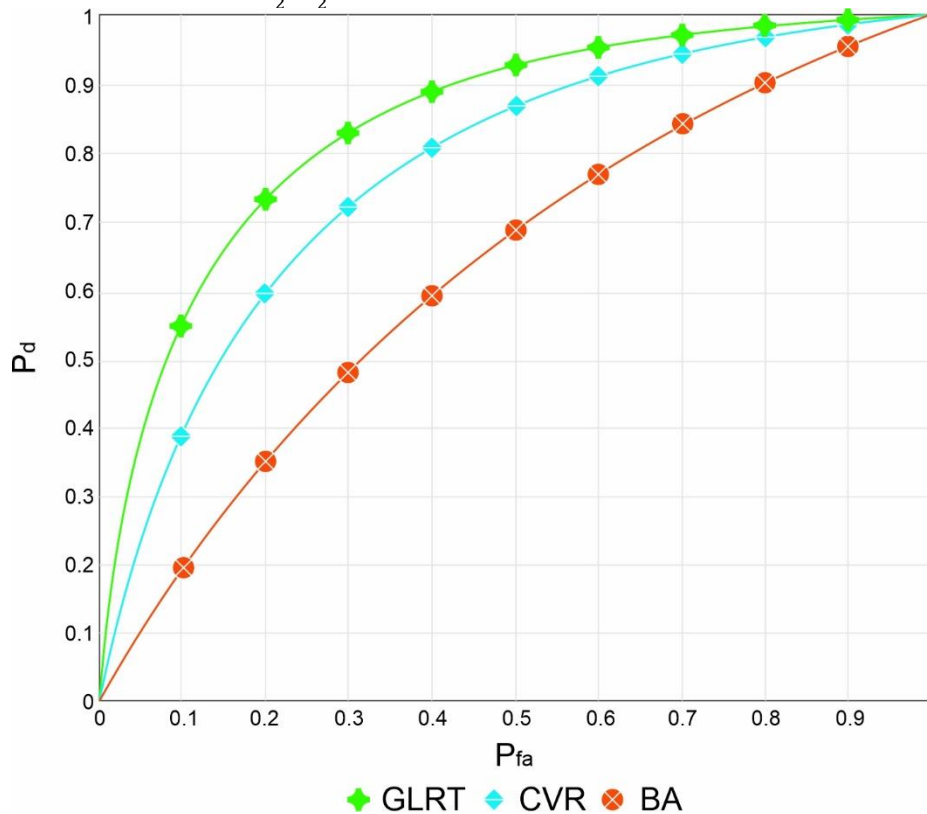


Figure 1: ROC curves obtained by calculation and simulations. P<sub>0</sub>=500, N = 1000. Here we observe the using of GLRT, CVR, BA techniques and performance based on probability of detection versus probability of false alarm. The performance of GLRT techniques shown the better performance compare to the CVR and BA techniques.

