Volume 3, Issue 1, January 2013 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

An Efficient Algorithm in WSN for Path finding & detecting The Tsunami

Dr.Ghanashyam Rout*
School of Electronics.
KIIT University,Bhubaneswar,
routg66@yahoo.com

Abhishek Rout
School of Electronics.
KIIT University,Bhubaneswar
abhishekrout45@gmail.com

Mukulesh Maharana
School of Electronics.
KIIT University,Bhubaneswar,
mukulesh010@gmail.com

Abstract: During the last decade, operational oceanography had to face the challenge of building integrated observational systems capable of real-time recording and transmitting parameters not only from the atmosphere and the upper sea, but also from the deep sea layers. The real-time measurements are transmitted to operational centre through the existing Iridium telecommunication network. The present paper looks at algorithms to be implemented in the software of bottom pressure recorders (BPRs) for the automatic, real-time detection of a tsunami within recorded signals. The structure of an algorithm based on the use of genetic algorithm (GA) is presented under the Deep-ocean Assessment and Reporting of Tsunamis (DART) program run by the National Oceanic and Atmospheric Administration (NOAA). Results show that an improvement in detection performance can be obtained by using the genetic algorithm.

Keywords: Wireless Sensor Network, Tsunami Detection Algorithm, Path finding, Genetic algorithm, Tsunami Early Warning System.

I. Introduction

Tsunami is a series of water waves caused by the displacement of a large volume of a body of water, typically an ocean or a large lake. Earthquakes, volcanic eruptions & other underwater explosions (including detonations of underwater nuclear devices), landslides, glacier calving, meteorite impacts and other disturbances above or below water all have the potential to generate a tsunami. Tsunami waves do not resemble normal sea waves, because their wavelength is far longer. Rather than appearing as a breaking wave, a tsunami may instead initially resemble a rapidly rising tide, and for this reason they are often referred to as tidal waves. Tsunamis generally consist of a series of waves with periods ranging from minutes to hours, arriving in a so-called "wave train". Wave heights of tens of metres can be generated by large events [1-2]. Although the impact of tsunamis is limited to coastal areas, their destructive power can be enormous and they can affect entire ocean basins; the 2004 Indian Ocean tsunami was among the deadliest natural disasters in human history with over 230,000 people killed in 14 countries bordering the Indian Ocean.

Earthquakes cause tsunami by causing a disturbance of the seafloor. Thus, earthquakes that occur along coastlines or anywhere beneath the oceans can generate tsunami. The size of the tsunami is usually related to the size of the earthquake, with larger tsunami generated by larger earthquakes. But the sense of displacement is also important. Tsunami is generally only formed when an earthquake causes vertical displacement of the seafloor [3]. The 1906 earthquake Near San Francisco California had a Richter Magnitude of about 7.1, yet no tsunami was generated because the motion on the fault was strike-slip motion with no vertical displacement. Thus, tsunami only occurs if the fault generating the earthquake has normal or reverse displacement. Because of this, most tsunami are generated by earthquakes that occur along the subduction boundaries of plates, along the oceanic trenches. Since the Pacific Ocean is surrounded by plate boundaries of this type, tsunami is Frequently generated by earthquakes around the margins of the Pacific Ocean. Earthquakes with an epicentre in the sea are not always tsunamigenic. Direct detection in sea-level measurements is therefore essential to confirm the actual generation and propagation of a tsunami. Only direct detection makes it possible to avoid false alarms and guarantees speed and accuracy in both the warning and the hazard assessment process. Deep-sea measurements are the main means of detecting tsunamis generated either by earthquakes or by submarine landslides. They are collected at a standard sampling rate of 15 s by bottom pressure recorders (BPRs) located at water depths ranging from hundreds to some thousands of meters. It is at such water depths that BPRs Can exclusively detects pressure fluctuations induced by propagating waves within the tsunami and tidal frequency band. Pressure fluctuations are, in fact, negligible at water depths greater than half a wavelength. This makes deep sea an ideal filter for waves characterized by lower periods (i.e. an ideal low-pass filter)[4]. BPRs measure pressure fluctuations indirectly by evaluating the vibration variations that these fluctuations cause in a quartz-bean piezometrically induced to oscillate in its lowest resonant flexural mode. Although the idea of Correlating vibration frequency with pressure-induced mechanical motion dates back to the end of the 1980s, BPR technology has received a strong boost during the last 10 years [5]. Such developments occurred under the Deep-ocean Assessment and Reporting of Tsunamis (DART) program run by the Pacific Marine Environmental Laboratory (PMEL) within the National Oceanic and Atmospheric Administration

(NOAA). Optimal use of BPR measurements depends both on instrument location and on the effectiveness of the detection algorithm. Whilst the instrument location should be determined by a tsunami hazard assessment (i.e. a previous knowledge both of probable tsunami sources and of places at risk along the coast), the requisites for an effective algorithm can be identified as:

(a) An ability to discriminate a tsunami from other sea level oscillations that, falling within the tsunami and tidal frequency band, are 'disturbances' in the context of tsunami detection

(b) An ability to identify the waveform of a tsunami and to characterize it in terms of both amplitude and period; and

(c) A fast computational time.

