Research Article

New Homotopy Perturbation Method For Analytical Solution Of Telegraph Equation

Rajesh Kumar
Assistant Professor, Department of Mathematics, D.R.A. Govt. Degree College, Bisauli, Budaun UP India

Dr. A.K. Singh
Assistant Professor, Department of Mathematics, RBS Engineering Technical Campus, Bichpuri, Agra, UP India

Dr. S.S. Yadav
Associate Professor, Department of Mathematics, Narain (P.G.) College, Shikohabad,UP India

Article History*: Received: 11 January 2021; Revised 12 February 2021 Accepted: 27 March 2021; Published online: 23 May 2021*

Abstract:

We develop a New Homotopy Perturbation Method (NHPM) in this paper to track down the informative arrangements of linear and non-linear Telegraph Equation. By utilizing the NHPM, it is plausible to get the semi-analytical arrangement or a closed structure assessed answer for an issue uncovers significant focuses. The calculation of models shows the straightforwardness and less control in contrast with the typical technique. The 3-dimesion graphical portrayals of linear and non-linear telegraph equations are likewise given to verify that numerical model. The MATLAB programming is utilized to address the 3-dimension and 2 dimension graphical arrangement of Telegraph condition and examine the arrangement found from NHPM.

Keywords: NHPM, Telegraph equations, MATLAB software.

Introduction:

To think about the message condition, first we need to understand what the significance of the word broadcast is. Where is it come from? Thus, here is the concise portrayal for the appropriate response of these inquiries with the end goal that the French designer of the Semaphore line, Claude dried right off the bat went to the word transmit in our insight. A message is a gadget for spreading and acknowledgment correspondences over significant distances. A message correspondence send by an electrical message mechanic was known as wire. The primary thought for utilizing power for correspondence was seen in the "Scots Magazine" in 1753. A message can be sent to an electrostatic machine, utilizing a wire for each letter of the letters in order, associating the wire terminals, and noticing the avoidance of the substance balls.

A substance ball is a minuscule, effortless item that sends electric charge very well. A charged substance ball works better to show the coupling power between two charged articles. On the off chance that a glass pole is scoured with silk, the silk discharges a few electrons from the bar. Subsequently the bar turns out to be decidedly charged. Due to the magnitude of these effects, we can provide a more accurate portrayal of the Telegraph situation, for example. The telegrapher condition, also known as the message condition, is a collection of coupled direct differential conditions that describe the voltage and flow on an electric transmission line over time and distance.

A transmission line an above power line is a development used to send electrical dynamism over significant distances in electric force correspondence and scattering. It comprises of at least one conductors suspended by pinnacles or posts. Broadcast conditions emerge from Oliver Heaviside. The transmission line model set up Oliver Heaviside in 1880s. This model discloses to us that electromagnetic waves can be pondered a loop, and this wave example can be noticeable after some time. The standard applies to the transmission line of all frequencies including high-recurrence transmission lines, sound recurrence, low recurrence and direct current.

Now, a general notation of one dimensional telegraph equation is

$$\frac{\partial^2 w}{\partial t^2} + \alpha \frac{\partial w}{\partial t} + \beta w = \gamma \frac{\partial^2 w}{\partial x^2} + h(x,t) \quad 0 < x < L, 0 < t \leq T \tag{1}$$

With initial boundary conditions

$$w(x,0) = \phi(x), \;\; 0 < x < L \tag{2}$$

$$\frac{\partial w}{\partial t}(x,0) = \varphi(x), \;\; 0 < x < L \tag{3}$$

Where α, β, γ are constants; h, g_1, g_2 are known functions.

w is an undefined feature that may be voltage or current flowing through the wire at x and time t. The coil's inductance is denoted by the letter L.

And a general notation of one dimensional telegraph equation (non-linear) is

$$w_{tt} + a_1 w_t = a_2 w_{xx} + f(w) + h(x,t) \tag{4}$$

$$f(w) = \alpha w^3 + \beta w^2 + \gamma w \tag{5}$$

Where α, β, γ, a_1, a_2 are constants

The message condition characterize the various wonders in a few helpful fields like arbitrary movement of a molecule in a liquid stream, spread of electromagnetic waves in superconducting media, engendering of pressing factor waves happening in pulsatile blood stream in supply routes. These conditions are tackled by different techniques, for example, arrangement of broadcast conditions by the exchanging bunch express strategy in (2003) by Evans and Bulut; Adomian disintegration technique (ADM) in (2007) by Biazar and Ebrahimi

; Variational cycle technique (VIM) in (2009) by Mohyud-Din et. al; Homotopy Analysis Method (HAM) by Hosseini et. al; Differential Transform Method (DTM) in (2010) by Biazar and Eslami; LT reversal procedure in (2013) by Javidi and Nyamorad; Reduced Differential Transform Method (RDTM) in (2013) by Srivastava and Awasthi; DGJ Method in (2014) by Sari et.al'; technique for line-bunch saving plan in (2019) by Hashemi et. al. Lakestani and Saray (2010) utilized an introducing scaling capacity for the mathematical arrangement of direct and non-straight message condition, while Su and Jiang (2013) utilized outspread premise work. Jiwari et. al (2012) presented a differential quadrature calculation utilizing Dirichlet and Neumann limit conditions to settle the two dimensional straight exaggerated message condition.

