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Energy-Resourceful Routing by Fuzzy Based Secured CH Clustering for Smart Dust

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ABSTRACT- Smart Dust Network (SDN) consists of no-infrastructure, sovereign network, smart dust nodes are associated with wireless paths in multihop fashion. No-infrastructure and mobility atmosphere contains complexity to establish an innovative secure routing approach for MWSN. The major problem in MWSN is in routing because of its scarce resource accessibility and mobility in nature. Energy-resourceful routing is indispensable since each smart dust node is containing constrained battery energy. Power breakdown of a particular smart dust node splits network design. So MWSN routing utilizes offered battery power in successful manner to amplify network life. Fuzzy Based Secured CH Clustered (FSCC) approach identifies trustworthy and loop-open path among smart dust nodes by deciding a finest cluster-head. FSCC utilize velocity, signal potency and lingering energy as parameters to discover resourceful cluster-head. Smart dust nodes applying fuzzy rules to evaluate node cost. Smart dust node with maximum cost is decided as cluster-head. Cluster-head accomplishes event exchange among base station. Consequently, FSCC conserve constant network by diminishing re-association of entire smart dust nodes, re-selection of cluster-head and re-clustering. FSCC approach retains packet-delivery, delay, energy utilization by 88.073%, 16.485 %, and 24.6813% than offered AODV and FCESRB methodologies.

Keywords: Sovereign, Clustering, Fuzzy rules, and Signal Potency.

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1. INTRODUCTION

The Smart Dust Network (SDN) contains a rapid improvement in wireless equipments. Usually wireless network is categorized into two (i) infra-structure and (ii) infra-structure-less topology. Infra-structure related links smart dust nodes are associated and preserved via stationary central regulator for example Wireless-Local Area Networks (W-LANs). Infra-structure-less topology smart dust nodes are accumulated in ad-hoc behavior wherever smart dust nodes are utilized broadcasting through multi-hop manner [1] [2]. MWSN is a sovereign network of smart dust nodes that travels randomly and joins via multi-hop associations [3]. In MWSN smart dust nodes are functioning as a router to exchange information in network [4]-[6].

MWSN smart dust nodes are stirring freely and design of network alters automatically which constructs routing complexity in route detection method. The characteristics of MWSN are quick exploitation, scalability, flexible, sturdiness and mobility [9]. Energy-resourceful routing is a resolution to amplify life of the MWSN [7], [8]. To establish energy related routing methodology in MWSN mobility and low resource are important factors to consider. Fuzzy related mechanism is utilized to enhance success of routing in MANET [10], [11]. Fuzzy logic is proficient to estimate accuracy of output related with estimation of factors concerned. In MWSN clustering approach supports accessibility and enlarges scalability of system [12], [13]. Clustering approach offers a proficient manner to diminish energy expenditure by reducing amount of packets broadcasted to nearby smart dust nodes [14]. Clustering approach formulates network design in simple and controllable to enlarge network throughput and diminishes routing precision [15].

The remaining parts of research work are structured as. In *Section 2* related work is presented. *Section 3* provides an epigrammatic depiction of Fuzzy Based Secured CH Clustered methodology. *Section 4* converse the simulation outcomes of Fuzzy Based Secured CH Clustered methodology. In *Section 5* the collusion of proposed Fuzzy Based Secured CH Clustered methodology is offered.

2. RELATED WORK

The Cluster-Based Routing-Protocol-(CBRP) splits system into various overlapped two-hop width clusters. In clusters cluster-head (CH) conserve cluster association information. Cluster association information utilized to decide CH. Clustering approach diminishes flooding in route innovation stage and expands routing approach [16]. The Low-Energy-Adaptive-Clustering-Hierarchy-(LEACH) approach arbitrarily decide CH and broadcast node responsibility to allocate smart dust node energy expenditure [17]. In Hybrid-Energy-Efficient-Distributed-(HEED) clustering approach to enlarge network life. Choosing CH is related with node lingering energy to enlarge system life. The main objective of HEED is to diminish energy expenditure throughout CH selection stage and enlarge system life [18]. In Vice CH on Cluster-Based Routing-

Protocol-(VCHCBRP) established to enlarge throughput of CBRP [16]. It is intended to maintain self curing clusters. The throughput of VCHCBRP enlarges system constancy and clustering consequence [19]. Improved-Cluster Based-Routing-Protocol-(i-CBRP) is an improvement of CBRP [16] to establish a constant cluster [20].