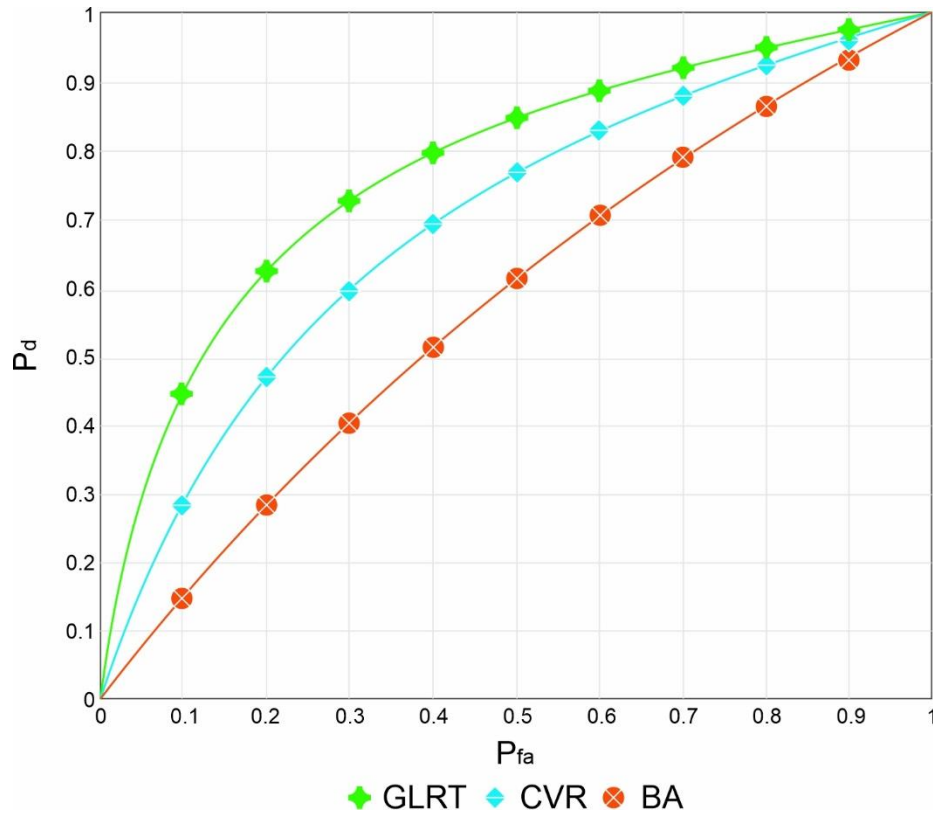


Figure 2: ROC curves obtained by calculation and simulations.  $P_0=1000$ ,  $N = 1000$ .

Here we observe the using of GLRT, CVR, BA techniques and performance based on probability of detection versus probability of false alarm. The performance of GLRT techniques shown the better performance compare to the CVR and BA techniques.

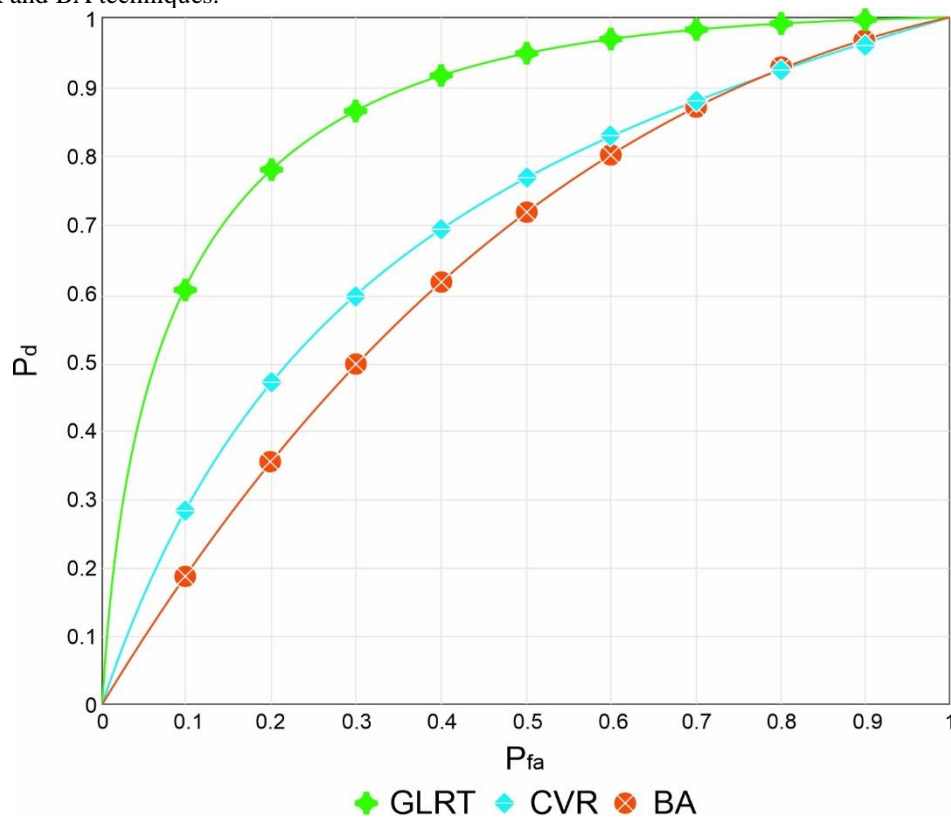


Figure 3: ROC curves obtained by calculation and simulations  $N = 1000$ .