In this paper, we presented a notable a semi-logical technique, to be specific as NHPM for the arrangements of second-request direct and non-straight exaggerated message condition, which strategy created by Aminikhah and Biazar in 2009 for the arrangement of ODE. Biazar et.al in (2011) worked on arrangement on PDEs, this technique is another change of Homotopy Perturbation Method (HPM). The HPM had proposed by Chinese mathematician He's in 1999 and effectively carried out to find in wave condition in (He's 2005). Again He's in (2006) utilized HPM for arrangement of many kind of limit esteem issues. Kumar and Singh (2010) presented HPM for got the logical arrangement of response dispersion (RD) condition. Before utilized HPM Kumar and Singh (2009) built up the arrangement of RD condition by utilizing the technique for Cole–Hopf change. Again Kumar and Singh (2011) presented a numerical model for the examination of ADM and HPM for the arrangement of RD condition, while the overall investigation of HPM and DTM of that condition talked about by Singh and Kumar (2017), and contrast and VIM a few models are conveyed, and conscious the capacity of each strategy.

Ayati et. al. (2014) built up a NHPM for getting the arrangement Schrödinger conditions, albeit the use of the NHPM was utilized for got the arrangement of non-direct PDEs by Gad-Allah et. al (2018). Singh et. al (2019)worked in HPM to addressing a non-straight Fisher condition and same creator in (2020) utilized HPM to tackle Burger's condition. Maurya et. al (2019) built up a NHPM for acquired a scientific arrangement of two sort of condition, first paper was RD Equation and second paper of Burgers-Huxley Equation. Creator ability and dependability of that technique a few models were give. In this work we tackled the straight and non-direct message condition by NHPM.

Basic idea of NHPM for Telegraph Equation:

In this section, we assumed a general notation of one dimensional telegraph equation is

$$\frac{\partial^2 w}{\partial t^2} + \alpha \frac{\partial w}{\partial t} + \beta w = \gamma \frac{\partial^2 w}{\partial x^2} + h(x,t) \quad 0 < x < L, 0 < t \leq T \tag{4}$$

With initial boundary conditions

$$w(x,0) = g_1(x) \quad 0 < x < L \;; \frac{\partial w}{\partial t}(x,0) = g_2(x) \quad 0 < x < L \tag{5}$$

Where α, β, γ are constants; h, g_1, g_2 are known functions

We set up a homotopy as follows to find the semi-logical arrangement of equation (4) using NHPM's critical conditions:

$$\left(\frac{\partial^2 w}{\partial t^2} - w_0(x,t)\right)(1-p) + \left(\frac{\partial^2 w}{\partial t^2} + \alpha\frac{\partial w}{\partial t} + \beta w - \gamma\frac{\partial^2 w}{\partial x^2} - h(x,t)\right)p = 0 \tag{6}$$

or

$$\frac{\partial^2 w}{\partial t^2} = w_0(x,t) - p\left(w_0(x,t) + \frac{\partial^2 w}{\partial t^2} + \alpha\frac{\partial w}{\partial t} + \beta w - \gamma\frac{\partial^2 w}{\partial x^2} - h(x,t)\right) \tag{7}$$

We obtained both sides of the equation (7) by using the inverse operator, $I^{-1} = \int_{t_0}^{t}\int_{t_0}^{t}(.)dt$

$$w(x,t) = \int_{t_0}^{t}\int_{t_0}^{t} w_0(x,t)dt - p\int_{t_0}^{t}\int_{t_0}^{t}\left(w_0(x,t) + \frac{\partial^2 w}{\partial t^2} + \alpha\frac{\partial w}{\partial t} + \beta w - \gamma\frac{\partial^2 w}{\partial x^2} - h(x,t)\right)dt + w(x,0) \tag{8}$$

To solve the equation (8), we consider the following form:

$$w(x,t) = W_0 + pW_1 + p^2W_2 + p^3W_3 + \cdots \tag{9}$$

We convert equation (9) to equation (8) and the equal power of equation p is as follows:

$$p^0: \quad W_0(x,t) = \int_{t_0}^{t}\int_{t_0}^{t} w_0(x,t)dt + w(x,0) \tag{10}$$

$$p^1: \quad W_1(x,t) = -\int_{t_0}^{t}\int_{t_0}^{t}\left(w_0(x,t) + \frac{\partial^2 W_0}{\partial t^2} + \alpha\frac{\partial W_0}{\partial t} + \beta W_0 - \gamma\frac{\partial^2 W_0}{\partial x^2} - h(x,t)\right)dt \tag{11}$$

$$p^2: \quad W_2(x,t) = -\int_{t_0}^{t}\int_{t_0}^{t}\left(\frac{\partial^2 W_1}{\partial t^2} + \alpha\frac{\partial W_1}{\partial t} + \beta W_1 - \gamma\frac{\partial^2 W_1}{\partial x^2} - h(x,t)\right)dt \tag{12}$$

$$p^3: \quad W_3(x,t) = -\int_{t_0}^{t}\int_{t_0}^{t}\left(\frac{\partial^2 W_2}{\partial t^2} + \alpha\frac{\partial W_2}{\partial t} + \beta W_2 - \gamma\frac{\partial^2 W_2}{\partial x^2} - h(x,t)\right)dt \tag{13}$$

⋮

Similarly others.

