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Hamster (Cricetinae) Motion Assisted by Video Tracker Application on Motion Materials in Junior High School

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Abstract: This study aims to explain the phenomenon of motion in hamsters moving in a rolling wheel. Motion is one of the materials taught at the 7th-grade junior high school. The study can be used in learning with the practicum method, namely animal motion. Hamster (Cricetinae) motion is analyzed using a video tracker analysis application with a javascript program. This study used a direct experiment using a hamster using four reference points, namely the forelegs, head, middle body, and hind legs. The results of data analysis from the tracker application were processed using the Microsoft Excel program to obtain a graph of changes in the position and velocity of the hamster. Hamster motion on the rolling wheel is a type of translational motion, namely uniform linear motion. Changes in the hamster's position indicate motion on a horizontal line. The velocity obtained in the tracker application is more accurate than manual calculations.

Keywords: Hamster; Motion; Tracker

Introduction

Natural sciences is studied by prioritizing real facts and phenomena. Teachers are required to design real and direct science learning for students. One of the activities that can apply in the learning is a practicum method. Practical activities can encourage students to apply concepts, theories, and materials. Practical activities can generate science process skills by conducting experiments or experiments (Yulkifli & Ramli, 2018).

According to Sakti (2011), a practicum is a learning activity to strengthen students' knowledge of the material through the application, analysis, synthesis, and assessment of theory carried out either in the laboratory. Through the practicum, students gain good organizational skills and the right way of guidance so that students gain knowledge according to science learning (Kustijono, 2011).

Physics is a branch of science that studies, describes, analyzes, and applies natural phenomena such as motion, heat, light, sound, electricity, and magnetism. Observing physical objects begins with observing the surrounding environment, then analyzing it by comparing the concepts of physics and research by experts (Rizky et al., 2016).

One of the natural phenomena observed in motion is related to the motion material in hamsters. Pennington et al. (2019) stated that tracking animal behavior through video is one of the most common tasks in science. The selection of motion material with the sub-topic of straight motion only discusses the material theoretically but also practically (Agustin & Budiningarti, 2012). Hamsters which have the Latin name Cricetinae belong to the family Cricetidae which is classified in the order Rodentia or the order of large mammals which are classified as rodents. The four major lineages of Cricetinae (Urocricetus, Phodopus, Cricetus and Mesocricetus) were suitable for living in transitions to drier and colder climates (Romanenko et al., 2021). The hamster's natural habitat is dry areas, rocky steppes, or bush slopes. The hamster's main diet is meat, but it also

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eats the parts and shoots of green plants, roots, insects, and fruit. Hamsters have white, cream, gray, and albino color variants (Smith, 2012).

Currently, digital video analysis is substantial and influential in physics education because its visual appearance can make learning more attractive and accessible to students (Hantoro & Suharno, 2014). Video analysis using the tracker application is a free Java video analysis developed by the Open Source Physics Project (Wee & Leong, 2015). This application can observe various motion and learn the basics of classical physics using video analysis (Gregorio, 2015; Hockicko, 2011) Tracker freeware also provides a Data Tool function to measure the area of the motion to be a graph (Ayop, 2017).

Most motion tracking systems are based on video recording and automatically transmit information about the location, distance traveled, and velocity. Video analysis can be adjusted such as the angle of the moving direction, the velocity distance between the subject, and the distance the test animal will travel. The tracker also makes it easy to change the frame of reference to not only analyze but also see the direction of the meeting from the center of mass (Brown & Cox, 2009).

Motion analysis in hamsters analyzed using this video analysis application has not yet been found, where hamsters are more often studied as test objects (probandus) in various scientific fields. Hamsters are animals that are often encountered in everyday life and even become pets. However, several studies have begun to analyze animal motion, such as research conducted by Ramadhanti et al. (2021) which examined the motion of cats jumping, Perner's study (2001) on motion tracking in pigs, then video tracking on the motion of Drosophila melanogaster during sleep (Gilestro, 2012) and mouse motion by (De Chaumont et al., 2012).

This study was conducted using a tracker application to analyze the motion of hamsters in science learning, especially motion materials. This study aims to analyze the motion of a hamster that can be used as practical material independently on the concept of motion for class 7th-grade Junior High School.

Method

The method in this study is a direct experiment using video tracker analysis. Tracker can be used in science learning, especially in physics practicum about the law of conservation of mechanical energy (Ilma et al., 2022). The subject is a hamster that moves in a rolling wheel taken from a youtube video. The results from a hamster moving on a rolling wheel and the acceleration value are obtained with the help of a video tracker application.

