Object Motion Simulation in Two Dimension Using Digital Image

محاكاة حركة جسم في بعدين باستخدام الصور الرقمية

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Abstract:

In this research, we have been simulated the motion of an object according to the Newton's linear motion equations in two dimensions.

This simulation are building with software Visual Basic language (version 6) which is studying the movement of this object in sequence frames, and calculate the instantaneous velocity and kinetic energy at any point in the course of the object using digital color images with some initial conditions as a velocity in x-axis and y-axis, linear acceleration in x-axis and y-axis.

Used color digital images of type (bmp) and (RGB) color model in the simulation for easy handling them, after determining the center of the image on the x-axis, and y-axis and tracking movement on the basis of the center, and the results were expected to conform to the movement of the body.

الخلاصة:

تم في هذا البحث محاكاة حركة جسم طبقا لمعادلات نيوتن في الحركة الخطية في بعدين. المحاكاة تمت بأستخدام لغة فيجول بيسك (الاصدار 6)، حيث درست الحركة بلقطات متتابعة للجسم مع حساب السرعة الانية والطاقة الحركية في كل نقطة من مسار الجسم مستخدما صور رقمية ملونة بشروط ابتدائية من سرعة على المحور السيني والمحور الصادي، والتعجيل الخطي على الحور السيني والمحور الصادي. استخدمت الصور الرقمية الملونة من نوع (bmp) وذات نموذج لوني (RGB) في المحاكاة لسهولة التعامل بها، و تعيين مركز الصورة على محور السينات، والصادات ومتابعة الحركة على اساس المركز، وكانت النتائج مطابقة لما متوقع لحركة الجسم.

Introduction:

The branch of physics concerned with the study of motion and what produces and affects motion is called mechanics. Kinematics mechanic expressions that may be used to solve any problem involving the motion at constant acceleration. The kinematics method requires the specific positioning of the object's movements over time. Motion is the change of the position of a body during a time interval. To describe the motion, numerical values (coordinates) are assigned to the position of the body in a coordinate system[1].

The simulation describes the pertinent aspects of the system as a series of equations and relationships, normally embedded in a computer program. Simulation is a descriptive tool, allowing us to experiment with a model instead of the real system. Simulation embodies the principle of "learning by doing", to learn about the system we must first build a model of some sort and then operate the model [2,3].

There is Ph.D. thesis about simulation in 1 and 2-D [2], and published research of simulation in 1-D [4], In addition to published research of projectile [5].

Digital Images:

Image processing is characterized by processing huge amount of information, results in a computing intensive algorithm which hardly meets the real time computation requirements. Most of the improvements are the optimization based on the basic algorithms to improve its processing speed, and if necessary to achieve the speed at the cost of reduction in information processing with marginally compromising in the objective[6].

The reason behind using moving images was that, these images have impressive effects to everyone who watching them. However the images effect increase when these are move similar to the real representation or real motion[7].

RGB color model is basic color model that make use of Red, Green and Blue as primary colors. This is an additive model, which means any other new color can be obtained by adding primary colors[8].

Finding the center of an object will help us to locate an object in the two-dimensional image plain. We can compute the center of an object by using the following equation[4,9]:

$$C_x = \frac{\sum_{i=1}^{n} x_i}{n} \qquad C_y = \frac{\sum_{i=1}^{n} y_i}{n} \qquad (1)$$

Where are the locate of each point in image from i to n pixels for its heigh and width C_y و C_x respectively.

The Motion in 2-Dimension:

To study motion with constant acceleration in two dimensions, we will separate equations for both x and y components. To obtain x as a function of time t we write [10,11]:

$$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2 \qquad (2)$$

Where v_{ox} is the initial component of velocity in **x**- direction, and to obtain **y** as a function of time we write **y** in place **x** in equation (2):

$$y = y_0 + v_{0y}t + \frac{1}{2}a_y t^2 \qquad (3)$$

Where v_{0y} is the initial component of velocity in y- direction, a_x and a_y are the component of acceleration in x and y direction respectively.

To find the relation between v as a function of time with respect to x and y-directions [11]:

$$\left.\begin{aligned} v_x &= v_{0x} + a_x t \\ v_y &= v_{0y} + a_y t \end{aligned}\right\} \qquad (4)$$

Where a_x and a_y are the components of acceleration in x and y-directions, respectively.

