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AN EMPIRICAL ANALYSIS ON SECURITY AND CONFIDENTIALITY ISSUES IN MOBILE AD-HOC NETWORKS IN ASSOCIATION WITH METAHEURISTIC ALGORITHMS

Dr. Parvinder Singh
Associate Professor
Department of CSE
DCRUST, Murthal, Haryana, India

Dr. Manoj Duhan
Chairman
ECED
DCRUST, Murthal, Haryana, India

Rajinder Singh
Research Scholar
DCRUST, Murthal, Haryana, India

Abstract

Mobile Ad-hoc Network (MANET) is defined as the moving node rather than any fixed infrastructure, act as a mobile router. These mobile routers are responsible for the network mobility. The history of mobile network begin after the invention of 802.11 or WiFi they are mostly used for connecting among themselves and for connecting to the internet via any fixed infrastructure. Vehicles like car, buses and trains equipped with router acts as nested

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Mobile Ad-hoc Network. Vehicles today consists many embedded devices like build in routers, electronic devices like Sensors PDAs build in GPS, providing internet connection to it gives, information and infotainment to the users. These advances in MANET helps the vehicle to communicate with each other, at the time of emergency like accident, or during climatic changes like snow fall, and at the time of road block, this information will be informed to the nearby vehicles. This paper highlights the security and confidentiality issues associated with the mobile ad-hoc networks.

INTRODUCTION

Nowadays technologies rising to provide efficiency to MANET users like providing enough storage space, as we all know the cloud computing is the next generation computing paradigm many researches are conducting experiments on Mobile Ad-hoc Network to provide the cloud service securely.

Genetic algorithm is useful for providing optimization solution in various search related problems using the natural evolutionary techniques like

- Inheritance
- Mutation
- Selection
- Crossover

The main technique followed in genetic algorithm was among the group of people an individual has been selected to solve the optimization problem. The individuals, who have been selected among the group, should be fit for the mutation. Those individuals are mutated form next generation. After producing enough number of generations, this algorithm terminates automatically.

Secure on demand routing technique using Genetic Algorithm

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Routing path is needed for the source and destination nodes connecting for the first time, by broadcasting RREQ message to the neighbouring nodes to find the destination node. If there is a route already established between source and destination.

Implementation of Genetic algorithm in MANET

Genetic algorithm is applied to the paths obtained in route discovery mechanism. These paths should contain Ids of node and their length of strings should not be greater than number of nodes in the network. Genetic algorithm has various components in its design. They are

- Primary population
- Robustness function
- Crossover and mutation

Primary population

In Genetic algorithm more than one offspring can be produced from each chromosome or gene, similar to this, the channel acquired from route discovery mechanism is referred as the primary chromosomes.

Robustness function

The quality of the solution attained with the help of robustness function. The main objective of the Genetic algorithm is to obtain the shortest path the source and destination nodes without any loss of packets and improved throughput. The sustainability of the each node has been obtained through the following calculation.

$$r(Chi) = \sum i \epsilon P(s,r) Ci + Cd$$

$$r(Chi) = chromosome\ robustness\ value$$

$$Cd = delay\ time\ of\ chromosome$$

$$Ci = cost\ of\ the\ path$$

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Crossover and mutation

Crossover has been used to obtain better result from the current chromosome by interchanging its genetic structure, without crossover the offspring looks exact to their parent. Mutation is defined as the changes in the chromosome sequence or DNA sequence to alter the genetic information carried out by the gene.

Genetic algorithm in MANET

Genetic algorithm is used in MANET to identify the shortest path. Shortest path is identified by selecting the route with minimum hop count. This path helps in reducing the delay.