As far as the first requisite is concerned, it should be noted that the presence of other oscillations in a BPR recorded signal guarantees the instrument's poli-functionality. Indeed, it is desirable to have a device that, although realized With the aim of detecting tsunamis, is also capable of measuring other oscillation phenomena. A fourth requisite should also be considered and met. A BPR must work far out at sea, at great water depths and for a long period of time [6]. This implies that the device must have an autonomous power supply. Economy of power is therefore a major concern: to be effective, detection Algorithm should automatically run with the lowest possible power consumption. The main 'disturbance' recorded by a BPR is caused by the superposition of actual sea-surface fluctuations (e.g. planetary waves, astronomical and meteorological tides or gravitational normal modes) and background sea noise. The close prediction of such a 'disturbance' makes it Possible to filter it out simply by subtracting the values observed from those predicted. The actual propagation of a tsunami can then be monitored by checking the amplitude of the filtered signal against a prescribed threshold. The Amplitude of a perfectly filtered signal should, in fact, be equal to zero in the absence of a propagating tsunami. Furthermore, the closer the prediction (i.e. the better the filtering performance), the lower the threshold to be prescribed, and the smaller the detectable tsunami. The core of the algorithm is therefore its method of using preceding actual observations to make (and update) predictions. In other words, its method of extrapolating new data from past observations.

At present, the only algorithm expressly designed to detect a tsunami in real-time within a BPR recorded signal is the one developed by Mofjeld (1997) under the NOAA's DART program [7]. The aim of the present paper is to introduce the structure of a new algorithm, based on the use of genetic algorithm, and to analyze its ability to meet the requisites set out above. Genetic computing (Bishop, 1995; Lippmann, 1987) has emerged as a practical technology and is now widely applied in many engineering fields, including, in particular, the application area of forecasting (Zhang et al., 1998). For example, genetic algorithm have been applied successfully to tidal wave (Tsai and Lee, 1999; Lee and Jeng, 2002; Cox et al., 2002; Huang et al., 2003; Sztobryn, 2003; Lee, 2006) and wind wave forecasting (Deo and Sridhar Naidu, 1999;Deo et al., 2001). The main damage from tsunami comes from the destructive nature of the waves themselves. Secondary effects include the debris acting as projectiles which then run into other objects, erosion that can undermine the foundations of structures built along coastlines, and fires that result from disruption of gas and electrical lines. Tertiary effects include loss of crops and water and electrical systems which can lead to famine and disease. Within the last century, up until the December 2004 tsunami, there were 94 destructive tsunami which resulted in 51,000 deaths. Despite the fact that tsunami warning systems have been in place in the Pacific Ocean basin since 1950, deaths still result from tsunami, especially when the source of the earthquake is so close to a coast that there is little time for a warning, or when people do not heed the warning or follow instructions associated with the warning. These factors point out the inadequacy of the world in not having a tsunami warning system in place in the Indian Ocean, where in one event, the death toll from tsunami was increased by a factor of 5 over all previous events.

II. LITERATURE SURVEY

The researcher [8] had presented an analytical view on WSN architecture design issues and its implementation. He had described about the security and node characteristics of WSN architecture. Kenan Casey and et.al [9] had proposed a sense and response system for tsunami detection and mitigation. They had included an efficient flooding technique, a route repair algorithm, and distributed services framework. Finally, they had described potential barrier mechanisms and the real-time communication protocol that supports time-critical response of the system.

The authors [10] had proposed a system to the Thames Barrier, a series of movable gate structures which protect London from tidal floods [11] and the gate system currently being developed to shield the city of Venice from dangerously high tides which was the relative similarity between tsunamis and hurricane-induced storm surges. Harminder Kaur and et.al [12] had reviewed technological solutions for managing disaster using wireless sensor networks (WSN) via disaster detection and alerting system. The researcher [13] had implemented some facilities for the GPS buoy system to detect the Tsunami. That type of application was called GPS/Acoustic system for monitoring ocean bottom crustal deformation. The second plan is an application to atmospheric research through estimating zenith tropospheric delay. Rocken et al. [14] and Fujita et al. [15] showed that GPS is capable of measuring atmospheric water vapor through troposphere zenith delay measurements. Sanjay V. Khobragade and et.al. [16] had given the different theoretical Tsunami detection and measurement techniques to provide critical information that may have used for various future activities and subsequent recovery activities.

