APPLICATION OF BLOCKCHAIN FUZZY GRAPH IN ZIGBEE PROTOCOL

J. Jon Arockiaraj[1] and V. Charumathi[2]
Head of the dept[1], Research scholar[2]
PG & Research Department of Mathematics,
St. Joseph' s College of Arts and Science(Autonomous),
Cuddalore, Tamil Nadu, India.

Abstract: ***In this paper, we have found application for Blockchain fuzzy graph with zigbee protocol. The relation between the zigbee protocol and blockchain fuzzy graph are established and we have shown working of zigbee protocol using Blockchain Fuzzy graphs has also been derived with algorithm and flow chart.***

Keywords: Fuzzy graphs, Blockchain, Blockchain Fuzzy Graphs, Zigbee protocol.

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1. Introduction:

1.1 - Fuzzy Graph

Fuzzy Logic has developed into a large and deep subject. Zadeh addresses the terminology and stress the fuzzy graph are the generalization of the calculi of crisp graphs. Several other formulations of fuzzy graph problems have appeared in the literature. The first definition of fuzzy graph by Kaufmann in 1975 who considered fuzzy relation on fuzzy sets and developed the theory of fuzzy graphs. During the same time Yeh and Banh in 1975 also introduced fuzzy graph independently and studied various connectedness concepts. The degree of the vertex in fuzzy graph was discussed by Nagoorgani and Radha.

1.2 - Blockchain

The first blockchain was conceptualized in 2008 by an anonymous person or group recognized as Satoshi Nakamoto and implemented in 2009 as a core component of bitcoin where it serves as the public ledger for all transactions.

The discovery of the Blockchain for the bitcoin made it the first digital currency to solve the double spending problem without the need of a trusted authority or central server. As a distributed ledger, a blockchain is typically managed by a peer-to-peer network collectively adhering to a protocol for validating new blocks. Once recorded, the data in given block cannot be changed retroactively without any adjustment of all subsequent blocks, which requires collision of the network majority. The first work on a cryptographically secured chain of blocks was described in 1991 by Stuart Haber and W. Scott Stornetta 1992. Bayer, Haber and Stornetta incorporated Merkle trees to the design, which improved its efficiency by allowing several documents to be collected into one block. By using a blockchain, bitcoin became first digital currency to solve the double spending problem without requiring a trusted administrator and has been the inspiration for many additional applications. In this paper we are establish a relationship between blockchain fuzzy graph and zigbee protocol.

1.3 - Zigbee protocol

Zigbee Technology is a Wireless Communication Standard that defines a set of protocols for use in low data rate, short to medium range wireless networking devices like sensors and control networks. The target of Zigbee Technology is low cost, low power, battery operated wireless sensors that do not need to constantly update its status and also allows sleep mode or low power mode for its electronics and radio. Zigbee Technology is based on IEEE 802.15.4 Standard and the Zigbee devices operate in the unlicensed 2.4 GHz ISM Band (ISM – Industrial, Scientific and Medical).Although 2.4 GHz band is commonly used worldwide for commercial Zigbee devices, there are devices that use a different set of frequency bands like 784 MHz, 868 MHz and 915 MHz in China, Europe and USA (and Australia) respectively.

The data rates in Zigbee Technology are dependent on the frequency band. For example, the 868 MHz band supports a data transfer rate of 20 kbps while the more common 2.4 GHz band supports data rates up to 250 kbps. Before digging deep in to Zigbee Technology, let us take a look at two application, where Zigbee can be used. One application is the in-home patient monitoring, where a patient wears a Zigbee device, which periodically collects the information like blood pressure and heart rate. This data is then wirelessly transmitted to a local server in the patient's home . The local server performs basic analysis and the vital information is sent to the Doctor over the internet. Another application of Zigbee is the building's structural health monitoring. This application is very useful in earthquake prone areas. Several Zigbee based wireless sensors like accelerometers are installed throughout the build. These sensors, which form a wireless sensor network, collect information that can be used to detect signs of damage and evaluate whether the building is safe for public or not.