The steps involved in computation of genetic algorithm are

- The first step is to set the constraint limits for the shortest path.
- Values are randomly generated between these limits.
- The route value that has been generated is put into the intent function.
- The robustness is evaluated for various routes using this procedure

$$rmax\ (n,1) = \max\left(rx(n,1)\right)$$

$$rmin(n,1) = min\left(rx(n,1)\right)$$

$$for\ i = 1{:}z$$

$$rt(i,j) = \left(rmax(n,1) - rmin(n,1)\right) - rx(n,1);$$

$$end$$

$$rtb = mean(rt);$$

$$for\ i = 1{:}z$$

$$bf(i,1) = \frac{rt(i,1)}{rtb};$$

$$end$$

- The best fit is calculated using this equation

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- Roulette wheel concept is used for the selection, the values providing best fit has higher probability of providing the offspring.
- Crossover grants inclusion of extra character into the offspring.
- Mutation is performed if the repeated values are similar.
- The new values increases minimization techniques are plotted to perform route optimization.

$$rx = robustness\ value$$

$$rt = normalized\ rx$$

Swarm intelligence

Swarm intelligence is an artificial intelligence technique introduce by Beni and wang in 1989, in the perspective of cellular robotics, it is based about the study of combined behaviour of self organized systems.

Swarm intelligence is usually conjured of simple agents from a population interacting with each other locally. Basically there is no instructor to control the system how to perform, but this local instance lead to the global activities emergence.

Swarm intelligence types

There are two basic swarm intelligence types namely

- Ant colony optimization
- Atom swarm intelligence

Ant colony optimization

A complex task cannot be performed by a single ant, but a group of ants can make even a complex task into simpler ones. Ant colony optimization technique is used to provide fair resolution to the various optimization problems. In this optimization technique moving man-made ants are really helpful in providing solutions by impersonating the real ants, dump

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fake pheromone on the graph so that the future man-made ants can provide even better solution to these problems.

Implementation of ant colony optimization algorithm

In an ant colony, the ants sorted their foods and larvae in consistent heaps. There are several steps helpful solving the optimization problems in MANET.

- The platform is a two dimensional lattice
- The mobile nodes are sprinkled on the lattice
- The artificial ants are developed in such a way that automatically leap from one node to the another node
- Each and every node has ability to change the colour of the mobile node in accordance with the perspective rules.
- This perspective rule requires only local values as the input.

The mobile nodes are coloured, re-coloured or made colourless by a mechanism which take local data as an input. The constriction on colouring the node depends on type of node and its cluster capability.

The **probability** $P(d)$ of discolouring a mobile node A, is denoted as follows

$$P(d) = (Cd/(Cd + fa(x)))^2$$

x=number of exclusive neighbour

Cd=constant

$fa(x)$=local density function related to node A

The **probability** $P(r)$ of re colouring a mobile node A, increases with number of similar coloured nodes in the neighbourhood.

$$P(r) = (fa(x)/(Cr + fa(x)))^2$$

Cr=constant

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$fa(x)$=local density function related to node A

The probability of untouched nodes $P(U)$

$$P(U) = 1 - (P(d) + P(r))$$

It is used to estimate the traffic overhead of the mobile node A.

Benefits

- This algorithm helps in the reduction of IP header size
- It reduces the transmission power to reach the cluster heads in MANETs
- Nodes registered with more than one group acts as a bridge for providing many paths with fault tolerance capacity.

Atom swarm intelligence

Atom swarm intelligence is used to optimize the problem with the observance of its quality. This technique solves the problem using mathematical formulae, by means of position and speed of the atom. The solutions are represented in n-dimensional space.

Implementation of Atom swarm intelligence algorithm

Atom swarm intelligence consists of group of s atoms, which helps in providing prospective solutions.

- The atoms explore in the n-dimensional to find universal solution
- The n represents the constraint that has to be improved.
- All the atoms resides in a location Lid and transfers with a velocity vid, where $1 \leq i \leq s$ and $1 \leq d \leq n$.
- The atoms are assigned primarily with indiscriminate location and velocity
- The robustness of the atom is determined from its positions.
- The atoms closure to the universal solutions has the greatest robustness values than the atoms which are too far from universal solutions.
- To obtain better robustness the location details and the velocities are updated frequently.