Finally, we can write the relation between v and S(distance) in x and y-directions[11]:

$$\left.\begin{aligned} v_x^2 &= v_{0x}^2 + 2a_x S_x \\ v_y^2 &= v_{0y}^2 + 2a_y S_y \end{aligned}\right\} \qquad (5)$$

Where Sx = x - xo and Sy = y - yo

the kinetic energy (Ek) and the momentum (Ptot) of a particle of mass (m) moving with total velocity (Vtot) is defined as[9]:

$$Ek = \frac{1}{2} mVtot^2 \qquad (6)$$

$$Ptot = mVtot \qquad (7)$$

where $Vtot = \sqrt{Vx^2 + Vy^2}$ (8)

Algorithm of Simulation:

Algorithm for motion simulation according to equations (2, 3, 4 and 5)

Start algorithm

1. load color image and determine the centre of it using equation(1).
2. Determine max number of motion steps and determine step length.
3. Determine 1st center of object point in image plane, and determine initial conditions in equations 2, 3, 4 and 5.
4. Remove all object points from the image plane.
5. Loop for k=0 To max number step some number, then determine the motion in x-direction, and y-direction using equations (2and 3) or (4) or (5). These equations are at least varying with k-value to determine the new center of the object location(C_x, C_y).
6. Save the result. Then remove the object again from the image plane i.e. from location (C_x, C_y).
7. calculate: kinetic energy, the total momentum and total velocity from equations 6, 7 and 8 respectively.
8. End for.

End algorithm

The Results:

We use in the simulation the center of a moving object (equation 1) to help us to determine the object position for the geometric objects or not .

The previous algorithm was applying to move the object according to all equations in this simulation(equations 2 and 3, 4 and 5), then determining the component of kinetic energy, total momentum and total velocity for this object, this is clear in tables (1), (2) and (3).

Table (1) represent the motion simulation of object applying equation 2 and 3 in x and y-direction, then the simulation of this motion as shown in figure (1) and the shape of it as shown in figure (2) for different initial conditions (the components of velocity).

Table(1): The motion of object according to equation 2 and 3 for 9 frames.

No. of Frames	***Cx***	***Cy***	***Vx***	***Vy***	***Vtot***	***Ek***	***Ptot***
1	52	64	2.9	5.2	6.440	8.296	2.576
2	58	80	3.8	5.3	7.083	10.036	2.833
3	66	96	4.7	5.4	7.779	12.104	3.111
4	77	112	5.6	5.5	8.514	14.5	3.405
5	88	128	6.5	5.6	9.280	17.224	3.712
6	102	144	7.4	5.7	10.068	20.276	4.027
7	118	160	8.3	5.8	10.875	23.656	4.350
8	135	178	9.2	5.9	11.697	27.364	4.678
9	154	194	10.1	6	12.529	31.4	5.011
	Total Distance = 165.23922						

