$p_{ij}(m+n) = \sum_k p_{ik}(m) p_{kj}(n)$

The Probability distribution of the n-step system can be calculated by using initial probability distribution and power of transition matrix, is given as
$p^{(n)} = p^{(0)} P^{(n)}$ (10)

where $p^{(0)}$ is initial probability distribution and P is probability transition matrix.

Fetching the data from critical sensing nodes dynamically to sink node can be predicted using probability distribution transform matrix. Initial cluster state can be passive, active or critical. Each state transformation of a cluster can be given by right stochastic matrix. A stochastic matrix is a matrix that can be used to describe transition of Markov chain. Each entry is representing probability. In right stochastic matrix each row summing to 1. As state of next node is dependent on the state of current state only, because when any critical event detected at current node, then and then only the probability of next critical event sensing node comes into picture. Such chains are called Markov chains. Initial state of a node is active that's why we represent this as a single row matrix [0 1 0 0] as per PACR model. By using the equation (10), the probability of current node after a time unit is given by:

f (n) = [P A C R] * [Transition Matrix] (11)

Initial Condition for PACR is [0 1 0 0] because when any sensor node becomes active then only the process is going to start. The state transition diagram can be given as:

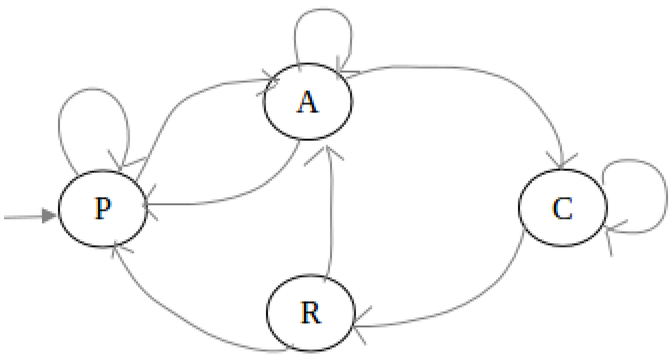

Figure 6: State transition diagram

The computation can be performed by using right stochastic matrix as follow.

$$f(0) = [0\ 1\ 0\ 0] \begin{pmatrix} 1/2 & 1/2 & 0 & 0 \\ 1/3 & 1/3 & 1/3 & 0 \\ 0 & 0 & 1/2 & 1/2 \\ 1/2 & 1/2 & 0 & 0 \end{pmatrix}$$

$$f(0) = [1/3\ \ 1/3\ \ 1/3\ \ 0]$$

$$f(1) = [1/3\ 1/3\ 1/3\ 0] \begin{pmatrix} 1/2 & 1/2 & 0 & 0 \\ 1/3 & 1/3 & 1/3 & 0 \\ 0 & 0 & 1/2 & 1/2 \\ 1/2 & 1/2 & 0 & 0 \end{pmatrix}$$

This matrix multiplication gives the probability of a sensor node after a unit time. As a critical node is responsible to make its in-range sensor node active .We use divide and conquer method. The first critical node state can be calculated using above calculation. We use recursion method as time progresses

$f(n) = [0\ 1\ 0\ 0]\ t_n$ for n=0
$= f(n-1).\ t_n$ otherwise (12)

Hence f(n) gives the probability distribution function of an critical event over the time n.

8. Proposed Algorithms

1. Data Filtration: Detection of critical event by active sensor using threshold values. This task is done by active sensor node. Suppose a an active sensor node i is reading a set of multiple sensing parameters like temperature, humidity, light etc. and that are indicated by $R_{it}=\{R_1,R_2,R_3,\ldots R_n\}$. The sensor nodes are programmed with a short program that detects the critical event by providing a threshold value th_1, th_2, th_3, …, th_n to $R_1,R_2,R_3,\ldots R_n$ respectively. If the condition $((R_1>th_1) \wedge (R_2> th_2) \wedge (R_3>th_3) \wedge \ldots, (R_n> th_n))$ satisfy then sensor node becomes critical node.
2. Send Signal: Critical node will send 'wake up' call to all 'in range' passive sensor nodes and send own (nodeid, t) pair to sink node, where *t* is the timestamp when critical event was detected by sensor node with nodeid *nodeid.*
3. Searching critical event: All waked up sensor nodes starts detecting critical event repeats step 1 and 2 by comparing sensor reading with some predefined values.
4. Reporting: All nodes those detected critical event will report to sink node along with <nodeid,xi, yi,ts> as explained in section 6.
5. Computation: Sink Node calculates growth of critical event and speed of critical event.

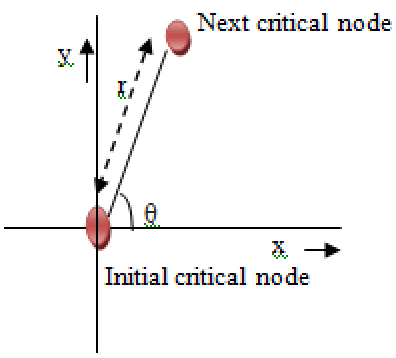

Figure 7: Establishment of node location in graph

Sink node uses directional graph to draw the map of critical nodes. At sink, sequence of operations is performed for evaluating direction of growth and speed of the critical event. a)Next, as each critical node is bounded with the timestamp, we can calculate the average speed of critical event by subtracting two consequent critical node's timestamp using equation (8).

6. Compute probability distribution using HMM: Depends on parameter calculated in step 5, sink node will identify probability distribution by using HMM, probability transformation matrix and Markov chain.
7. Recursion: Use recursion until all nodes are recovered and we have PACR status as [0 0 0 1] for each cluster using equation (12).
8. Search and activate prevention system: Identify all preventing objects in probable affecting area and give activation alert to all.

9. Conclusion

The focus of the work is environmental critical event detection. Sensor nodes are reporters and responsible to sense environmental dimensions for any critical anomaly detection .The sink node is the actor node and responsible to take the appropriate action against the calamity. This model leads the automation and gives an intelligent system that prevents the more losses due to the natural disaster. Wireless Sensor Networking permits more connectivity for sensor applications and provides advanced control over monitoring, automation for a range of industries. The applications of Wireless Sensor Networks are almost titanic with many industries and applications having specific technology requirements such as reliability, battery life, range, frequencies, and topologies, size of the network, sampling rate and sensor use.

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