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- The magnitude and direction of the atoms are obtained from the previous velocities.
- The occurrence of the atom and its knowledge is obtained from the groups through the public interface.
- Every atom has its own memory, to store $ptopid$.
- $ptopid$, is stored in most suitable position in a memory.
- $mtopd$, is the greatest of all $ptopid$ in that memory.
- $mtopd$, produces the best results has ever been produced before.
- This intelligence algorithm inserts velocity vid into the atoms location Lid, on every iteration.
- The atoms are routed towards $ptopid$ and $mtopd$, velocity and location update are calculated using this equations respectively.

$$vid(i+1) = w.vid(i) + C1.random1.(ptopid - Lid) + C2.random2.(mtopd - Lid)$$

w=inertia coefficient it ranges $0.2 < w < 1.2$

$C1$=cognitive acceleration constant

$C2$=public acceleration constant

$$Lid(i+1) = Lid(i) + vid(i+1)$$

Pseudo code for atom swarm intelligence algorithm

Declare $w, C1, C2$, max_iterations, target_suitability, $Lmin, Lmax, vmin$ and $vmax$

FOR each atom A

FOR each dimension d

Declare Location randomly, $Lmin \leq Lid \leq Lmax$

Declare Velocity vid randomly, $vmin < vid < vmax$

End FOR

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END FOR

Iteration i=0

DO

FOR each atom A

Calculate suitability (A)

IF suitability (A) > suitability $(ptopid)$

FOR each dimension d

$ptopid = Lid$

End FOR

END IF

IF suitability (A) > suitability $(mtopd)$

FOR each dimension d

$mtopd = Lid$

End FOR

END IF

END FOR

FOR each atom A

FOR each dimension d

Compute velocity according to the equation

$$vid(i+1) = w.id(i) + C1.random.(ptopid - Lid) + C2.random(mtopd - Lid)$$

Update atom position as per equation

$Lid(i+1) = Lid(i) + vid(i+1)$

Confine vid within $vmin$ and $vmax$

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Confine Lid with $Lmin$ and $Lmax$

END FOR

END FOR

i=i+1

WHILE i $\leq$ max_iterations AND suitability $(mtopd)$ $<$ target_suitability

Memetic algorithm

Memetic algorithm is used as an interaction of any population based approach for every individuals learning on their own. Memetic algorithm plays an important role in evolutionary computation. This algorithm is also named as evolutionary algorithm. According to Richard dawkins meme is the fundamental unit of cultural transmissions or replications. The term memetic came from the word meme. Meme represent the cultural changes apart from genetic changes.

Implementation of Memetic algorithm

This algorithm produces several solutions for a single problem at hand. These solutions are entitled as individual in Evolutionary algorithm terminology. These solutions are treated to show similar behaviour during corporate assistance and competition, to make everyone accept they are from same species.

Fundamental initialization pace

Manage Do-initiation $(\uparrow\downarrow ppl: single_persons[])$

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Variables

keepers← $select_from_General_people(ppl)$

newppl← $initiate_new_General_people(keeper)$

ppl← $update_General_people(ppl, newgrp)$

End

Initiating the new group

$(\downarrow ppl: single_persons[], \downarrow opr: operator[]) \rightarrow single_persons[]$

Variables

$buffer: single_persons[][];$

$i = [1..|opr|];$

BEGIN

$buffer[0] \leftarrow ppl;$

FOR $i - 1: |opr|$ do

$buffer[i] \leftarrow$ Use_Operator$(opr[i], buffer[i-1]);$

End FOR

Return $buffer[nopr]$

END

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Pseudocode for Memetic algorithm

```
BEGIN
    DECLARE family;
    ASSESS each participant;
    WHILE (FINAL CONDITION not satisfied) DO
        SELECT parents;
        RE-INTEGERATE parents in pairs;
        TRANSFORM the resulting children;
        LOCAL SEARCH the produced children;
        ASSESS new participant;
        SELECT individual children for the next generation;
    END WHILE
END
```

Pseudocode for Local search scheme

```
BEGIN
    WHILE (FINISHING CONDITION is not satisfied) DO
        new solution ← nearby (finest solution)
```

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IF new solution IS PERFECT THAN actual solution THEN

top solution ← real solution

END IF

END WHILE

END

Fuzzy logic

Fuzzy logic is a multi valued technique, it is proposed by lotif zade in the year of 1965. Fuzzy logic manages approximate reasoning rather than unchanging and exact prediction. Fuzzy logic uses the binary values like 0 and 1 as the variables, to predict the results. Fuzzy logic technique provides approximate solutions to the unclear data or partial data.