Let us consider

$$w_0(x,t) = \sum_{i=0}^{\infty}\alpha_i(x)R_i(t), R_i(t) = t^i \tag{14}$$

,

Where $\alpha_0(x)$, $\alpha_1(x)$, $\alpha_2(x)$, $\alpha_3(x)$,… are unknown coefficients, and $R_0(t)$, $R_1(t)$, $R_2(t)$, $R_3(t)$,… be the well-known functions dependent on this problem..

To solve the equations (10) to (13) such type, we assumed the hypothesis, $W_1(x,t) = 0$ then, the Equations (10)–(13) get the yield to:

$W_r(x,t) = 0,\ r = 2, 3, 4, \dots$
As a result, the following is the solution to equation (4):

$$w(x,t) = W_0(x,t) = f(x) + \sum_{i=0}^{\infty} \alpha_i(x) \frac{R_{i+1}(t)}{i+1} \quad (15)$$

Where, $R_i(t) = t^i$, $\alpha_i(x)$ $i = 0, 1, 2, 3, \dots$, be unidentified quantities, that would be evaluated.

Numerical Illustration: To include our discussion, two special cases of the telegraph equation, which correspond to certain physical processes, will be investigated and single solutions will be investigated. We determine the reliability of NHPM for various examples.

Example 1: Consider the following $\alpha = 2, \beta = 1, \gamma = 1, h(x,t) = 0$ in equation (1), the second-order telegraph equation (Biazar and Eslami (2010)),

$$w_{tt} + 2w_t + w = w_{xx} \quad (16)$$

With primary conditions:

$$w(x,0) = e^x \text{ and } w_t(x,0) = -2e^x \quad (17)$$

To find the semi-analytical solution of equation (16) using the primary conditions by NHPM, we established a homotopy as follows:

$$\left(\frac{\partial^2 w}{\partial t^2} - w_0(x,t)\right)(1-p) + \left(\frac{\partial^2 w}{\partial t^2} + 2\frac{\partial w}{\partial t} + w - \frac{\partial^2 w}{\partial x^2}\right)p = 0 \quad (18)$$

or

$$\frac{\partial^2 w}{\partial t^2} = w_0(x,t) - p\left(\frac{\partial^2 w}{\partial t^2} + 2\frac{\partial w}{\partial t} + w - \frac{\partial^2 w}{\partial x^2} + w_0(x,t)\right) \quad (19)$$

We obtained both sides of the equation (19) using the inverse operator, $I^{-1} = \int_{t_0}^{t}\int_{t_0}^{t}(.)dt$,

$$w(x,t) = w(x,0) + \int_{t_0}^{t}\int_{t_0}^{t} w_0(x,t)dt - p\int_{t_0}^{t}\int_{t_0}^{t}\left(w_0(x,t) + \frac{\partial^2 w}{\partial t^2} + 2\frac{\partial w}{\partial t} + w - \frac{\partial^2 w}{\partial x^2}\right)dt \quad (20)$$

To solve the equation (28), we consider the following form:

$$w(x,t) = W_0 + pW_1 + p^2W_2 + p^3W_3 + \cdots \quad (21)$$

The equal power of equation p is as follows when we transform equation (21) to equation (20).

$p^0: \quad W_0(x,t) = \int_{t_0}^{t}\int_{t_0}^{t} w_0(x,t)dt + w(x,0)$

(22)

$p^1: \quad W_1(x,t) = -\int_{t_0}^{t}\int_{t_0}^{t}\left(w_0(x,t) + \frac{\partial^2 W_0}{\partial t^2} + 2\frac{\partial W_0}{\partial t} + W_0 - \frac{\partial^2 W_0}{\partial x^2}\right)dt$

(23)

$p^2: \quad W_2(x,t) = -\int_{t_0}^{t}\int_{t_0}^{t}\left(\frac{\partial^2 W_1}{\partial t^2} + 2\frac{\partial W_1}{\partial t} + W_1 - \frac{\partial^2 W_1}{\partial x^2}\right)dt$

(24)

$p^3: \quad W_3(x,t) = -\int_{t_0}^{t}\int_{t_0}^{t}\left(\frac{\partial^2 W_2}{\partial t^2} + 2\frac{\partial W_2}{\partial t} + W_2 - \frac{\partial^2 W_2}{\partial x^2}\right)dt$

(25)