1. Preliminaries:

Definition:2.1

Let V be a non empty set. A fuzzy graph is a pair of functions G:(σ,μ) where σ is a fuzzy subset of V, μ is a symmetric fuzzy relation on σ. (i. e) σ:V →[0,1] and μ: V×V→[0,1] such that μ(u,v) ≤ σ(u) □ σ(v) for all u, v in V where □ stands for minimum. The Underlying crisp graph of the fuzzy graph G:(σ,μ) is denoted as G* :(σ*,μ*) where σ*={ u ϵ V/ σ(u)>0}, μ*={(u,v) ϵV x V/μ(u,v)>0}.

Definition:2.2

A fuzzy graph G:(σ,μ), with the underlying set V, the order of G is defined as O(G) and it is denoted as O(G)=∑σ(v), where v ϵ V.
A fuzzy graph G:(σ,μ), with the underlying set V, the size of G is defined as S (G) and it is denoted as S(G)=∑{μ(u,v)} where u,v ϵ V.

Definition:2.3

Let V be a non empty set. A blockchain fuzzy graph is a pair of functions G:(σ,μ) where σ is a fuzzy subset of V, μ is a symmetric fuzzy relation on σ. (i.e.) σ:V →[0,1] and μ: V×V→ [0,1] such that μ(x ,y) ≤ σ(x) □ σ(y) for all u, v in V, with the following criterion.
If i≠j then∑ [μ (v_i, v_j) ≤ min[σ(v_i), σ(v_j)]] = 1,
If i≠j then∑ [μ (v_i, v_j) ≤ max[σ(v_i), σ(v_j)]] = 1,
then i=j then∑ [μ (v_i, v_j) ≤min[σ(v_i),σ(v_j)] = 0.

Definition:2.4

Let G: (σ,μ) be a fuzzy graph such that μ (u, v) ≥ ½ min {σ (u), σ (v)} for all u,v ∈ V. Then G is self complementary blockchain fuzzy graph.

Definition:2.5

Let G: (σ,μ) be a fuzzy graph. If $d_G(v)=k$ for all v ∈V (i.e.) if each vertex has the same degree, then G is said to be a fuzzy graph of degree k. In a blockchain regular fuzzy graph Σμ(u,v)=1.

Definition:2.6

Let G: (σ,μ) be a fuzzy graph. The total degree of a vertex u ∈V is defined by
$td_G(v)=\sum_{uv\in E}\mu(uv) + \sigma(u) = d_G(u) + \sigma(u) = 1+ \sigma(u)$.
If each vertex has same degree k then G is said to be a totally regular fuzzy graph.
In a blockchain totally regular fuzzy graph all the vertices have the same value.

2. APPLICATION OF BLOCKCHAIN FUZZY GRAPH USING ZIGBEE PROTOCAL USING HOUSEHOLD APPLICANICES

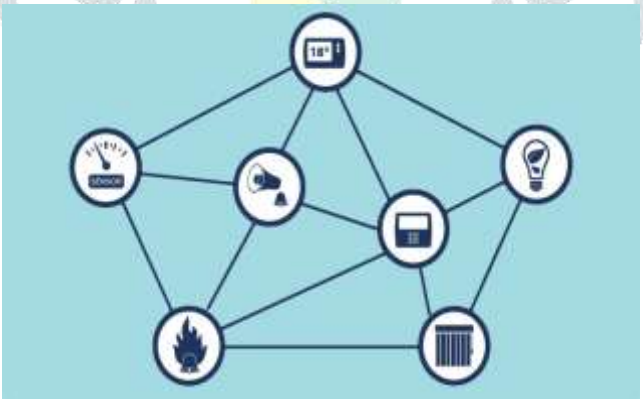


Fig:1-Zigbee Protocol for Home Appliances

Let us consider each appliance as a vertex and each edge as router which transfers the networking route. Let us convert this zigbee household network into blockchain fuzzy graph. Following illustration explains how it connect with zigbee network.
V_1 – Water pump motor, V_2 – Air conditioner, V_3 – Light, V_4 – Sound system, V_5 – Television,
V_6 – Fire alarm, V_7 – Washing Machine.