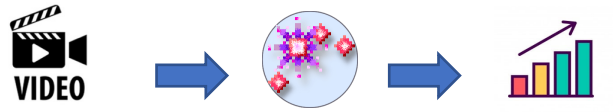


Figure 1. Video Analysis Procedure

Based on the above scheme, the procedure of study is described as follows:

1. Looking for some videos on the youtube channel regarding the motion of the hamster on the rolling wheel in the cage.
2. Analyzing videos using a video tracker application as done by Ramadhanti et al. (2021) begins by entering the video in the File menu >> import >> video >> select video >> open.
3. After the video enters the application, then set the hamster frame by tracking >> new >> calibration tools >> calibration stick.
4. Then to set the coordinates of the x and y axes to be analyzed by clicking the track menu >> axes >> visible.
5. Next, determine the point mass of the hamster using track >> new >> point mass. Then the final stage of hamster motion analysis with the auto track command.

In processing the hamster motion video using the tracker application, data is obtained from the time it takes for the hamster to move on the X-axis. Then the velocity and acceleration are calculated on the X-axis. The hamster's motion around the rolling wheel is analyzed using four reference points consisting of the forelegs (FL) blue, the head (H) purple, the midpoint of the body (M) green, and the hindlegs (HL) red as shown in Figure 2.

Figure 2. Hamster Motion Reference Point on Rolling Wheel

Result and Discussion

In this study, video analysis of hamster motion assisted by a tracker application aimed to investigate how the hamster's body as the center of mass changes the position, distance, and acceleration of the hamster concerning time. The hamster motion focuses on the motion of the hamster in the rolling wheel. The hamster

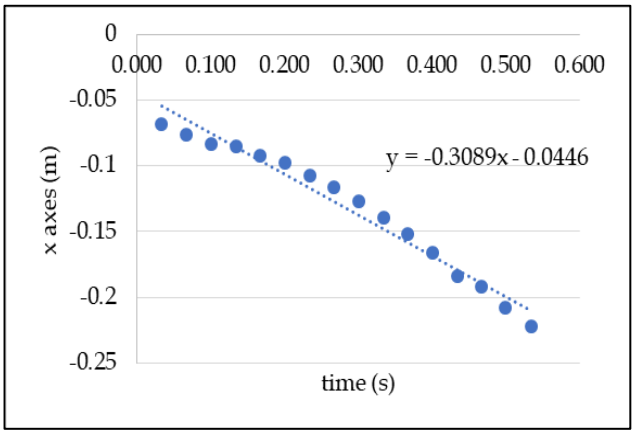
motion creates a distance using the video tracker analysis (Fahrunnisa et al., 2021). The result of the hamster motion is a translational motion. Translational motion is the motion of an object with the same shape and trajectory at each point which can be vertical or horizontal.

After analyzing the hamster motion video using the tracker application on changes in motion or position every time x(t) for four points, the resulting magnitude of the distance against time by the hamster motion can be seen in Table 1.

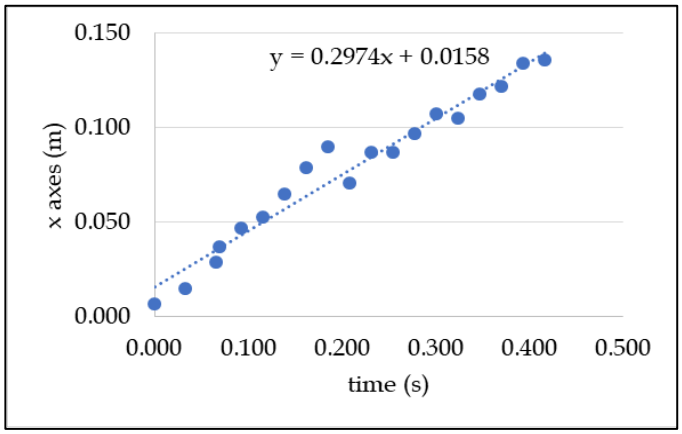
The distance formed over a certain time by the hamster is a vertical motion in the direction of the X-axis. The results of the data analysis were processed using Microsoft Excel and obtained a graph of changes in the position of H, FL, M, and HL, hamsters along with the equations formed.