Fuzzy logic degree of truth

Fuzzy logic is mathematically similar to the probabilistic logic, but fuzzy logic differ from probabilistic logic only based on truth values like 0 and 1, fuzzy logic related to degree of truth, whereas probabilistic logic corresponds to probability prospects.

Types of fuzzy logics

There are several types of fuzzy logic as per mathematical logic, they are

- Relative fuzzy logic
- Predicate fuzzy logic

Relative fuzzy logic

The significant relative fuzzy logics are

- Monoidal t-norm predicate relative fuzzy logic
- Fundamental relative fuzzy logic

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- Lucasiewicz relative fuzzy logic

Monoidal t-norm predicate relative fuzzy logic

Monoidal t-norm predicate relative fuzzy logic is maximization logic in this left incessant t norm defines the combinations and residuum of t-norms defines the suggestion. Monoidal t-norm predictive algebra related to this model.

The left incessant t norms is defined as

$u * v \leq w$ if and only if $u \leq (v \rightarrow w)$

The residuum of left incessant t norms are defined as

$$u \rightarrow v - \sup [w | w * u \leq v]$$

This equation promotes residuum is the largest function for all u and v

$$u * (u \rightarrow v) \leq v$$

The residuum of left in cession t norms can be determined as the feeble function it makes fuzzy logic model as legitimate

Fundamental relative fuzzy logic

Fundamental relative fuzzy logic is the extension of monoidal t-norm predicate fuzzy logic, in this the combinations are denoted as residuum of t-norm, fundamental relative fuzzy logic is related to the fundamental relative fuzzy logic algebra.

Lucasiewicz fuzzy logic

Lucasiewicz fuzzy logic is the extension of fundamental relative fuzzy logic. It has the adage of basic fuzzy logic as well as adage of double negotiation. Lucasiewicz model includes the fundamental relative fuzzy logics.

Godel fuzzy logic

Godel fuzzy logic is the fundamental relative fuzzy logic, it has the combination of Lucasiewicz fuzzy logic as well as the adage of combination, and its models are called G-algebra.

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Invent fuzzy logic

it is also the extension of fundamental relative fuzzy logic, it has the combination of invent fuzzy logic and another adage of eliminate combination, and its models are called invent algebras.

Predicate fuzzy logic

Predicate fuzzy logic widens the above mentioned fuzzy logics by including worldwide and existential identifiers in this manner the propositional logic creates the predicate logic. The terminology of worldwide identifier is Infimum in the t-norm fuzzy logic Infimum is also called as infima.

Implementation of fuzzy logic

A= collective objects

A = Denoted as a

Fuzzy set W= ordered pairs

$W = \{(A, \mu_W(A))| \ a \epsilon A\}$

$\mu_W(A)$ = Membership function

Or

$\mu_W(A)$ = Grade of Membership of a in W which maps A to member M

Logical connections

OR

$W \cup V \rightarrow \mu_{W \cup V}$ =Max $[\mu_W(a), \mu_V(a)]$

AND

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$$W \cap V \rightarrow \mu_{W \cap V} = \text{Max}\ [\mu_W(a),\ \mu_V(a)]$$

NOT

$$V : \bar{V} \rightarrow \mu_{\bar{V}}\ (a) = 1 - \mu_V\ (a)$$

Pseudocode for fuzzy logic technique

STEP 1

BEGIN

IF target is DAMAGER OR IMPACTER OR INDICATOR

THEN

The target is SIGNIFICANT

END

STEP 2

BEGIN

IF the target is FINISH and NO FRIEND

THEN

The target is DAMAGING

END

Artificial neural network

An artificial neural network is an interconnection of nodes, like neurons connected to the brain. A neural network consists of many artificial neurons with interconnected groups, it process the information using the psychology approach to the calculation. Neural systems have the adaptive character so that it can change its structure during the learning phase.