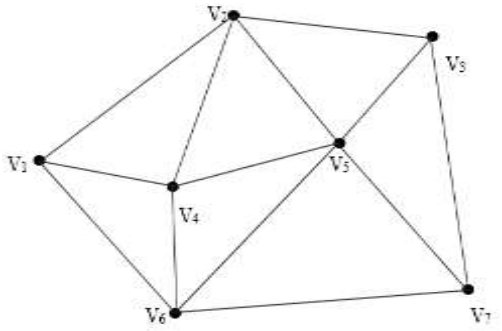


Fig:2- Zigbee Blockchain Fuzzy Graph

	0.6	0.4	0.9	0.7	0.8	0.5	0.3	$\sum V_i$
	V_1	V_2	V_3	V_4	V_5	V_6	V_7	1
V_1	0	0.3	0	0.3	0	0.4	0	1
V_2	0.3	0	0.3	0.3	0.1	0	0	1
V_3	0	0.3	0	0	0.2	0	0.5	1
V_4	0.3	0.3	0	0	0.2	0.2	0	1
V_5	0	0.1	0.2	0.2	0	0.2	0.3	1
V_6	0.4	0	0	0.2	0.2	0	0.2	1
V_7	0	0	0.5	0	0.3	0.2	0	1
$\sum V_i$	1	1	1	1	1	1	1	

Table:1- $\mu(v_i, v_j) \leq \min[\sigma(v_i), \sigma(v_j)]$

3.MINIMUM NO OF WAYS THAT PASSES THROUGH ALL THE VERTEX

Minimum no of ways that circuit pass through to vertex v_1

$V_1 \to V_2 \to V_3 \to V_7$, $V_1 \to V_4 \to V_5 \to V_7$, $V_1 \to V_6 \to V_7$, $V_1 \to V_2 \to V_4 \to V_5 \to V_4 \to V_6 \to V_7$, $V_1 \to V_4 \to V_5 \to V_3$, $V_1 \to V_4 \to V_5 \to V_3$, $V_1 \to V_2 \to V_5 \to V_7$, $V_1 \to V_6 \to V_4 \to V_5 \to V_7$, $V_1 \to V_2 \to V_4 \to V_5 \to V_7$, $V_1 \to V_2 \to V_4 \to V_6 \to V_7$.

Minimum no of ways that circuit pass through to vertex v_2

$V_2 \to V_1 \to V_6 \to V_7$, $V_2 \to V_4 \to V_5 \to V_7$, $V_2 \to V_5 \to V_7$, $V_2 \to V_3 \to V_7$, $V_2 \to V_1 \to V_4 \to V_5 \to V_3 \to V_7 \to V_6$, $V_2 \to V_4 \to V_5 \to V_3 \to V_7$, $V_2 \to V_3 \to V_5 \to V_7$, $V_2 \to V_4 \to V_6 \to V_7$, $V_2 \to V_1 \to V_4 \to V_5 \to V_7$, $V_2 \to V_3 \to V_5 \to V_4 \to V_6 \to V_7$.

Minimum no of ways that circuit pass through to vertex v_3

$V_3 \to V_2 \to V_5 \to V_7$, $V_3 \to V_5 \to V_4 \to V_6 \to V_7$, $V_3 \to V_5 \to V_7$, $V_3 \to V_5 \to V_7$,
$V_3 \to V_2 \to V_1 \to V_6 \to V_4 \to V_5 \to V_7$, $V_3 \to V_2 \to V_1 \to V_6 \to V_7$, $V_3 \to V_2 \to V_5 \to V_7$, $V_3 \to V \to V_6 \to V_7$, $V_3 \to V_5 \to V_4 \to V_1 \to V_6 \to V_7$,
$V_3 \to V_2 \to V_4 \to V_5 \to V_7$.