$\vdots$

Similarly others.
Let us consider

$$w_0(x,t) = \sum_{i=0}^{\infty}\alpha_i(x)R_i(t)\,, R_i(t) = t^i \qquad (26)$$

Where $\alpha_0(x)$, $\alpha_1(x)$, $\alpha_2(x)$, $\alpha_3(x)$,… are unknown coefficients, and $R_0(t)$, $R_1(t)$, $R_2(t)$, $R_3(t)$,… be the well-known functions dependent on this problem..
To solve the equations (22) to (25) such type, we assumed the hypothesis, $W_1(x,t) = 0$ then, the Equations (22)–(25) get the yield to:
$W_r(x,t) = 0, \; r = 2,3,4,\ldots..$
As a result, the solution to equation (16) will be as follows:

$$W_0(x,t) = e^x + \sum_{i=0}^{\infty}\alpha_i(x)\frac{R_{i+1}(t)}{i+1} \qquad (27)$$

Where, $R_i(t) = t^i$, $\alpha_i(x)$ $i = 0,1,2,3,\ldots..$, are unknown quantities that would be evaluate. To calculate $\alpha_i(x)$ $i = 0,1,2,3,\ldots..$, we have used MATLAB as follows, we get:
. $\alpha_0 = -2e^x, \alpha_1 = \frac{4e^x}{1!}, \alpha_2 = \frac{(-2)^3e^x}{2!}, \alpha_3 = \frac{(-2)^4e^x}{3!}, \ldots\ldots, \alpha_n = \frac{(-2)^{n+1}e^x}{n!}, \ldots.$
So, the solution of equation (16) is as follows:
$w(x,t) = e^x - 2te^x + \frac{t^2}{2!}4e^x - \frac{t^3 2^3}{3!}e^x + \frac{t^4}{4!}2^4e^x - \cdots\cdots\cdots$

(28)

So,

$w(x,t) = e^x[1 - 2t + \frac{2^2t^2}{2!} - \frac{2^3t^3}{3!} + \frac{4^3t^4}{4!} - \cdots\cdots\cdots]$

$w(x,t) = e^x.e^{-2t} = e^{x-2t}$

(29)

Which is an exact solution, same as finding by DTM (Biazar and Eslami (2010)),

Figure (1) shows the 3-D graphical arrangement utilizing by MATLAB of condition (16) by NHPM the takes the estimation of t and x lies between $t = 0$ to $t = 3$ and $x = 0$ to $x = 3$. While the figure (2) and figure (3) presentation the 2-D graphical arrangement of condition (16) taking the fix esteem t are $t = 0, t = 1, t = 2$ when x lie between from $x = 0$ to $x = 3$, and taking the fix esteem x are $x = 1, x = 2, x = 3$ when t lie between from $t = 0$ to $t = 3$.

In figure (1) the estimation of x be increments, and the estimation of t be decline then the estimation of $w(x,t)$ will be increment; and estimation of x be diminishes, the estimation of t be increment then the estimation of $w(x,t)$ will be decline. In figure (2) the estimation of x be builds, at that point the estimation of $w(x,t)$ will be increment erroneously at estimation of $t = 0$, as contrast with $t = 1$, $t = 2$.

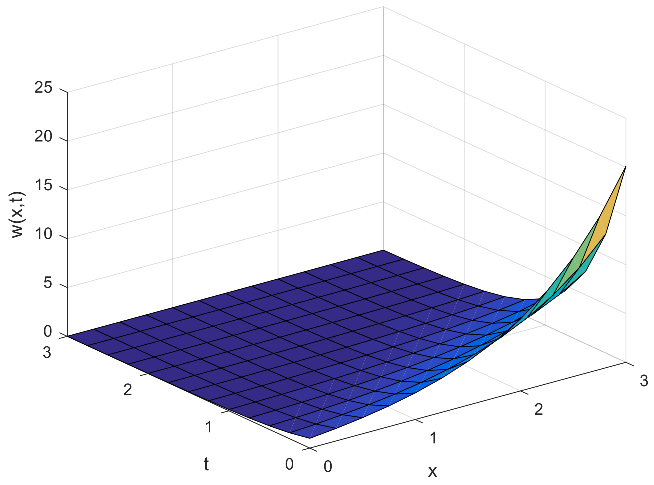

Figure1. 3-D graphical solution of equation (16) taking the different value of x and t