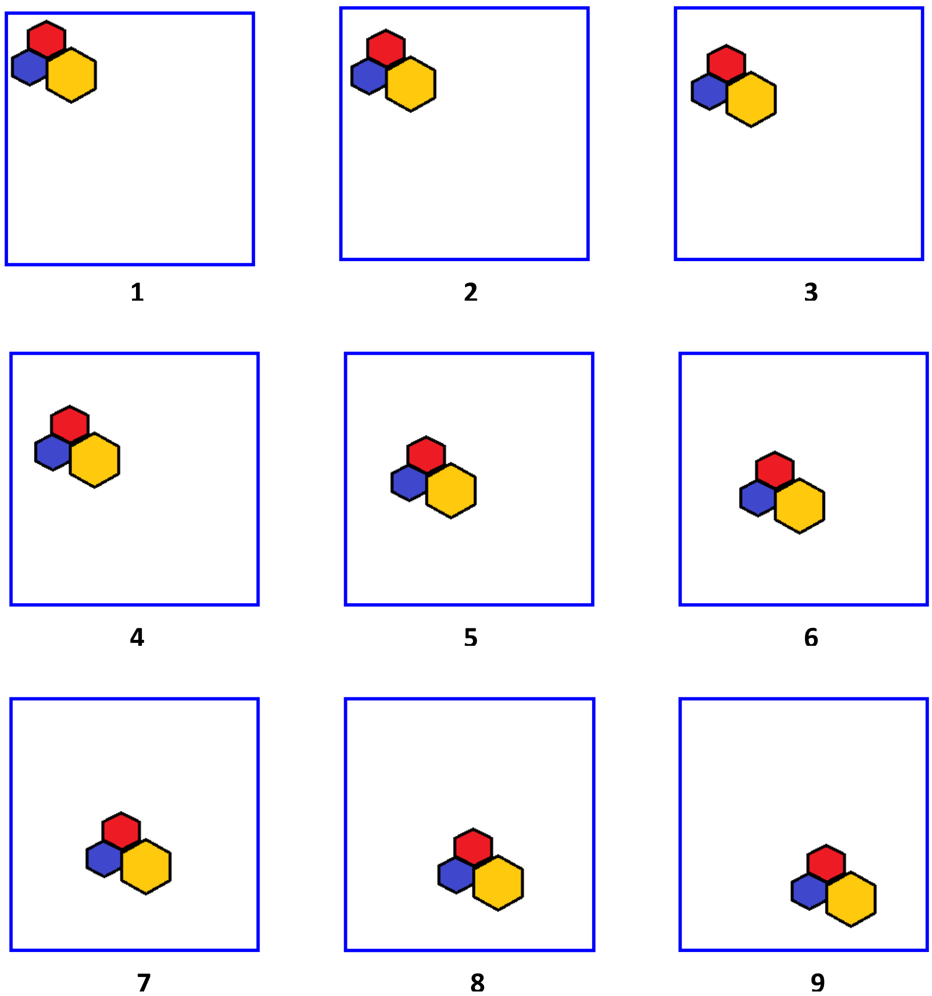

Figure (1): Motion of object according to the equation(2 and 3) (generate 9 frames)

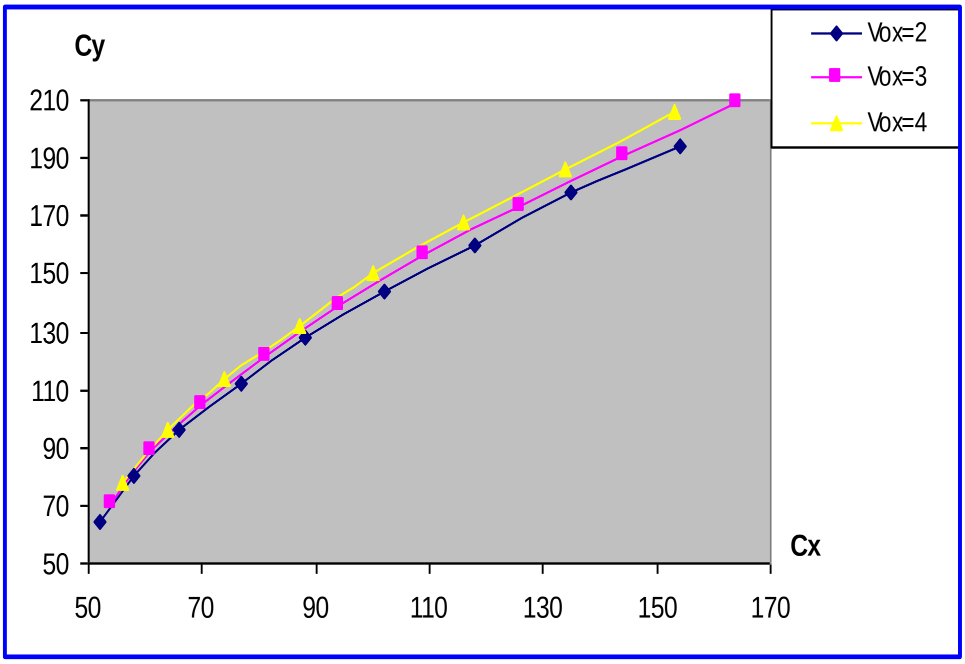

Figure (2): Shape of motion of object according to the equation (2 and 3)

Table (2) represent the motion simulation of object applying equation 4 for different initial conditions (the components of velocity in 2- dimension), with some initial value of the components acceleration. We can see that the values of ***Vx*** and ***Vy*** increase uniformly because the equations are linear.

Table(2): The motion of object according to equation 4 for 8 frames.