Neural networks are used to design a complex relationship between input and output data. The neural networks are inspired from exploratory central nervous system. In artificial neural network the artificial nodes are connected to each other to form a network.

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Neural network models in artificial intelligence are referred as artificial neural network. It is usually defined by the function

$$f = U \rightarrow V$$

Sometimes it is associated with some rules or particular algorithms. Artificial neural networks are used for defining the class functions.

Network function

Network refers to interconnections between neurons, suppose consider a network consist of five levels the first level is the input, second, third and fourth level are the senders and the fifth level is the output neurons.

Artificial neural networks consists of three parameters

- The interconnection prototype between different levels of the neurons.
- The learning procedure for updating the weights of the interconnections.
- The activation neuron function converts the neurons biased input to its output commencement.

The network function $f(s)$ is defined from work of other functions $ni(s)$, this expediently represented as network structure, the extensively used type of work is the non linear weighted sum, where

$$f(s) = C(\sum_i wini(s))$$

C = activation function

ni = Vector

There are two types of views in artificial neural networks

- First view or fundamental view
- Second view or probabilistic view

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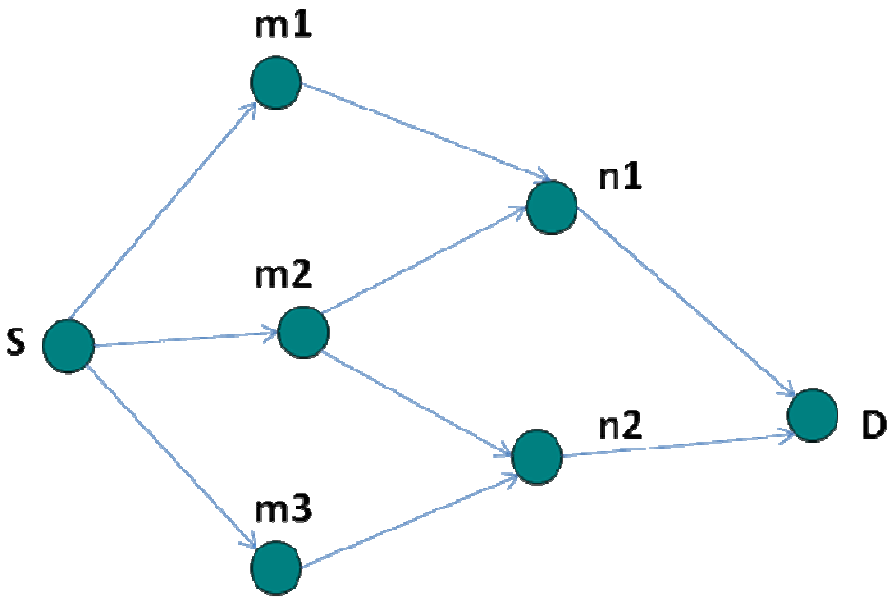

Figure 1 : Artificial dependency graph

First view or fundamental view

The input S is transformed into a 3-dimensional vector m, which is then transformed into a 2 dimensional vector n, which is finally transformed into D. This type of view is commonly encountered as optimization.

Second view or probabilistic view

The random variable $F = f(N)$ depends upon the random variable $N = n(M)$, which depends upon $M = m(S)$, which depends upon the random variable S. this is most commonly known as graphical models.

Erudition paradigms

There are three major erudition paradigms, each corresponding to a particular abstract erudition task. These are

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- Supervised erudition
- Unsupervised erudition
- fortification erudition

Supervised erudition

In the supervised erudition, the example pairs $(u, v), u\epsilon U, v\epsilon V$. The aim is to find the function $f: U \rightarrow V,$ the cost functions relate to the mismatch between the mapping and its data and also contains proceeding to the knowledge of the problem domain.

The jobs that fall within the hypothesis of the supervised erudition are pattern detection and deterioration. The supervised erudition concept is suitable to chronological data.

Unsupervised erudition

In unsupervised erudition, some data s is given and the cost of the function is diminished, that can be any function of the data s and the system's output f.