Hyung-Woo Lee and et.al. [17] had investigated the incurs various security threats mechanics of wireless communication technology. The scheme was used a bidirectional verification technique and also introduces multi-path multi-base station routing if bidirectional verification was not sufficient to defend the attack. The authors [18] had described the sensing capabilities and sensor nodes in hostile areas or physically inaccessible regions where it was not easy to have human intervention to maintain. Thus, sensor devices may range from milli metre-sized devices fabricated on custom silicon to more general purpose cell-phone-sized devices with advanced capabilities. The authors [19] had stated that rationale for the measurement of open-ocean tsunami signatures were presented, and available pertinent data were reviewed. Models for tsunami signature and background noise are proposed in order to synthesize an optimum tsunami receiver. In deep-ocean system, for tsunami detection, transducer temperature sensitivity and other system noises should be considered.

The author [20] had viewed that decision about whether and how to proceed with establishing an international tsunami early warning system for the Indian Ocean having complicated for a number of reasons. One reason is because of the number of different potential international parties that would be involved with the need to coordinate data collection and warning dissemination, and a second is the funding needed to establish a tsunami warning system in that region. A third is that nations, including some in the Indian Ocean, might charge for access to critical satellite data that may help in warning potential victims.

3. GENETIC ALGORITHM IN A NUTSHELL

3.1 Introduction

Evolutionary computing was introduced in the 1960s by I.Rechenberg in his work "Evolution strategies". His idea was then developed by other researchers. Genetic Algorithms are inspired by Darwin's theory about genetic. It was invented by John Holland & developed by him & by his colleagues during 1975.

Genetic Algorithms are a Class of adaptive methods that can be used to solve search & optimization problems involving large search spaces. The search is performed using the idea of simulated evolution (Survival of the fittest). These algorithms maintain & manipulate "generations" of potential solutions or populations. With each generation, the best solutions (as determined by a problem specific fitness function) are genetically manipulated to form the solution set for the path generation. As I nature solutions are combined (via, crossover) &/or undergo random mutation.

3.1.1 Basic steps of Genetic Algorithm:

Step 1: Generate random population of n chromosomes out of the given problem. This is the most important step for the problem solution.

Step 2: Evaluate the fitness function f(x) of each chromosome x in the population.

Step 3: Create the new population by repeating following steps until the new population is complete.

(a)Select two parent chromosomes from a population according to their fitness. The better will be fitness; the bigger is the chance to be selected. The step is called **selection.**

(b) Crossover the parents to form new offspring or children, with a crossover probability. If no crossover was performed, offspring is an exact copy of parents.

(c) Mutate new offspring at each locus or position in the chromosome, with a mutation probability. This step is called **Mutation** & places these new offspring in the population.

(d) Use new generated population for a further run of the algorithm. This process is called **Replacement.**

Step 4: If the condition satisfied then stop & return the best solution in current population or else **go to Step 2**.

This is a generalized algorithm, but there are many variations, which can be implemented differently for different problems. Next the question is how to create chromosomes & what kind of encoding one should follow how to select parents for crossover. This can be achieved in many ways, but the idea behind is to select the better parents. But while marking new population only by the new offspring may sometimes loose the best chromosome from the corrupt population. In order to overcome this at least one best solution must be copied without changes to a new population. So that the best solution found at nay iteration can survive to the end of run.

3.2 Definition for Genetic Algorithms

The genetic program is a probabilistic algorithm, which maintains a population of individuals, P(i)={x│i,……,xni}at iteration i. Each individual represents a potential solution to the problem at hand & each solution is evaluated to give some measure of its "fitness". Then a new population at iteration (i+1) is formed by selecting the better-suited individuals. Some members of these population undergo transformations by means of unary transformations mi(mutation),which create new individuals by a small change in a single individual (mi:S->S) & higher order transformations like cj(crossover),which create new individuals by combining parts from several(two or more) individuals,(cj:S S ->S). After several number of generations, the program converges to a near optimum solutions, hopefully represents the best individual. The structure of a genetic program is shown below

3.2.1 Procedure for Algorithm Genetic

Begin

I<- 0;

Initialize Population Pi;

Evaluate population Pi;

While (not termination-condition) do For i=1 to n

i <-i+1;
Select population Pi from previous population P_{i-1};

Apply genetic operators i.e., crossover & mutation on population Pi;

Evaluation of population Pi by the predefined criteria;

End For;

End While

End;

Genetic algorithms have been successfully employed in various classical problems of AI such as intelligent search: Optimization & machine learning. Let us first discuss about genetic algorithms & its formulation
in detail.