No. of Frames	*Cx*	*Cy*	*Vx*	*Vy*	*Vtot*	*Ek*	*Ptot*
1	58	47	12	6.5	13.647	37.25	5.458
2	60	67	14	7	15.652	49	6.260
3	62	87	16	7.5	17.670	62.45	7.068
4	64	107	18	8	19.697	77.6	7.879
5	66	127	20	8.5	21.731	94.45	8.692
6	68	147	22	9	23.769	113	9.507
7	70	167	24	9.5	25.811	133.25	10.324
8	72	187	26	10	27.856	155.2	11.142
Total Distance = 140.69825							

Table(3): The motion of object according to equation 5 for 9 frames.

No. of Frames	***Cx***	***Cy***	***Vx***	***Vy***	***Vtot***	***Ek***	***Ptot***
1	67	142	10.315	5.603	11.738	27.56	4.695
2	77	146	10.488	5.916	12.041	29	4.816
3	87	150	10.695	6.276	12.401	30.76	4.960
4	97	156	10.936	6.678	12.814	32.84	5.125
5	107	162	11.207	7.113	13.274	35.24	5.309
6	117	168	11.506	7.576	13.776	37.96	5.510
7	127	176	11.832	8.062	14.317	41	5.727
8	137	184	12.181	8.567	14.892	44.36	5.957
9	147	194	12.553	9.088	15.498	48.04	6.199

Total Distance = 165.23922

From the results in table(3), we drawn The shape of motion of object according to the equation 5, that shown in figure (3) with different initial conditions for the component of velocity.

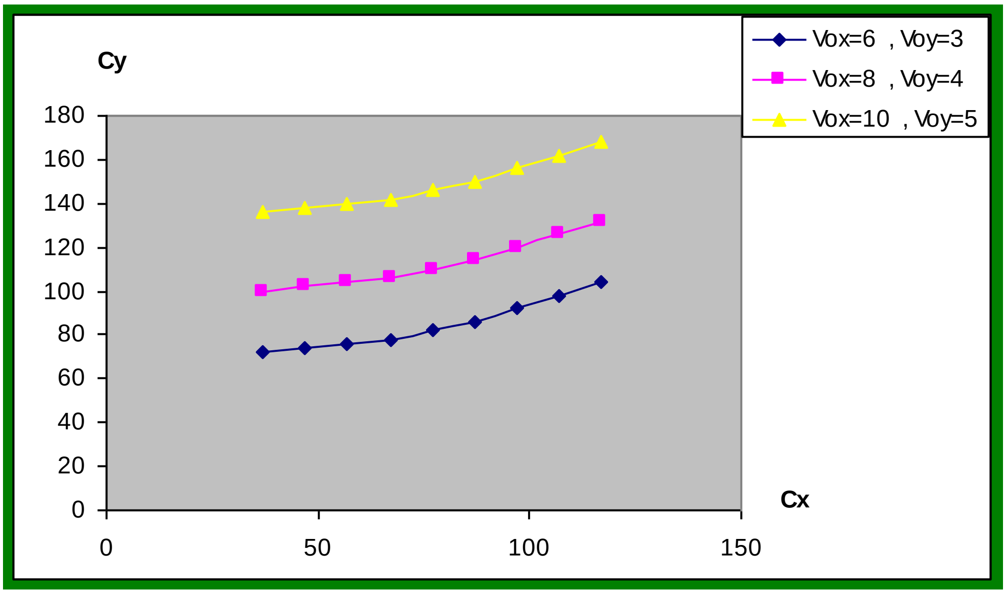

Figure (3): Shape of motion of object according to the equation (4)

From tables (1,2 and 3), we note that the velocity increase with the frames increase because the object take longer distance, as well as the kinetic energy and the momentum because they will be depended on velocity and all the unite in SI system. The simulation was been with small velocity, didn't reach to the relative velocity.

Conclusions:

Simulation are used in many scientific studies and industrial applications in order to examine some of the action plans in the real world or test the security of some of the processes or determine the extent of their scientific and economic feasibility. The researchers, engineers, and others often interested in the outcome that will get if one of the elements of the system subjected to change.

From this simulation, we can conclusion:

1. The motion depends on initial conditions of object motion, therefore all the final results will be changed according to initial conditions.

2. Calculation of the speed, the velocity, the kinetic and the potential energy, which were very important to study moving object in nature.

3. We can simulate the motion of any object and move it according to an equation that needed.

4. Done small mechanic laboratory in computer.

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