Minimum no of ways that circuit pass through to vertex v_4

$V_4 \to V_2 \to V_5 \to V_7$, $V_4 \to V_5 \to V_3 \to V_7$, $V_4 \to V_5 \to V_7$, $V_4 \to V_6 \to V_7$, $V_4 \to V_2 \to V_3 \to V_7 \to V_6 \to V_1$, $V_4 \to V_1 \to V_6 \to V_7$, $V_4 \to V_5 \to V_3 \to V_7$, $V_4 \to V \to V_6 \to V_7$, $V_4 \to V_6 \to V_1 \to V_2 \to V_3 \to V_5 \to V_7$, $V_4 \to V_5 \to V_2 \to V_1 \to V_6 \to V_7$

Minimum no of ways that circuit pass through to vertex v_5

$V_5 \to V_4 \to V_6 \to V_7$, $V_5 \to V_2 \to V_4 \to V_6 \to V_7$, $V_5 \to V_4 \to V_7$, $V_5 \to V_3 \to V_7$, $V_5 \to V_4 \to V_2 \to V_1 \to V_6 \to V_1$, $V_5 \to V_2 \to V_3 \to V_7$, $V_5 \to V_4 \to V_1 \to V_6 \to V_7$, $V_5 \to V_4 \to V_6 \to V_7$, $V_5 \to V_3 \to V_2 \to V_4 \to V_1 \to V_6 \to V_7$,

Minimum no of ways that circuit pass through to vertex v_6

$V_6 \to V_4 \to V_5 \to V_7$, $V_6 \to V_1 \to V_2 \to V_3 \to V_7$, $V_6 \to V_1 \to V_2$, $V_6 \to V_4 \to V_2$, $V_6 \to V_4 \to V_1 \to V_2 \to V_5 \to V_7$,
$V_6 \to V_1 \to V_2 \to V_3 \to V_7$, $V_6 \to V_4 \to V_2 \to V_5 \to V_7$, $V_6 \to V_7 \to V_3 \to V_2$, $V_6 \to V_4 \to V_1 \to V_2 \to V_5 \to V_3 \to V_7$,
$V_6 \to V_4 \to V_5 \to V_2 \to V_3 \to V_7$

Minimum no of ways that circuit pass through to vertex v_7

$V_7 \to V_5 \to V_4 \to V_1$, $V_7 \to V_3 \to V_5 \to V_4 \to V_1$, $V_7 \to V_6 \to V_1$, $V_7 \to V_5 \to V_2$, $V_7 \to V_5 \to V_4 \to V_2 \to V_1$,
$V_7 \to V_6 \to V_4 \to V_2 \to V_1$, $V_7 \to V_3 \to V_5 \to V_2 \to V_1$, $V_7 \to V_3 \to V_2 \to V_1$, $V_7 \to V_5 \to V_3 \to V_2 \to V_4 \to V_6 \to V_1$,
$V_7 \to V_3 \to V_5 \to V_4 \to V_2 \to V_1$

4 .ALGORITHM FOR THE WORKING OF ZIGBEE PROTOCAL USING BLOCKCHAIN FUZZY GRAPH:

Precondition: ON==1 , OFF==0.

1.v_1(Water pump):

if (v_1==0.6)and if(v_1 and e_2)==0.3

ac==1;
else
ac==0 and water pump ==1;

if(v_1==0.6)and if(v_1 and e_4)==0.3
sound==1;
else
sound==0 and water pump==1;

if (v_1==0.6)and if(v_1 and e_6)==0.4
Electric alarm==1;
else
Electric alarm===0 and water pump==1;

2.v_2(Air Condition):

if (v_2==0.4)and if(v_2 and e_1)==0.3
water pump motor ==1;
else
water pump=0;AC==1;

if (v_2==0.4)and if(v_2 and e_3)==0.3
light==1;
else
light==0 and AC==1;

if(v_2==0.4) and if(v_2 and e_4)==0.3
sound==1;
else
sound==0 and AC==1;

if(v_2==0.4) and if(v_2 and e_5)==0.1
TV==1;
else
TV==0 and AC==1;