3.3 Common Features of Genetic Algorithms

It is important to note that, despite all the surrounding hype, the successful design & use of GA is as much art as science. GA theory is elegant, fascinating & full of subtle variations that may not be useful in certain applications. One of the most powerful features of GA is their elegant simplicity. In fact, the simple power of a genetic approach may be harnessed with little more than a few lines of computer code & a random number generator [21].There are no closed from gradients to derive & no differentiability or continuity requirements to satisfy. A GA is, essence, nothing more than a repeated application of a few simple operations .moreover, a GA knows nothing about the problem at hand, nor does it care. In fact, GAs need not know how to solve a problem; they just need to recognize a good solution when they see it. GAs begin by randomly generating r seeding, an initial population of candidate solutions. Each candidate is an individual member of a large population of size. The individuals (Chromosomes) in genetic algorithms are usually constant length character sequences (vector of constant size).In the traditional GA, these vectors are usually sequences of zeros & ones, but in practice may be anything including a mix of integers a7 real numbers or even a mix of numbers & character strings. The actual data encoded in the vectors is called representation scheme. There are two basic parameters of Genetic Algorithm i.e. crossover probability & mutation probability. Crossover probability says how often will be crossover performed. If there is no crossover i.e. 0% probability, offspring is exact copy of parents. If there is full crossover or is 100% probability then all offspring is made by crossover. The objective of the crossover is that new chromosomes will have good parts of old chromosomes & some the new chromosomes, which are better, will be evolved. However it is good to leave some part of population survive to next generation, which are really better chromosome. Mutation probability says how often will be parts of chromosome mutated. If there is no mutation or 0% probability offspring is taken after crossover or copied without any change. If mutation probability is 100%, whole chromosome is changed. Mutation is made to prevent falling into local extreme, but it should not occur very often, then GA will behave as random search. There are also some other parameters of GA, one of them is Population size, which specifies how many chromosomes should be in population in one generation. If there are too few chromosomes, Genetic algorithm has a few possibilities to perform crossover & only a small part of search space is explored. On the other hand, if there are too many chromosomes, the genetic process slows down. Selection is the process by which chromosomes are selected from the population for the crossover. The main problem is how to select these chromosomes. According to Darwin's theory the best ones should survive & create new offspring. There are many schemes how to select the best chromosomes, for example roulette wheel selection, Boltzman selection, tournament selection, rank selection.

4. Genetic Algorithms in WSN for path finding & detecting Tsunami

Each DART II tsunameter is designed to detect and report tsunamis autonomously .The Tsunami Detection Algorithm works by first estimating the amplitudes of the pressure fluctuations within the tsunami frequency band, and then testing these amplitudes against a threshold value. The amplitudes are computed by subtracting predicted pressures from the observations, in which the predictions closely match the tides and lower frequency fluctuations. If the amplitudes exceed the threshold, the tsunameter goes into Event Mode to provide detailed information about the tsunami. Tsunami detection has been the focus of much research effort in recent decades. The detection task is posed as follows

The DART II pressure sensor is a 0-10,000 psi model 410K Digiquartz unit manufactured by Par scientific [22]. The pressure sensor outputs two frequency-modulated square waves, proportional to the ambient pressure and temperature.

The high resolution precision reciprocal counting circuit continuously measures the pressure and temperature signals simultaneously, integrating them over the entire sampling window, nominally set to 15 seconds. At the end of each sampling window, the computer reads the pressure and temperature data and stores the data in a flash memory card.

The embedded computer system in both the buoy and the tsunameter was designed around the 32-bit, 3.3 volt Motorola 68332 microcontroller, and was programmed in C. The embedded computer implements and regulates the primary functions of the surface and seafloor units: transmitting data communications, running the tsunami detection algorithm, storing and retrieving water column heights, generating checksums, and conducting automatic mode switching.

A Benthos [23] ATM-880 Telesonar acoustic modem with an AT-421LF directional transducer has a 40° conical beam which is used to transmit data between the tsunameter and the surface buoy. Modems transmit digital data via MFSK modulated sound signals with options for redundancy and convolutional coding.

Now the modulated sound signal is specified initial & final locations, a collision free path with certain optimization criteria in a real environment, which could vary with time or be only partially known. Most previous research assumes that the environment in which the modulated sound signal has to be transmitted & its initial, final points are geometrically known & obstacles in the environment may be largely static or mobile. In such cases, the detection problem can be simplified to that of planning a collision free path. Normally, when a previously unknown obstacle later becomes apparent, a new path to be followed needs to be regenerated by the planner.

When the path of the transmitted signal's environment is known, it can plan its trajectory before transmitting to a predefined final point from the starting point. But many times the signal can't decide about the entire trajectory before transmission, because the obstacles change their positions over time. Further in a dynamic environment meant which includes one or more mobile objects it is useless to plan a path before transmission. In this situation, the signal plans a sub-path & thus transmits to that point & the process continues until the signal reaches the destination.

Among search methods, Genetic Algorithm provides an effective optimal technique that has been inspired by natural evolution, which is a better adopted individual, will have a greater chance of survival. The evolutionary planner proposed that an evolutionary approach is able to solve the planning problem for the modulated signal in both known & unknown environments. Incorporating heuristic knowledge into specific operators can able a near optimal solution for the signal transmission problem to be found. However there is a no. of drawbacks with most recent version of evolutionary planner.
.