3. PROPOSED FSCC TACTIC

The main goal of Fuzzy Based Secured CH Clustered (FSCC) approach is to enlarge life of MWSN by deciding an energy-resourceful CH by fuzzy related technique. The FSCC approach is intended to establish an energy-resourceful path to diminish complete drainage of energy from smart dust node. The appropriate CH choice preserves smart dust node energy throughout route innovation procedure. The FSCC cluster method reduces network congestion and routing transparency. When smart dust nodes are located in system they are combined into groups as clusters. The smart dust nodes inside cluster evaluate velocity, signal potency and lingering energy of its intermediary smart dust nodes. The smart dust nodes apply fuzzy rules procedure to evaluate smart dust node cost. Smart dust node with greater cost is chosen as CH. CH implements packet broadcasting. Smart dust node cost is evaluated for time T, and evaluated cost is smaller than earlier smart dust node cost, then smart dust node with greater cost is chosen as CH.

3.1. Evaluation of Metrics

In this section elucidates routing constraints engaged in FSCC approach. FSCC approach utilizes velocity, signal potency and lingering energy to construct a consistent CH.

Lingering Energy

Smart dust nodes lingering energy represents smart dust nodes left behind energy capability. Smart dust nodes can globule energy of diverse causes as amount of packet, nature of packet and remoteness amongst smart dust nodes. Existing energy indicates quantity of energy exhausted throughout system process. Therefore, existing energy is utilized to enlarge network life and exposed in *equation 1*,

$$LE = I_{eng} - [(tn * T_{pow}) + (rn * R_{pow})] \quad (1)$$

Where, I_{eng}-Starting energy, T_{pack}-amount of packets Broadcasted, T_{pow}-Broadcasting power, R_{pack}-amount of received packets, R_{pow} -entire energy expenditure.

Velocity

Velocity is represented by space travelled in duration time. Velocity (V) of smart dust node is depends on movement of smart dust nodes from one location to other location. Velocity is symbolized in *equation 2*,

$$V = \sum_{t=1}^{T} \left(\frac{\sqrt{a-x} + \sqrt{b-y}}{T} \right) \quad (2)$$

Where a->a_t, b->b_t, x-> a_{t-1}, y->b_{t-1}.

(a_t, b_t) and (a_{t-1},b_{t-1}) are smart dust node points at time t and (t − 1)- normal velocity for every smart dust node for existing time T.

Signal Potency

Signal potency (SP) exposes broadcasting power at transceiver smart dust node (BP_{trans}) and receiving power at recipient smart dust node (BP_{rec}). Related with Friis' formula identifying signal potency is based on sender farness. Receiving power is represented in *equation 3*,

$$SP = BP_{trans} * \alpha * \beta * \left(\frac{\lambda}{4\pi f} \right) \quad (3)$$

BP_{trans}-transceiver power, BP_{rec}-receiving power, α – transceiver-gain, β-receiver-gain, λ-wavelength, and f - farness.

3.2. Algorithm for Cluster Formation

Cluster Formation steps include in FSCC approach portray as,

1. Group of smart dust nodes (s_i, i=1, 2… n) are located in system. Each s_i divided into group of smart dust nodes into nearby groups as clusters.
2. For every nearby smart dust nodes, s_i calculates Velocity, Signal potency and Lingering energy by utilizing equations 1, 2, 3.
3. Every s_i, utilize fuzzy rule procedure for inputs Velocity, Signal potency and Lingering energy and produce output as Cost.
4. After evaluating cost every s_i decides one of its nearby smart dust nodes contains greatest cost is preferred as CH.
5. Every s_i circulates Join_Request packet to elected CH.
6. When CH receives Join_Request packet then CH transfer a CH_ACK packet to entire smart dust nodes in cluster.
7. After s_i joins with CH smart dust nodes exchange information to CH and CH exchanges to basestation.

3.3. Fuzzy Based CH Selection

In this part elucidates selection of most favorable CH by utilizing fuzzy inference system (FIS). In fuzzification part three input constraints as lingering energy, velocity and signal potency are fuzzified. In FSCC approach triangular member-ship function is utilized member-ship function is formed by straight lines. Fuzzy inputs are characterized in *Figures 1*, *2* and *3* as Lingering energy, Velocity and Signal potency. *Figure 4* describes output fuzzy as Node Cost.