3.v_3(Light):

if (v_3==0.9) and if (v_3 and e_2)==0.3
AC==1;
else
AC===0 and light==1;

if(v===0.9)and if(v_3 and e_5)==0.2
TV==1
else
Tv==0 and light==1;

if(v_3==0.9) and if(v_3 and e_7)==0.5
washing machine==1;
else
Washing machine==0 and Light==1;

4.v_4(Sound System):

if (v_4==0.7) and if (v_4 and e_1)==0.3
water pump==1;
else
water pump==0 and sound==1;

if(v_4==0.7)and if (v_4 and e_2)==0.3
AC==1;
else
AC==0; and sound==1;

if(v4==0.7)and if(v4 and E5)==0.2
Tv==1;
else

Tv==0; and sound==1;

if(v_4==0.7)and if(v_4 and e_6)==0.2
electric alarm==1
else
electric alarm==0 ;and sound==1;

5.v_5(Television):

if (v_5==0.8) and if (v_5 and e_2)==0.1
AC==1;
else
AC==0; and Television==1;

if(v5==0.9) and if(v5 and E3)==0.2
Light==1;
else
Light==0; and Television==1;

if(v_5==0.9)and if (v_5 and e_4)==0.2
sound==1;
else
sound==0; and Television==1;

if(v_5==0.9) and if (v_5 and e_6)==0.2
Electric alarm==1;
else
Electric alarm==0; and Television==1;

if(v_5==0.9) and if (v_5 and e_7)==0.3
washing machine==1;
else
washing machine==0; and Television==1;

6.v_6(Electric alarm):

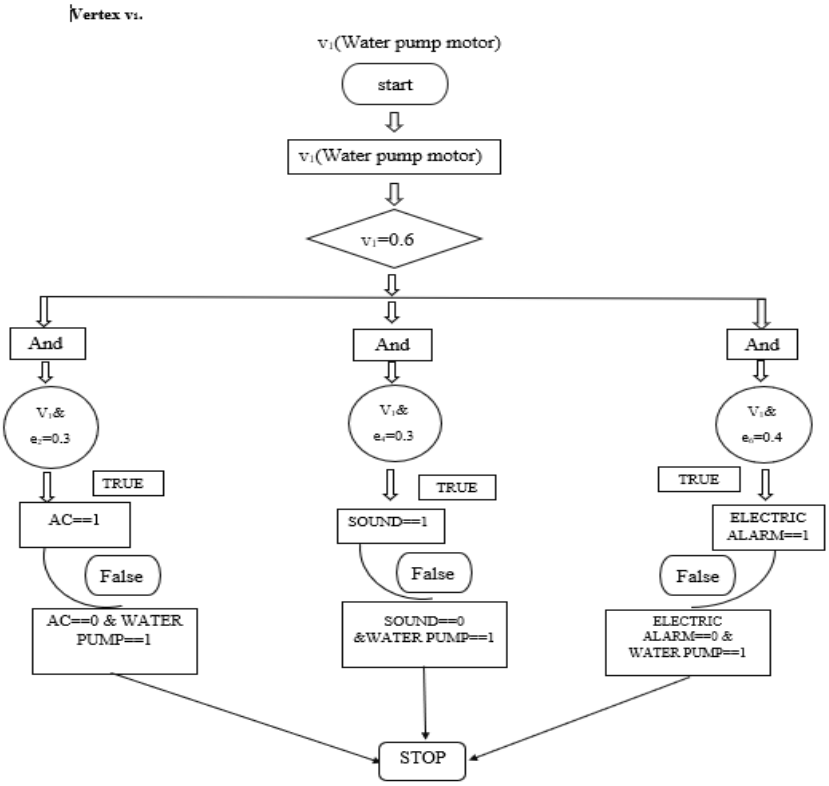
if(v_6==0.5) and if (v_6 and e_1)==0.4
water pump==1;
else
water pump==0; and Electric alarm==1;
if (v_6==0.5) and (v_6 and e_4)==0.2
sound==1;
else
sound==0; and Electric alarm==1;
if(v_6==0.5) and (v_6 and e_5)==0.2;
television==1;
else
television==0; and Electric alarm==1;
if(v_6==0.4)and (v_6 and e_7)==0.2
washing machine==1;
else
washing machine==0;and Electric alarm==1;