- It is unable to react to moving obstacles.
- It can't guarantee to find the global optimum.
- The plan produced may be different even when applied to the same environment with identical initial & final locations.
- It is unrealistic to assume that when an obstacle is first observed its geometry becomes known completely.
- It does not model noise such as sensor errors.

Current literatures have established that genetic algorithm is a useful tool based on the principles of natural selection and natural genetics, which has been quite successfully, applied in machine learning and optimization problems. Michalewicz first successfully applied GA in signal transmission [24]. In their model Michalewicz, considered a set of operators including crossover & mutations. An operator is based on its probability of occurrence & the operation is executed. The fitness evaluation function is then measured & proportional selection is employed to get population in the next generation. The model is ideal for static environment, but in case of a dynamic environment much of the computation time will be wasted for planning a complete path, which later is likely to be disposed off. An alternative solution in this situation can be selection of a path segment from the sensory reading after each genetic evolution. This can be extremely fast & thus can take care of movable obstacles having speed less than or equal to that of the modulated signal.

4.1 Encoding of a chromosome

In GA, each individual in a population is usually coded as coded as a fixed-length binary string. The length of the string depends on the domain of the parameters and the required precision. The chromosomes should in some way contain information about solution, which is represents. The most used way of encoding is a binary string, which can be represented as follows

Chromosome 1	1101100100110110
Chromosome 2	1101111000011110

Table 1: Encoding of Chromosome

Each Chromosome has one binary string. Each bit in this string can represent some characteristic of the solution or the whole string can be representing a number. Of course, there are many other schemes of encoding, which depend mainly on the problems to be solved. For instance, one can encode directly integer or real numbers, which is sometimes useful for some specific problems.

4.2 Crossover

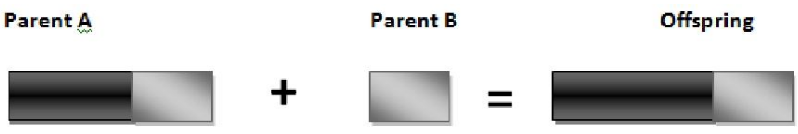
During the operation of reproduction crossover is applied on the chosen parent chromosome only within a certain probability, the cross over probability. In the chosen crossover operator, two parent chromosomes are combined applying a single cross point, value encoding crossover. The crossover operator has been modified to produce two offspring Chromosomes with each crossover operation. This is achieved by using the gene information, which were not used to build offspring one, in order to build a second Chromosome. The simplest way how to do this is to choose randomly some cross over point & everything before this point copy from a first parent & then everything after the cross over point copy from the second parent. There exists also many complicates cross over like, multi point & ring crossover, which depends on encoding scheme of the chromosome. Specific crossover designed for a specific problem may not be suitable for other problems.

Chromosome 1	**01011|0010011110**
Chromosome 2	11011|11000011010
Offspring 1	**01011**|11000011010
Offspring 2	11011|**00100111110**

Table 2: Crossover operation (|is the crossover point)

- **Single Point Crossover**

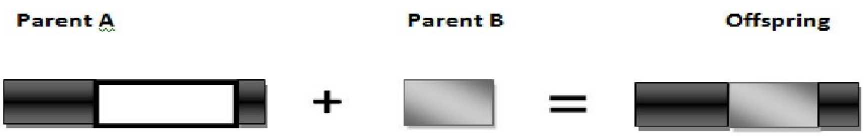
One crossover point is selected, binary string from the beginning of the chromosome to the crossover point is copied from the first parent, and the rest is copied from the other parent.



11001011+11011**111**=**11001111**

- **Two point crossover**

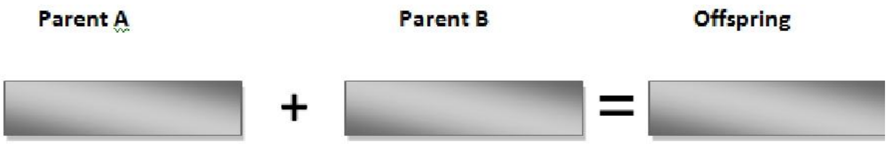
Two crossover points are selected, binary string from the beginning of the chromosome to the first crossover point is copied from the fast to the second crossover point is copied from the other parent & the rest is copied from the first parent again.



11001011+11011111=11011111

- **Uniform Crossover**

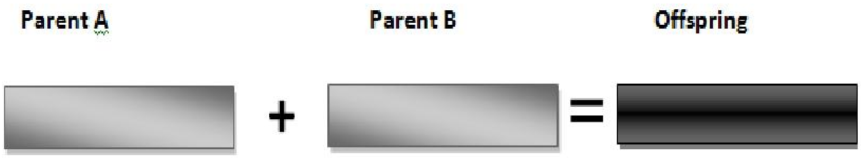
Bits are randomly copied from the first or from the second parent.