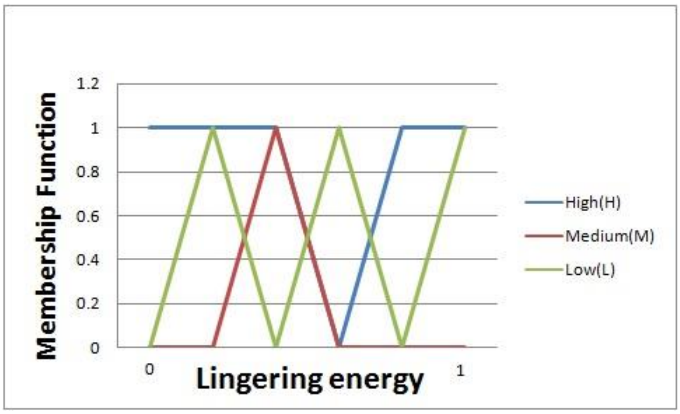

Figure 1: Member-ship Function for lingering energy

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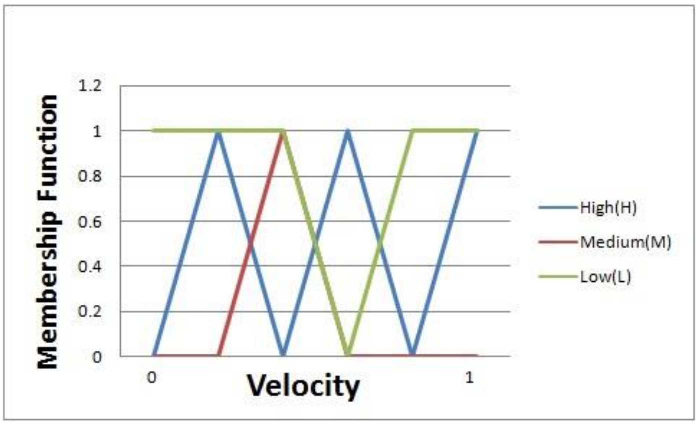

Figure 2: Member-ship Function for Velocity

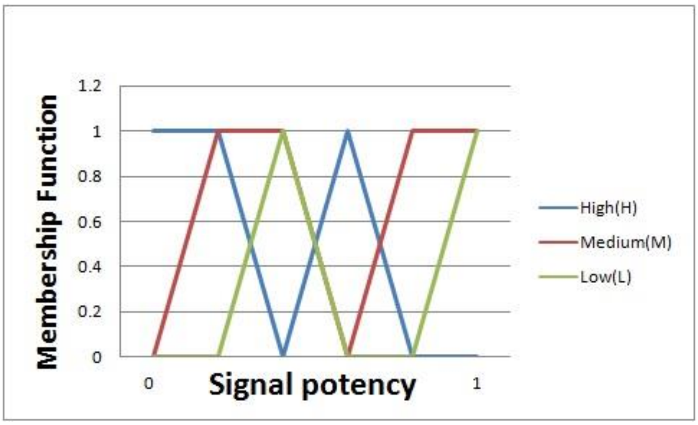

Figure 3: Member-ship Function for Signal Potency

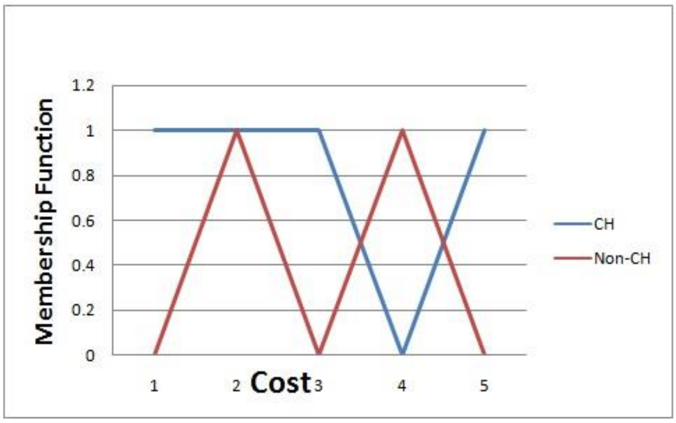

Figure 4: Member-ship Function for Fuzzy output Node Cost

The mobile smart dust node with utmost lingering energy important factor in routing and choosing appropriate Cluster Head(CH) that accumulates mobile smart dust node energy so that enhances network duration. The signal potency is utilized to recognize connection quality amongst couple of mobile smart dust nodes. The velocity is measured as a vital parameter since the velocity of mobile smart dust node reversely agitates the signal power. Fuzzy inference procedure is related with fuzzy rule which combines input and output membership procedure.

Table 1 Indicates fuzzy rules for CH election.