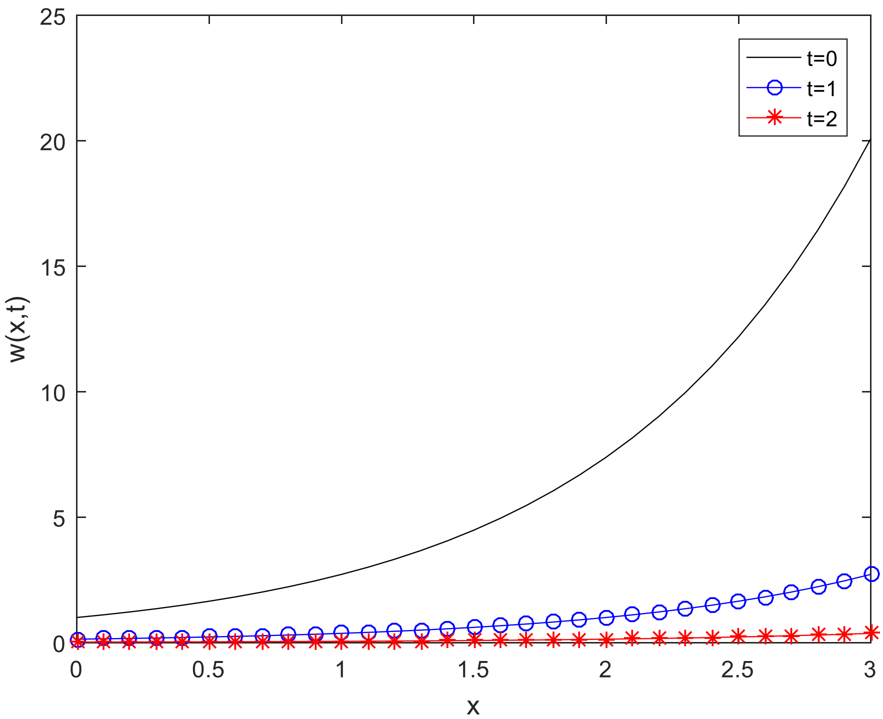

Figure2. 2-D graphical solution of equation (16) taking the $t = 0, t = 1, t = 2$

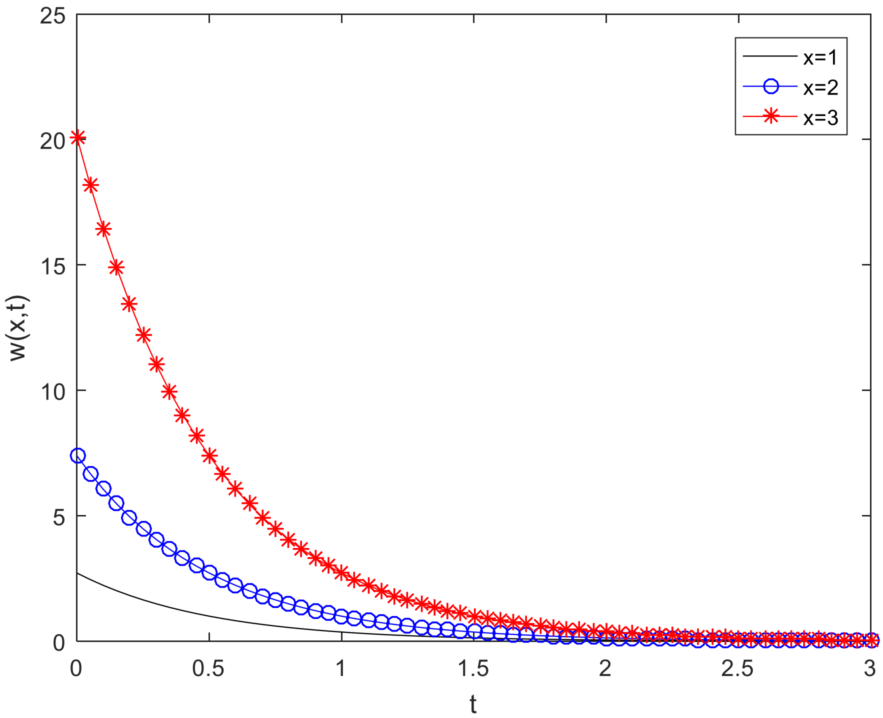

Figure3. 2-D graphical solution of equation (16) taking the $x = 1$, $x = 2$, $x = 3$

In fig. 3, If the value of t rises, the value of $w(x,t)$ falls incorrectly at $x = 3.$, as compare to $x = 1$, $x = 2..$ The equation (29) denotes the exact solution of telegraph equation (16) by NHPM, same as finding by DTM (Biazar and Eslami (2010)),

Example 2: Consider the following $\alpha = 8, \beta = 4, \gamma = 1, h(x,t) = -2e^{-t}\sin(x)$ in equation (1), the second-order telegraph equation (Hosseini et. al (2010)),

$$w_{tt} + 8w_t + 4w = w_{xx} - 2e^{-t}\sin(x) \tag{30}$$

With regards to the primary circumstances:

$$w(x,0) = \sin(x) \text{ and } \quad w_t(x,0) = -\sin(x) \tag{31}$$

To solve equation (30) by NHPM, Now we've built a homotopy that looks like this:

$$\left(\frac{\partial^2 w}{\partial t^2} - w_0(x,t)\right)(1-p) + \left(\frac{\partial^2 w}{\partial t^2} + 8\frac{\partial w}{\partial t} + 4w - \frac{\partial^2 w}{\partial x^2} + 2e^{-t}\sin(x)\right)p = 0 \tag{32}$$

or

$$\frac{\partial^2 w}{\partial t^2} = w_0(x,t) - p\left(w_0(x,t) + \frac{\partial^2 w}{\partial t^2} + 8\frac{\partial w}{\partial t} + 4w - \frac{\partial^2 w}{\partial x^2} + 2e^{-t}\sin(x)\right) \tag{33}$$

Using the inverse operator, $I^{-1} = \int_{t_0}^{t}\int_{t_0}^{t}(.)dt$, of the equation (33) both sides, we obtained