1**10**010**11**+**1**10**111**01=11011111

- **Arithmetic Crossover**

Some arithmetic operation is performed to make a new offspring.



11001011+11011111=11001001(AND)

Mutation- Here selected bits are inverted

1**1**001001=> 1**0**001001

Crossover

Single point crossover-one crossover point is selected, the permutation is copied from the first parent till the crossover point ,then the other parent is scanned & if the number is not yet in the offspring, it is added likely there are more ways how to produce the rest after crossover point.

(1 2 3 4 5 6 7 8 9) +(4 5 3 6 8 9 7 2 1) = (1 2 3 4 5 6 8 9 7)

Mutation- Here two numbers are selected & exchanged.

(1 2 3 4 5 6 8 9 7) => (1 8 3 4 5 6 2 9 7)

- **Value Encoding**

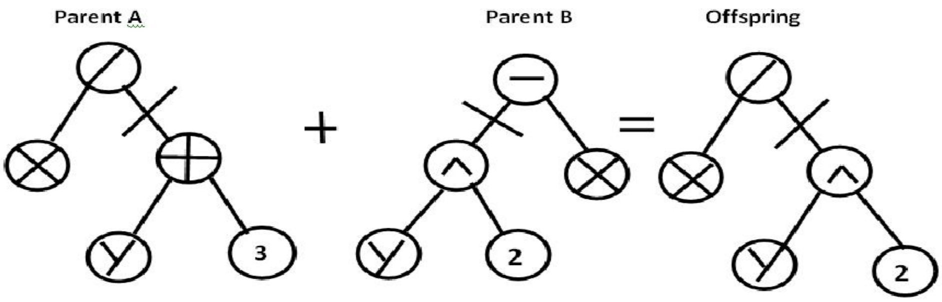
Crossover- All crossovers from binary encoding can be changed.

Mutation- Adding a small number (for real value encoding)- a small number is added to (or subtracted from) selected values

(1.29 5.68 2.86 4.11 5.55) => (1.29 5.68 2.73 4.22 5.55)

- **Tree Encoding**

Crossover- One crossover point is selected in both parents, parents are divided in that point & the pars below crossover points are exchanged to produce new offspring.



Mutation – Changing operator, selected nodes are changed.

4.3 Mutation

After a crossover is performed, mutation is done, in order to prevent falling all solutions in current population into a local optimum of solved problem. For mutation almost every operation that changes a gene's value (such as location or direction) is valid mutation operator. The mutation operator has been designed according to the addressed path planning problem. The chosen mutation operator checks with a mutation probability for every single gene whether it should be mutated or not. If a gene is to be mutated, a random number between 1 & the total number of columns in the search space is assigned to location & a random direction either vertical or horizontal is assigned to direction. This mutation variant has the advantage that it gives the opportunity for a chromosome to become significantly altered. That means that the complete search space will be explored & it therefore prevents the GA from getting stuck in a local optimum. Mutation can then be followed as shown in the table

.The mutation also depends on the encoding scheme as well as the crossover.

Table 3: Mutation Scheme

Original offspring 1	01011 1100**0**011010
Original offspring 2	11011 00100111**1**110
Mutated offspring 1	01011 1100**1**011010
Mutated offspring 2	11011 0010011**0**0110

4.4 Selection

Selection is the process by which chromosomes are selected from the population for the crossover. The main problem is how to select these chromosomes. According to Darwin's evolution theory the best ones should survive & create new offspring. There are many schemes how to select the best chromosomes, for example roulette wheel selection, Boltzman selection, steady state selection & some others. Some of them have been covered here.

Elitism: While creating new population by crossover & mutation, there is more chance that the best chromosome is lost. Elitism is name of a method, which first copies the best chromosome or a few best chromosomes to new population. The process of crossover & mutation does the rest. Elitism can very rapidly increase performance of GA, because it prevents losing the best-found solution.

5. Formulations for Transmission

For the selection of the chromosome or to setup an initial population, the sensor information has been taken into account & the coordinates obtained from these sensors are used to setup the initial population. The formulation ensures that, all the initial populations are feasible in the sense that they are obstacle-free points & the straight path segments between the starting point & via points are also obstacle free. Since the path segment to the next point is evaluated after each genetic evolution, the data structure to represent the chromosome becomes very simple, as shown in the fig

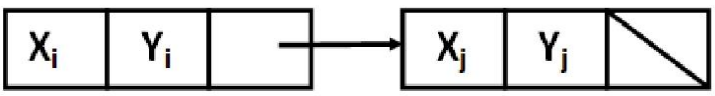


Fig 1. Representation of the chromosome of a single path segment from the sensory readings.