Table 1: CH Selection utilizing Fuzzy

If			Then
LE	**V**	**SP**	**Cost**
L(0)	L(0)	L(0)	Non-CH
L(0)	L(0)	M(1)	Non-CH
L(0)	L(0)	H(2)	Non-CH
L(0)	M(1)	L(0)	Non-CH
L(0)	M(1)	M(1)	Non-CH
L(0)	M(1)	H(2)	Non-CH
L(0)	H(2)	L(0)	Non-CH
L(0)	H(2)	M(1)	Non-CH
L(0)	H(2)	H(2)	Non-CH
M(1)	L(0)	L(0)	Non-CH
M(1)	L(0)	M(1)	Non-CH
M(1)	L(0)	H(2)	CH
M(1)	M(1)	L(0)	Non-CH
M(1)	M(1)	M(1)	CH
M(1)	M(1)	H(2)	CH
M(1)	H(2)	L(0)	Non-CH
M(1)	H(2)	M(1)	Non-CH
M(1)	H(2)	H(2)	Non-CH
H(2)	L(0)	L(0)	Non-CH
H(2)	L(0)	M(1)	CH
H(2)	L(0)	H(2)	CH
H(2)	M(1)	L(0)	Non-CH
H(2)	M(1)	M(1)	CH
H(2)	M(1)	H(2)	CH
H(2)	H(2)	L(0)	Non-CH
H(2)	H(2)	M(1)	Non-CH
H(2)	H(2)	H(2)	CH

Defuzzification is ultimate phase of fuzzy inference procedure. The defuzzification procedure removes the crispy cost from output fuzzy value. Centroid methodology is applied for defuzzification since of its accurateness. *Equation 4* represents centroid methodology for defuzzification procedure.

$$F_{sc} = \frac{\sum_{rules} f_i * \mu(f_i)}{\sum_{rules} \mu(f_i)} \qquad (4)$$

Where, F_{sc} represents the steady connection, fi - fuzzy variable, μ (fi) -membership procedure.

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4. SIMULATION OUTCOMES

The FSCC is simulated in NS2 to demonstrate proposed approach. *Table 2* shows the simulation characteristics. The FSCC approach is evaluated with AODV and FCESRP routing approaches with related environmental parameters shown in *table 3*.

Table 2: Evaluation of AODV, FCESRP with FMC

Characteristic	AODV	FCESRP	FSCC
Path Evaluation	Hasty	Hasty	Hasty
Path Configuration	Smooth	Hierarchical	Hierarchical
Local renovate	Yes	Yes	Yes
Revise Period	Event-Driven	Event-Driven	Event-Driven
CH election	-	Bandwidth, Number of Intermediate Nodes, Computer effectiveness, Power utilization	Lingering Energy, Velocity, Signal power
Path election Parameter	Freshness and Shortest Path	Energy-Aware	Energy-Aware
Transparency	Huge	Huge	Small
Cycle Avoidance	Yes	Yes	Yes
Path Attainment Duration	Small	Modest	Huge
Energy Management	Small	modest	Huge
Multiple Path	Yes	Yes	Yes
Scalability	No	Yes	Yes

4.1. Evaluation Metrics

Packet deliverance Rate (PDR): PDR denotes amount of packets, exchanged effectively to target mobile smart dust node is portrayed in *equation 5*.

$$PDR = \frac{\sum \text{Amount of packet obtained}}{\sum \text{Amount of packet broadcast}} \quad (5)$$

Average Delay (AD): AD represents to time engaged for packet to arrive at target mobile smart dust node is portrayed in *equation 6*.

$$AD = \frac{\sum \text{Entry time-deliverance time}}{\sum \text{Entire packet obtained}} \quad (6)$$

Energy utilization (EU): EU signifies quantity of energy utilized by mobile smart dust node in the environment is portrayed in *equation 7*.

$$EU = \frac{\sum \text{Entire energy utilized}}{\sum \text{Total mobile smart dust}} \quad (7)$$

Table 3: Simulation Constraints

Constraints	Cost
Amount of Smart dust nodes	50,100,150,200
Network range	500 x500m^2
velocity	5-27.5m/s
µ	0.5,0.6,0.7,0.8,0.9
Broadcasting Bandwidth	250m
Simulation Duration	300S
MAC	802.11

4.2. Output Evaluation by Altering Number of Nodes

Output of FSCC is compared with established AODV and FCESRP routing approaches. *Figure 5* demonstrates the PDR Vs amount of mobile smart dust nodes. The normal PDR for FSCC is 88.13% since it desires an efficient CH that alleviates the network configuration and diminishes the regular linkage breakdowns.