$w(x,t) = w(x,0) + \int_{t_0}^{t}\int_{t_0}^{t} w_0(x,t)dt - p\int_{t_0}^{t}\int_{t_0}^{t}\left(w_0(x,t) + \frac{\partial^2 w}{\partial t^2} + 8\frac{\partial w}{\partial t} + 4w - \frac{\partial^2 w}{\partial x^2} + 2e^{-t}\sin(x)\right)dt$ (34)

To solve the equation (34), we consider the following form:

$w(x,t) = W_0 + pW_1 + p^2W_2 + p^3W_3 + \cdots$ (35)

Equation (35) is converted to equation (34) and the equal power of equation p is:

$p^0 : W_0(x,t) = w(x,0) + \int_{t_0}^{t}\int_{t_0}^{t} w_0(x,t)dt$ (36)

$p^1 : W_1(x,t) = -\int_{t_0}^{t}\int_{t_0}^{t}\left(w_0(x,t) + \frac{\partial^2 W_0}{\partial t^2} + 8\frac{\partial W_0}{\partial t} + 4W_0 - \frac{\partial^2 W_0}{\partial x^2} + 2e^{-t}\sin(x)\right)dt$ (37)

$p^2 : W_2(x,t) = -\int_{t_0}^{t}\int_{t_0}^{t}\left(\frac{\partial^2 W_1}{\partial t^2} + 8\frac{\partial W_1}{\partial t} + 4W_1 - \frac{\partial^2 W_1}{\partial x^2} + 2e^{-t}\sin(x)\right)dt$ (38)

$p^3 : W_3(x,t) = -\int_{t_0}^{t}\int_{t_0}^{t}\left(\frac{\partial^2 W_2}{\partial t^2} + 8\frac{\partial W_2}{\partial t} + 4W_2 - \frac{\partial^2 W_2}{\partial x^2} + 2e^{-t}\sin(x)\right)dt$ (39)

$\vdots$

Similarly others.

Let us consider

$$w_0(x,t) = \sum_{i=0}^{\infty}\alpha_i(x)R_i(t)\,, R_i(t) = t^i \tag{40}$$

Where $\alpha_0(x),\ \alpha_1(x),\ \alpha_2(x)\,,\alpha_3(x),\ldots$ are unknown coefficients, and $R_0(t),\ R_1(t),\ R_2(t)\,,$ $R_3(t),\ldots$ be the well-known functions dependent on this problem..

To solve the equations (36) to (39) such type, we assumed the hypothesis, $W_1(x,t) = 0$ then, the Equations (36)–(39) get the yield to:

$W_r(x,t) = 0,\ r = 2,3,4,\ldots\ldots$

So, solution of equation (30) will be obtain in the following form

$$w(x,t) = W_0(x,t) = \sin(x) + \sum_{i=0}^{\infty}\alpha_i(x)\frac{R_{i+1}(t)}{i+1} \tag{41}$$

Where, $R_i(t) = t^i$, $\alpha_i(x)\ i = 0,1,2,3,\ldots\ldots$, are unknown quantities that would be evaluate. To calculate $\alpha_i(x)\ i = 0,1,2,3,\ldots\ldots$, we have used MATLAB as follows, we get:

. $\alpha_0 = -\sin(x),\ \alpha_1 = \frac{\sin(x)}{1!},\ \alpha_2 = \frac{(-1)^3\sin(x)}{2!},\ \alpha_3 = \frac{(-1)^4\sin(x)}{3!},\ldots\ldots,\ \alpha_n = \frac{(-1)^{n+1}\sin(x)}{n!},\ldots.$

As a result, the solution to equation (30) is:

$w(x,t) = \sin(x) - t\sin(x) + \frac{t^2}{2!}\sin(x) - \frac{t^3}{3!}\sin(x) + \frac{t^4}{4!}\sin(x) - \cdots\cdots\cdots\cdots$ (42)

So,

$$w(x,t) = \sin(x)\left[1 - t + \frac{t^2}{2!} - \frac{t^3}{3!} + \frac{t^4}{4!} - \cdots\cdots\cdots\cdots\right]$$

$w(x,t) = \sin(x)\,.\,e^{-t} = \sin(x)\,e^{-t}$ (43)

Which is an exact solution, same as finding by HAM (Hosseini et. al (2010)).

Figure (4) presentation the 3-D graphical arrangement utilizing MATLAB of condition (20) by NHPM, takes the estimation of t and x lies between $t = 0$ to $t = 2$ and $x = 0$ to $x = 3$. While the figure (5) and figure (6) show the case the 2-D graphical arrangement of condition (30) taking the fix estimation of $t = 0, t = 1, t = 2$ when x lie between from $= 0$ to $x = 3$, and taking the fix estimation of $x = 1, x = 2, x = 3$ when t lie between from $t = 0$ to $t = 2$. In figure (4) the estimation of x and t be expands, at that point the estimation of $w(x,t)$) will be initially increment and after some time will be decline. In figure (5) the estimation of $w(x,t)$ be increment when estimation of x lies between $x = 0$ to $x = 1.5$ and the estimation of $w(x,t)$ be decline when estimation of x lies between $x = 1.5$ to $x = 3$ erroneously at estimation of $t = 0$, as contrast with $t = 1, t = 2$.