Here we observe the using of GLRT, CVR, BA techniques and performance based on probability of detection versus probability of false alarm. The performance of GLRT techniques shown the better performance compare to the CVR and BA techniques.

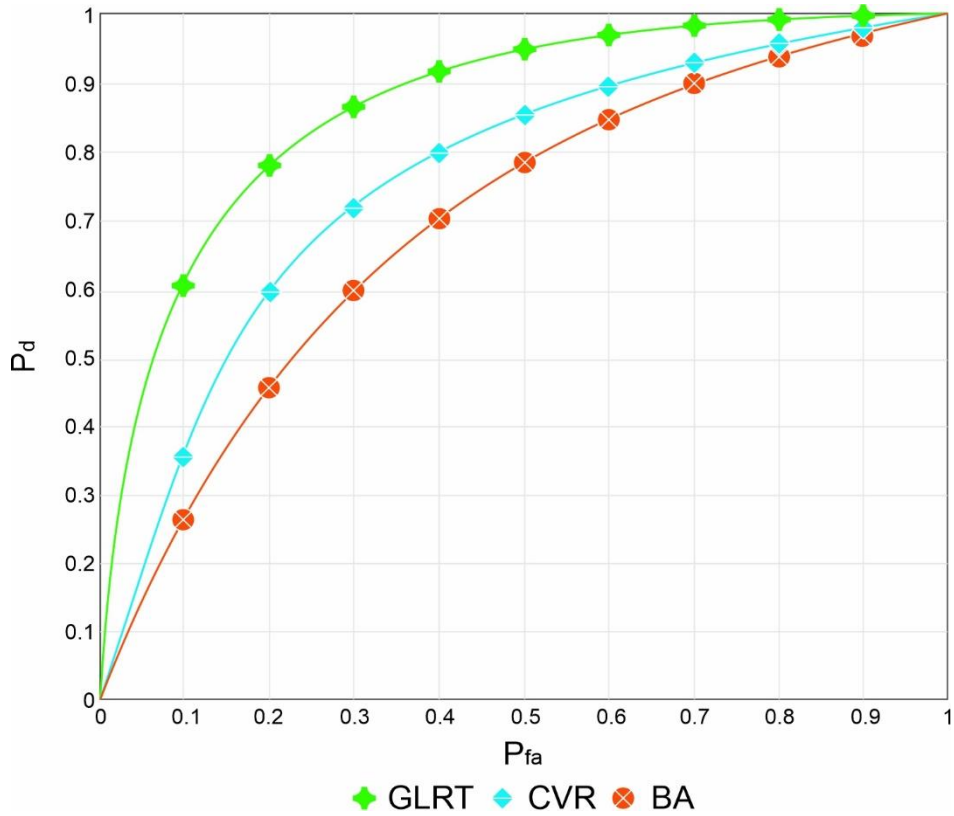


Figure 4: ROC curves obtained by calculation and simulations  $N = 500$ . Here we observe the using of GLRT, CVR, BA techniques and performance based on probability of detection versus probability of false alarm. The performance of GLRT techniques shown the better performance compare to the CVR and BA techniques.