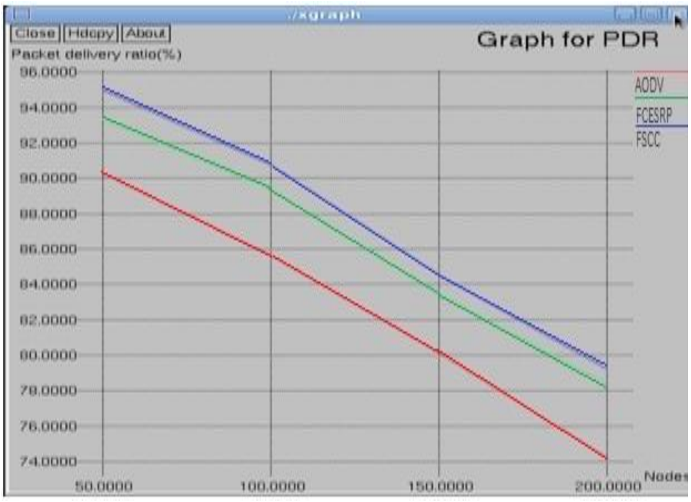

Figure 5: PDR Vs Amount of mobile smart dust nodes

Figure 6 demonstrates the delay in provisions of m/s with the amount of mobile smart dust nodes. The FSCC divulges the minute end-to-end delay by 16.825% due to signal potency is calculated as a foremost constraint for determining a successful CH that diminishes packet dropping.

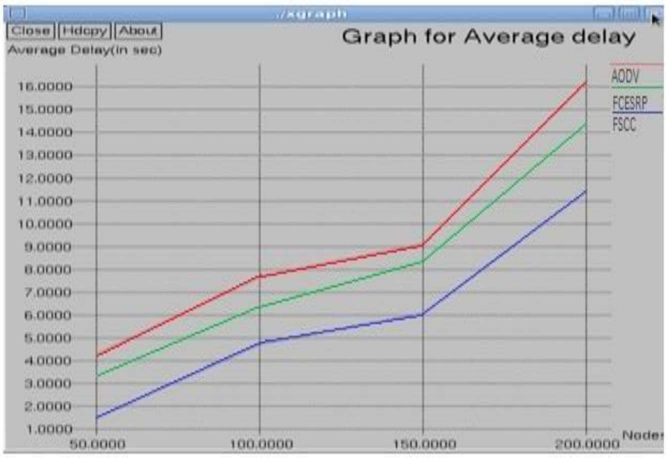

Figure 6: Average Delay Vs Amount of mobile smart dust nodes

Figure 7 demonstrates the energy utilization in provisions of *joules* with the amount of mobile smart dust nodes. The FSCC diminishes the energy debauchery by 26.273% since the most favorable CH determination diminishes the packet dropping and diminishes the retransferring of data packets.

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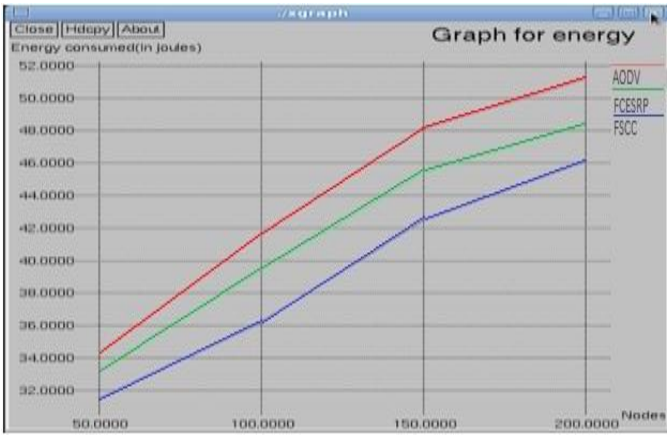

Figure 7: Energy utilization Vs Amount of mobile smart dust nodes

5. CONCLUSION

In this research work Fuzzy Based Secured CH Clustered (FSCC) approach, the mobile smart dust nodes in the cluster implements the outstanding energy, velocity and signal power of the intermediary mobile smart dust nodes. The intermediary mobile smart dust nodes are applying the fuzzy procedure to discover the mobile smart dust nodes cost. The mobile smart dust node with the maximum cost is elected as cluster head. Throughout the broadcasting, the cluster head accumulates the data from entire mobile smart dust nodes and executes data broadcasting. In the cluster preservation phase, the mobile smart dust nodes cost is premeditated for each cycle. If the cost of obtainable cluster head diminishes, the mobile smart dust node with subsequent maximum mobile smart dust node cost is elected as a fresh cluster head.

Conflict of Interest:

The author declares that they have no conflict of interest.

Research involving human participants and/ or animals:

This manuscript does not contain any studies with human participants or animals performed by any of the authors.

Informed consent:

Informed consent was obtained from all individual participants included in the manuscript.

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