The outlay task is dependent on the function and the a priori hypothesis, for the insignificant example, consider the model

$$f(s) = a$$

Where a = constant

Cost $C = E[(s - f(s))^2]$

x = Mean of the data

The outlay function is the more complex. So it is applicable only based on the application, in firmness it is connected to the common information between s and $f(s)$. In the numerical modelling, it could be related to the posterior prospect of the model of the given

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data. The chores that fall within the prospect of unsupervised erudition are in general evaluation predicament.

Reinforcement erudition

In reinforcement erudition, data s are not given by an agent actually, but it is generated by agent relations with environment, the main objective is to analyze the minimizing technique for the long term cost.

The background dynamics of the long term cost is not known, but it is predictable. The background is modelled as markov decision process with the states $s1, s2, sn \epsilon S$ and their actions are represented as $a1, a2 \ldots am \epsilon A$

Arithmetic neural networks are often used in reinforcement erudition as a part of on the whole algorithm.

Algorithm for artificial neural network

- First step is to instruct the network according to the required data.
- Classify the problems, each input corresponds to a unique value and each output is a class value.
- The ultimate aim of this approach is to encode the network by creating n-dimensional credence space.
- The network is represented by simply enumerating each connection.
- Usually there will be more than one output class value for input value.

Behaviour based robotics

Behaviour robotics is the division of robotics which incorporates behavioural artificial intelligence. The behaviour based robotics was first discovered by professor Rodney brooks and their students in MIT.

Artificial intelligence robotics

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In conventional the artificial intellect robotics is sequential dispensation units. The main technique behind this artificial intelligence robotics is

- Illustration, interpretation and development
- Representation of structure
- Practical disintegration, hierarchical systems
- Figure management

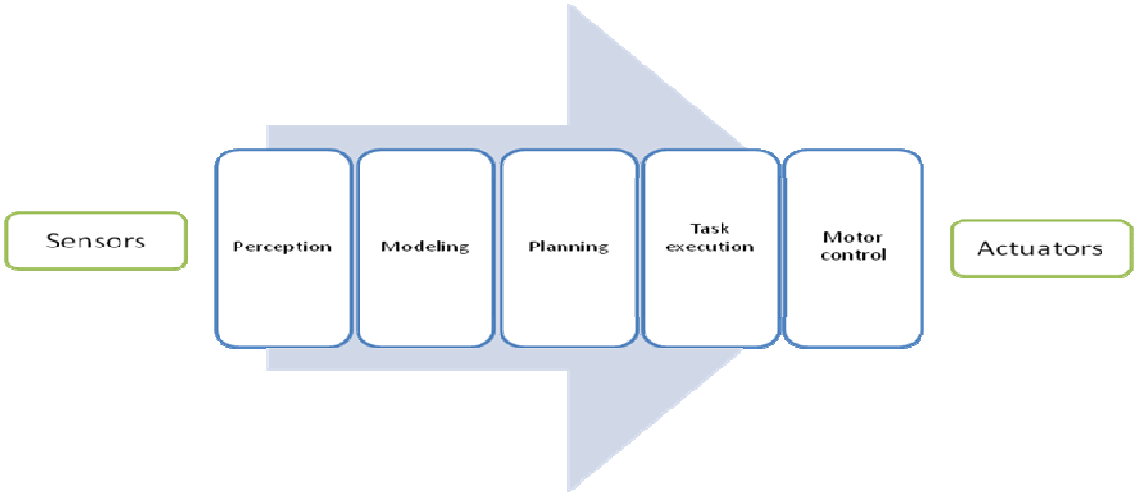

Figure 2: Artificial intelligence robotics

The actions based approach defines that intelligence is obtained from interaction among the synchronous environment. The main ideas after this approach are

- Personification
- Evolving complications
- Improper planning

Behaviour

Behaviour is defined as reaction to stimulus



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This process is most often seen in the automatic machine all over the world, it responds to every kind of actions.

CONCLUSION

In this manuscript, a novel approach is introduced to prevent the tunnelling between the malicious nodes, the technique includes trust creation, this can be achieved through dividing the network into sub groups, the nodes which are closer to one another forms a one group and the nodes, which are far away from the first group forms another group.

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