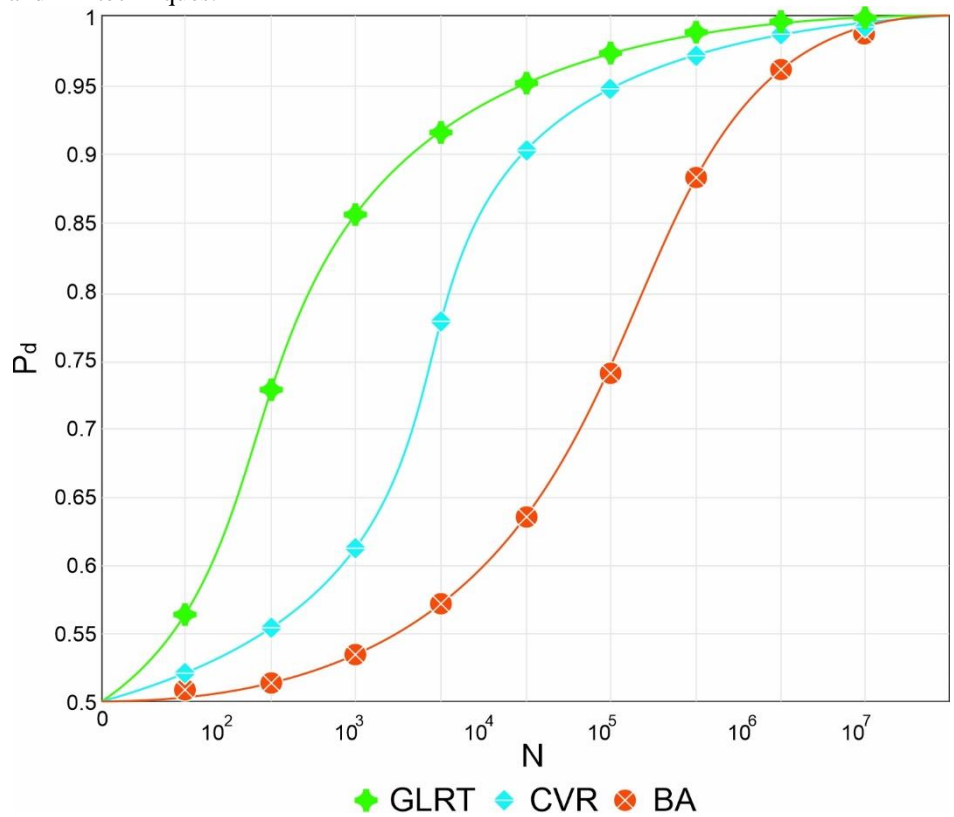


Figure 5: System level Pd as a function of N and  $SNR_0=15dB$ .



Here we observe the using of GLRT, CVR, BA techniques and performance based on probability of detection versus number of networks. The performance of GLRT techniques shown the better performance compare to the CVR and BA techniques.