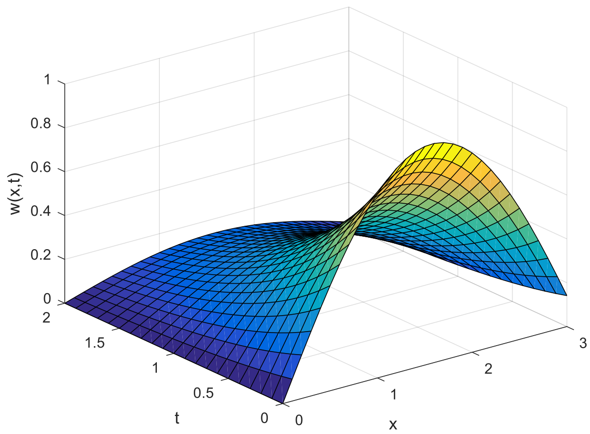

Figure4. 3-D graphical solution of equation (30) taking the different value of x and t

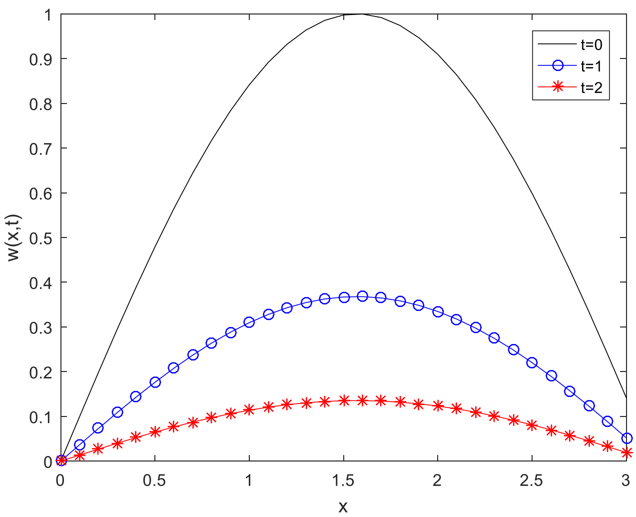

Figure2. 2-D graphical solution of equation (30) taking the $t = 0, t = 1, t = 2$

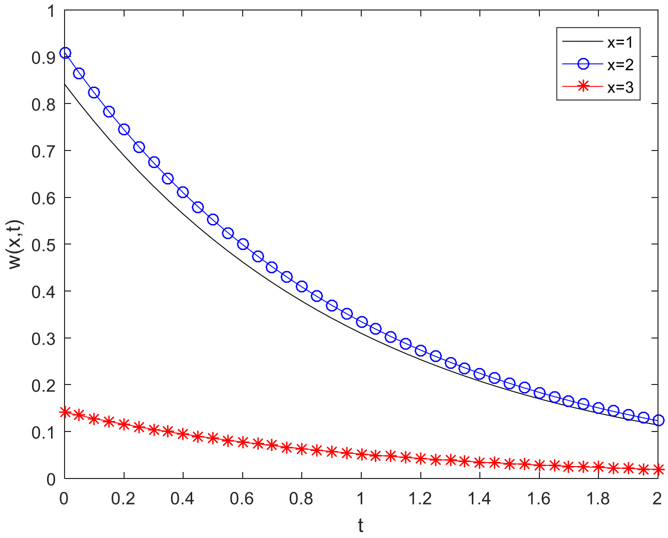

Figure3. 2-D graphical solution of equation (30) taking the $x = 1, x = 2, x = 3$

In figure (3) the estimation of t builds, at that point the estimation of $w(x, t)$ will be decline gradually at estimation of $x = 3$, as contrast with $x = 1$, $x = 2$. The condition (43) addresses the exact solution of transmit condition (30) by NHPM, same as finding by HAM (Hosseini et. al (2010)).

Closing Comments

The logical arrangements of linear and non-linear second order exaggerated message conditions were determined using the New Homotopy Perturbation Method (NHPM) in this paper. The acquired semi-logical arrangements by NHPM are very acceptable, concurring with different strategies. The outcomes show that NHPM is entirely solid and competent technique. MATLAB programming used to ascertain the arrangement, found from the NHPM and plot distinctive compelling charts of broadcast conditions based issues in 3-dimensional and 2-dimensional by setting various estimations of boundaries.