Here $(X_i, Y_i)$is the starting point & (X_j, Y_j) is the one of 2D points, obtained from the sensor information , which chromosomes from the initial population. Next crossover is done among the initial population. It has been observed that the crossover is not feasible, as those paths may, either encounter obstacles or fall outside the workspace. Hence integer crossover is chosen instead of binary crossover. In fig 2 the crossover point is set between the third & the fourth field for each pair of chromosomes & the new population is generated. For this population the feasibility is estimated, i.e. whether they are reachable from via point by the straight-line path. Next mutation is performed for fine-tuning the path to avoid the mobile obstacles.

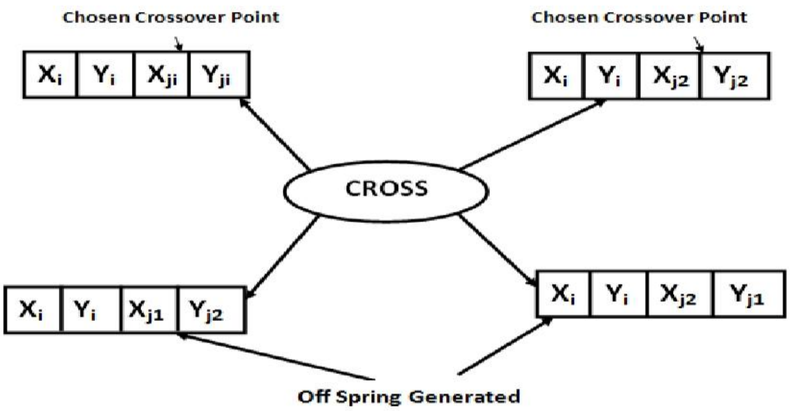


Fig 2: The crossover operation used in the proposed algorithm

The estimation of fitness of each & every chromosome is done subsequently, out of the total population (both for the initial & new populations),which involves finding the sum of the Euclidean distance from the starting point to the coordinate obtained from the sensor information & the distance from that point to the goal point.

Fitness of a chromosome $(X_i, Y_{i.}\ X_{jk}, Y_{jk})$ =1/ [((distance between $(X_i,Y_i)^2$ & $(X_{jk}, Y_{jk})^2$) + (distance between $(X_{jk}, Y_{jk})^2$) & $(X_{final},Y_{final})^2$)$]^{1/2}$

The best fit chromosome is evaluated, after finding the fitness value of each chromosome. The best-fit chromosome represents the predicted optimal path segment, towards destination. A near optimal intermediate point is found out after the each generation. The third & fourth fields of the best-fit chromosome become the next intermediate point to move & the starting point is updated with the best fit point. The whole process of the GA, from setting up the initial population is repeated, until the best-fit chromosome have its third & fourth field equal to the x-& y- coordinates of the destination. The algorithm is formally presented below & the detail code is given in the next section.

6. Procedure for Transmission Planning using Genetic Algorithm

// $(X_i$, Yi) = Starting point; (X_g,Y_g) = Destination point; //
Add path- segment to path-list $(X_i$, Yi) ; Repeat

(i) Initialization:

Get sensor information in all possible directions (X_{j1},Y_{j1}), (X_{j2},Y_{j2}),……. (X_{jn},Y_{jn}) ;

Form chromosomes like $(X_i,Y_{i,}X_j,Y_j)$;

(ii) Crossover:

Select crossover point randomly on the third & the fourth fields of the chromosome.

Allow crossover between all chromosomes & get new population.

(X_i,Y_i,X_{j1},Y_{j1}), (X_i,Y_i,X_{j2},Y_{j2}), $(X_i,Y_i,X_{j1}^{i},Y_{j1}^{i})$, $(X_i,Y_i,X_{j2}^{ii},Y_{j2}^{ii})$;

(iii) Mutation:

Select a mutation point in bit stream randomly & complement that bit position for every chromosome.

(iv) Selection:

Discard all chromosomes (X_i,Y_i,X_j,Y_j) from populationwhose line segment is on obstacle region

For all chromosomes in population find fitness using

Fitness $(X_i,Y_i,X_j,Y_j)=1/[(X_j-X_i)^2 +(Y_i-Y_i)^2 +(X_g-X_j)^2+(Y_g-Y_j)^2]^{1/2}$

Identify the best fit chromosome (X_i,Y_i,X_{bf},Y_{bf});

Add to path-list (X_{bf},Y_{bf}) ;

X_i=X_{bf} ; Y_i=Y_{bf} ;

End for;

Until (X_i=X_g)&& (Y_i=Y_g) ;

End.

7. CONCLUSION

With the increase in the number of occurrences of the tsunami, it has become quite essential to Develop an efficient tsunami warning system for the detection of tsunami before it arrives so that the loss of life and property could be minimized. As a system cannot be hundred percent efficient, so there is always scope to improve the tsunami warning system in terms of speed or accuracy or power consumption, etc. When an earthquake occurring under the sea is very close to the sea shore, then the tsunami warning system cannot provide sufficient time before the arrival of the tsunami.