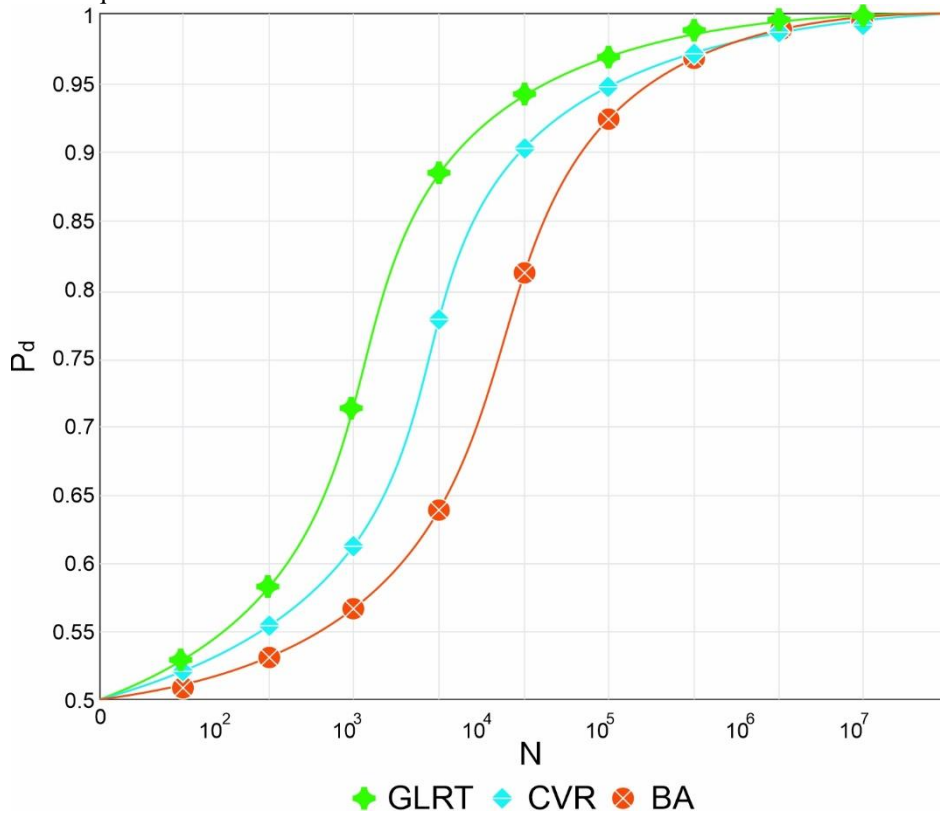


Figure 6: System level  $P_d$  as a function of  $N$  and  $SNR_0=30dB$ .

Here we observe the using of GLRT, CVR, BA techniques and performance based on probability of detection versus number of networks. The performance of GLRT techniques shown the better performance compare to the CVR and BA techniques.

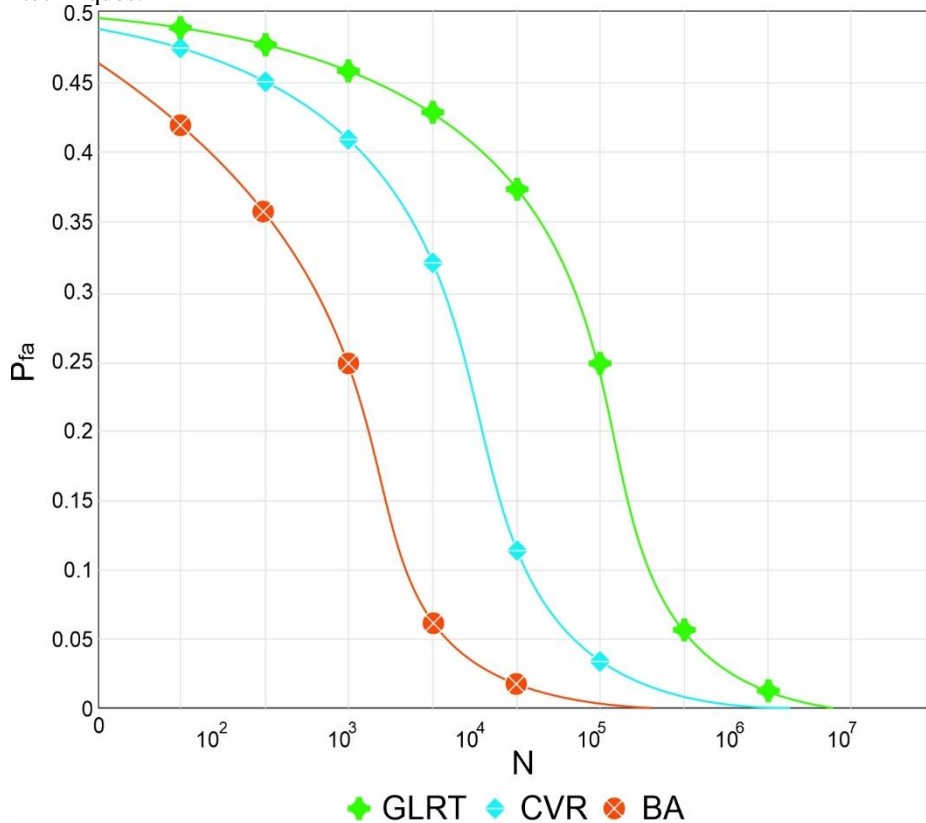
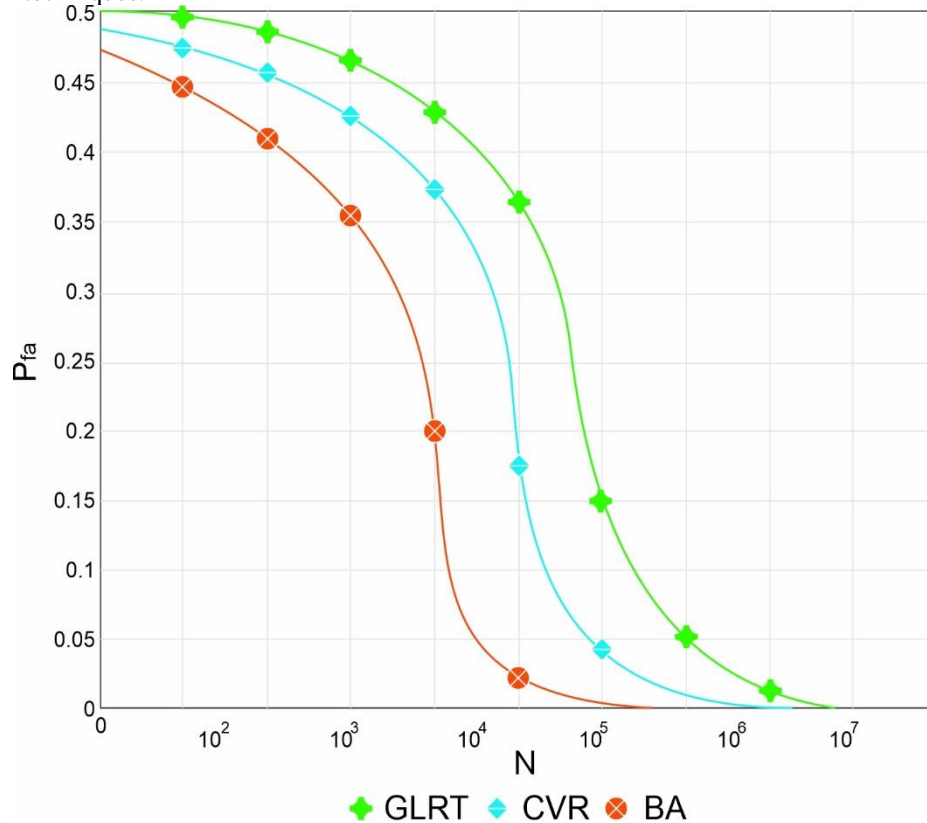