7.v_7(Washing Machine):

if(v_7==0.3)and if (v_7 and e_3)==0.5
light==1;
else
light==0; and washing machine==1;
if(v_7==0.3) and if (v_7 and e_5)==0.3
television==1;
else
television==0; and washing machine==1;
if(v_7==0.3)and (v_7 and e_6)==0.2
electric alarm==1
else
electric alarm==0; and washing machine==1;

5.FLOW CHART FOR ZIGBEE PROTOCOL USING BLOCKCHAIN FUZZY GRAPH FOR EACH VERTEX:

We construct the flow chart for the vertex v_1 . Its show that how zigbee house hold appliances are working under the control of blockchain fuzzy graph networking system.



6. Conclusion:

In this paper, we have discussed about application of blockchain fuzzy graph using zigbee protocol with some calculations. We have introduced working procedure of zigbee protocol with the blockchain fuzzy graph network. In the forthcoming paper on this application of blockchain fuzzy graph we will extend the other valid concepts with more examples.

7. References:

[1] J.Jon Arockiaraj, V. Charumathi ., " Blockchain Fuzzy Graph" International Journal of Current advanced Research, (2018).
[2] Jon Arockiaraj.J, Charumathi.V.," Regular and Totally Regular Blockchain Fuzzy Graph"., International Journal of Innovation in Engineering Research and Management,(2018).
[3] Kaufmann, "A Introduction a la Theorie des sons-ensembles flous", Vol. 1, Masson Paris,(1973).
[4] Mourad oqla Massa'deh and Natheer k.Gharaibeh , "Some properties of Fuzzy graph". Advances in fuzzy mathematics (2011).
[5] NagoorGani.A and Radha.K, "On Regular Fuzzy Graphs", Journal of Physical Sciences, (2008).
[6] A.Nagoor Gani and J.Malarvizhi, "Some aspects of total fuzzy graph", International Journal on mathematics and computations Tiruchirappalli (2009).
[7] T.Pathinathan, J.Jon Arockiaraj, J.Jesintha rosline. "Hesistancy Fuzzy graph", India Journal of science and technology.(2015)
[8] K.Radha, and A.Rosemine " Strongly Regular Fuzzy Graph", International journal of scientific and Research Publications(2017).
[9] K.Radha and M.Vijaya " Totally Regular Fuzzy Graph", International Journal of Current Research in Science and Technology.
[10] A.RosenField, Fuzzy Graphs in:L.A Zadeh, K.S Fu, K.Tanaka and M.Shimura, "Fuzzy graphs and its applications to cognitive and decision process",Academic press, New York, (1975)
[11] S.Sudha, M,Satheeshkumar, v.kanniga "On strong, complete, Regular Fuzzy Graph" Mathematical Sciences International Research Journal (2013)
[12] R.T.Yeh and S.Y.Banh, "Fuzzy relations, fuzzy graphs and their applications to clustering analysis", " In Fuzzy sets and their applications to cognitive and decision process", L.A.Zadeh, K.S.Fu.M.Shimura eds : Academic Press, New York, (1975).
[13] Zadeh, L.A., "*Fuzzy Sets"*, Information and Control, (1965).
[14] A gentle introduction to blockchain technology article from www.bitsonblock.net published on 9 september (2015).
[15] "Understanding of Blockchain" from www.blockgeeks.com.
[16] "Bitcoin and Blockchain definitions" from www.WikiPedia.com.