This thesis is a step taken to get knowledge of the existing tsunami detection algorithms and to study and implement them in C & C++. However implementation in the C++ or in MATLAB needs to be improved for the actual working of the tsunami detection algorithm continuously. The present tsunami detection systems are implemented in microcontrollers but here we want to implement the above mentioned optimization technique along with DART algorithm so that we can have many components of the Tsunameter on the same board. This will help in improving the speed of the tsunami detection system.

8. REFERENCE

[1] "Tsunami Terminology". NOAA. Retrieved 2010-07-15.

[2] Wells, John C. (1990). *Longman pronunciation dictionary*. Harlow, England: Longman. p. 736. ISBN 0-582-05383-8. Entry: "tsunami"

[3] Fradin, Judith Bloom and Dennis Brindell (2008). Witness to Disaster: Tsunamis. Witness to Disaster. Washington, D.C.: National Geographic Society. pp. 42, 43.

[4] Cox, D.T., Tissot, P., Michaud, P., 2002. Water level observation and short term predictions including meteorological events for entrance of Galveston Bay, Texas. Journal of Waterways, Port, Coastal and Ocean Engineering 125 (4), 195–202.

[5] Deo, M.C., Sridhar Naidu, C., 1999. Real time wave forecasting. Ocean Engineering 26, 191–203.

[6] Eble, M.C., Gonzlez, F.I., 1991. Deep-ocean bottom pressure measurements in the northeast Pacific. Journal of Atmospheric and Oceanic Technology 8 (2), 221–233.

[7] Gonzalez, F.J., Milburn, H.M., Bernard, E.N., Newman, J.C., 1998. Deep-ocean Assessment and Reporting of Tsunamis (DART): Brief overview and status report. In: Proceedings of the International Workshop on Tsunami Disaster Mitigation, Tokyo, Japan, pp. 118–129.

[8] Ajay Jangra ,"Wireless Sensor Network (WSN): Architectural Design issues and Challenges".

[9] Kenan Casey and et. Al. Sensor *Network Architecture for Tsunami Detection and Response", International Journal of Distributed Sensor Networks,* 4: pp. 27–42, 2008.

[10] T. Kaitoku, "Ioc glossary: General tsunami terms," 2006. [Online]. Available http://ioc3.unesco.org/itic/contents.php?id=21.

[11] J. D. Beaulieu, "Tsunami warning systems and procedures: Special paper 35," Oregon Department of Geology and Mineral Industries, Tech. Rep., 2001.

[12] Harminder Kaur, Ravinder Singh Sawhney, Navita Koma l" Wireless Sensor Networks for Disaster Management".

[13] Spiess, IEEE Trans. Geosci. Remote Sens., 23, 502-510, 1985.

[14] Fujita, etal, Geophys. Res. Lett. 35, L13803, doi:10.1029/2008GL033764, 2008.

[15] Sanjay V. Khobragade, Nikita Gosavi, Urmila S. Khobragade " Tsunami Detection Techniques" ,

[16] Hyung-Woo Lee ,Al-Sakib Khan Pathan ,Choong Seon Hong "Security in Wireless Sensor Networks: Issues andChallenges",

[17] Kaveh Pahlavan and Prashant Krishnamurthy, "Networking Fundamentals: Wide, Local and Personal Area Communications***".***

[18] Adam Elinski, senior member, IEEE, and Narendra K. SAaxena, "Tsunami Detectability Using Open-Ocean Bottom pressure Fluctuations",

[19] Wayne A. Morrissey "Tsunamis: Monitoring, Detection, and Early Warning Systems",

[20] M.L. Heron"12 "Tsunami Monitoring by HF Ocean Radar: Time and Space Scales 'Marine Geophysical Laboratory, James Cook University, Townsville, Australia 4811,2 AIMS@JCU, James Cook University, Townsville, Australia 4811.

[21] DeJong, K.A. (1985). Genetic Algorithms: A 10 Year Perspective. Proceedings of the First International Conference on Genetic Algorithms (pp.169{177). Pittsburgh, PA: Lawrence Erlbaum.

[22] Paroscientific, Inc. 4500 148th Ave. N.E. Redmond, WA 98052, USA Tel: (425) 883-8700 Fax: (425) 867-5407;http://www.paroscientific.com.

[23] Benthos, Inc., 49 Edgerton Drive, North Falmouth, MA 02556 USA, Telephone: (508) 563-1000 Fax: (508) 563-6444; http://www.benthos.com.

[24] Zbigniew michalewicz," genetic algorithms+ data structures= evolution programs",2nd extended edition,Springer-Verlag,1986.