Figure 7: System level Pfa as a function of N and SNR<sub>0</sub>=15dB.

Here we observe the using of GLRT, CVR, BA techniques and performance based on probability of false alarm versus number of networks. The performance of GLRT techniques shown the better performance compare to the CVR and BA techniques.

Figure 8: System level Pfa as a function of N and SNR<sub>0</sub>=15dB.

Here we observe the using of GLRT, CVR, BA techniques and performance based on probability of false alarm versus number of networks. The performance of GLRT techniques shown the better performance compare to the CVR and BA techniques.

## V Conclusion & Future Scope

This paper analyzed the performance of detection methods of the target node in the sensor network's distributed environments: the detection hypothesis based on the binary pattern. If the node is detected, the value of probability 1 otherwise 0. The process of analysis analyzed three detection methods as Bayesian methods, GLRT methods and van methods. The comparative analysis of methods shows the behaviors of the network. The signal attenuation is a major factor in the detection of an unknown source. Also, the noise or interference change the decision fusion centers value and detect false node. The variation of false and true node detection suggests the selection of the algorithm. The topology of the network also plays a vital role in the detection process. Most authors applied flat topology and hierarchical topology. Some case authors applied hybrid topology. The primary factor of influence is a limitation of bandwidth and energy factor. These factors forced the process of quantization to select a minimum bit in binary for the making decision. For the case of a known number of sensors, we showed that the Bayesian detector has better ROC performance than that of the GLRT. We applied the counting rule decision fusion rule for a random number of sensors that uses the same observation that the Scan Statistic utilizes. We also analyzed the performance of Bayesian fusion detection. We compared all results with given parameters in future applied optimization methods to select the optimal rule for decision by the fusion center.

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