References

1. Aminikhah H, & Biazar J. (2009); "A new HPM for ordinary differential equations", Numerical Methods Partial Diff. Eq., 26(2), pp. 480–489.
2. Ayati, Z., Biazar, J. & Ebrahimi, S. (2014); "A new homotopy perturbation method for solving linear and nonlinear Schrödinger equations", Journal of Interpolation and Approximation in Scientific Computing, pp.1-8.
3. Biazar, J. and Ebrahimi, H. (2007), "An approximation to the solution of telegraph equation by Adomian decomposition method", International Mathematical Forum, 2(45), pp. 2231 - 2236
4. Biazar, J. and Eslami, M. (2010), Analytic solutions for telegraph equation by differential transform method, Phys. Lett. A 374 (29), pp. 2904–2906.
5. Biazar, J., & Eslami, M. (2011), A new homotopy perturbation method for solving systems of partial differential equations. Computers & Mathematics with Applications, 62(1), 225–234.
6. Evans, D.J. and Bulut, H., (2003) "The numerical solution of the telegraph equation by the alternating group explicit method", Int. J. Comput. Math., 80, pp. 1289-1297.
7. Gad-Allah, M. R. & Elzaki, T. M. (2018); "Application of the New Homotopy Perturbation Method (NHPM) for Solving Non-Linear Partial Differential Equations", Journal of Computational and Theoretical Nanoscience, 14, pp. 1–9.
8. Hashemi, M.S., Inc, M., Karatas, E. and Darvishi, E. (2019), "Numerical treatment on one-dimensional hyperbolic telegraph equation by the method of line-group preserving scheme" Eur. Phys. J. Plus ,134, 153.

9. He J.H., (1999), “Homotopy perturbation technique”, Computational Methods in Applied Mechanics and Engineering, 178, pp. 257–262.
10. He J.H., (2005), “Application of homotopy perturbation method to non-linear wave equation”, Chaos. Solitons Fractals, 26, pp.295-700.
11. He J.H., (2006), “Homotopy perturbation method for solving boundary value problems”, Phys.Lett A, 350, pp.87-88.
12. Javidi M., Nyamorad N., (2013), “Numerical solution of telegraph equation by using LT inversion technique” International Journals of Advanced Mathematical Sciences, 1(2), pp.64-77
13. Hosseini, M.M., Mohyud-Din, S. T., Hosseini, S.M. and Heydari, M., (2010), “Study on hyperbolic telegraph equations by using homotopy analysis method”, Studies in Nonlinear Sciences, 1 (2), pp. 50-56.
14. Jiwari, R., Pandit, S. and Mittal, RC. (2012), “A differential quadrature algorithm to solve the two dimensional linear hyperbolic telegraph equation with Dirichlet and Neumann boundary conditions”, Appl. Math. Comput., 218 (13), pp. 7279–94.
15. Kumar S. & Singh R. (2009), “Exact and numerical solutions of nonlinear reaction diffusion equation by using the Cole–Hopf transformation”, International Transactions in Mathematical Sciences & Computer, 02 (2), pp. 241-252.
16. Kumar S., and Singh R., (2010), Solution of reaction–diffusion equations by using homotopy perturbation method. International Journal of Stability and Fluid Mechanics, 1(2), 235-244.
17. Kumar S., and Singh R. (2011), A mathematical model to solve reaction diffusion eq. using homotopy perturbation method and Adomain decomposition method, VSRD-TNTJ, 2 (4), 186-201.
18. Lakestani M., Saray B. N., (2010), “Numerical Solution of Telegraph Equation Using Interpolating Scaling Functions”, Computers and Mathematics with Applications,60, pp.1964-1972
19. Maurya D. K., Singh R., and Rajoria Y. K., (2019), “A Mathematical Model to Solve the Burgers-Huxley Equation by Using New Homotopy Perturbation Method”, International Journal of Mathematical, Engineering and Management Sciences, 4(6), pp.:1483–1495.
20. Maurya D. K., Singh R., and Rajoria Y. K., (2019), “Analytical Solution of a New Approach to Reaction Diffusion Equation by NHPM”, International Journal of Research in Engineering, IT and Social Sciences, 09(5), pp. 197-207.
21. Mohyud-Din, ST., Noor, MA., Noor KI. (2009), “Variational iteration method for solving telegraph equations”, Appl. Appl. Math., 4(1), pp.114–121.
22. Sari M., Gunay A. and Gurarslan, G. (2014), “A Solution to the Telegraph Equation by Using DGJ Method”, International Journal of Non-linear Science, 17, pp. 57-66.
23. Su L. D., Jiang Z. W. , and Jiang T.S. (2013), “Numerical Solution for a Kind of Non-linear Telegraph Equation Using Radial Basis Functions”, Communications in Computer and Information Science.
24. Srivastava V. K., Awasthi M. K., (2013), “The telegraph equation and its solution by reduced differential transform method”, Modelling and Simulation in Engineering, 2013, pp-1-6.
25. Singh R., & Kumar A., (2017), “A comparative study of homotopy perturbation method with differential transformation method to solve a reaction diffusion equation. Indian Journal of Science and Technology, 10(30), 1-9.
26. Singh R., Maurya D. K. and Rajoria Y. K. (2019), “A novel approach of homotopy perturbation technique to solution of non-linear Fisher equation”, International Journal of Applied Engineering Research, Vol. 14(4), pp. 957-96.
27. Singh R., Maurya D. K. and Rajoria Y. K. (2020), “A mathematical model to solve the nonlinear Burger’s equation by homotopy perturbation method”, Mathematics in Engineering, Science and Aerospace, Vol. 11(1), pp. 115-125.