Table 1. Tracker Analysis Result Data on Hamster Motion

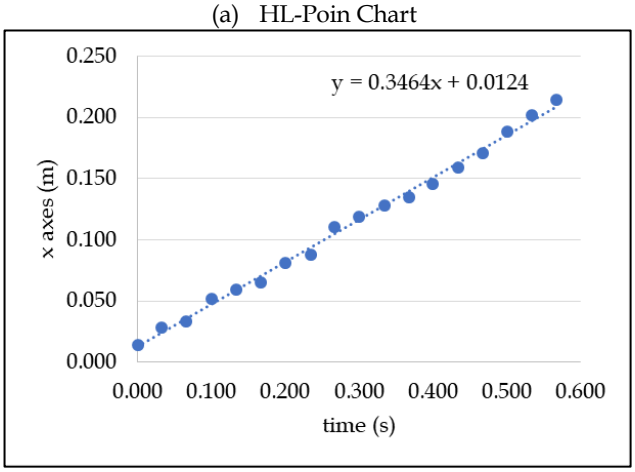
t (s)	Positions Changes x (m)			
	H	FL	M	HL
0.033	0.014	0.123	-0.125	-0.068
0.066	0.028	0.137	-0.106	-0.076
0.100	0.033	0.146	-0.093	-0.083
0.134	0.052	0.156	-0.086	-0.085
0.167	0.059	0.166	-0.076	-0.092
0.200	0.065	0.180	-0.068	-0.098
0.234	0.081	0.187	-0.054	-0.107
0.267	0.088	0.194	-0.044	-0.116
0.300	0.099	0.198	-0.034	-0.127
0.334	0.110	0.208	-0.023	-0.139
0.367	0.119	0.219	-0.019	-0.152
0.400	0.128	0.226	-0.014	-0.166
0.434	0.135	0.237	-0.012	-0.184



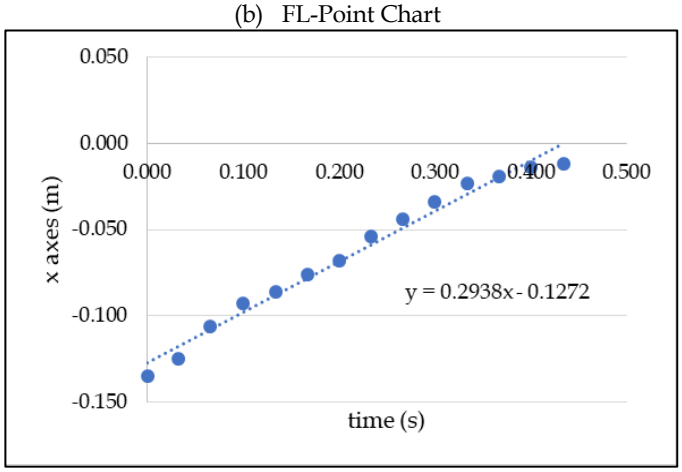
Equation: Y = -0.3089X – 0.0446
(a) HL-Poin Chart



Equation: y= 0.2974X + 0.0158
(b) FL-Point Chart



Equation: y = 0.3464x + 0.0124
(c) H-Point Chart



Equation: y = 0.2938x – 0.1272
(d) M-Point Chart

Figure 3. Hamster Motion Output from Tracker

The change in position formed by the motion of the hamster on the rolling wheel is a uniform linear motion with constant acceleration. It is like the graph of regular straight motion in the book Tipler (1998). uniform linear motion is a type of translational motion. Translational motion is the motion of an object with the same trajectory at each point. Every object is called experiences translational motion if at every point it is taken in the form of a straight line which can be a single straight line, repeated, or back and forth (Pangalinan et al., 2018).

Each point from the hamster's motion interprets the displacement of its position. Prihatini et al. (2017) explain that a change in the position of an object indicates the direction of increasing the number of coordinates, namely the right direction in the form of a positive direction and the direction to the left in the form of a negative direction. Table 1 shows that the direction of the middle of the body and the hind legs is to the left so that the direction shows a negative vector quantity. The energy expenditure of limb motion measured with motion velocity and acceleration. The equation used is as equation 1.

$$y = mx = c, \text{ then } x = v.t \quad (1)$$

Through equation 1, it will be obtained the velocity (v) which is formed from the hamster's motion. Furthermore, an analysis is carried out regarding the relationship between changes in the position of the hamster motion at each reference point which aims to see the relationship between changes in position and velocity and to see the reference point shown by the tracker application.

Graph of the relationship between changes in the position of H, M and FL with time (t)

Based on the Figure 4, shows the hamster's motion in body position based on the limbs which are divided into four points. The motion of a hamster walking on a rolling wheel shows the motion of an object in a straight line with an acceleration that increases regularly and has a stable or constant acceleration. It can be seen that the hamster's motion from front legs and head has a change in position with almost the same time from the initial time of 0.0 to 0.40 seconds. While the middle of the body shows the direction of motion in the negative vector, but still shows a stable motion as the forelegs and head.

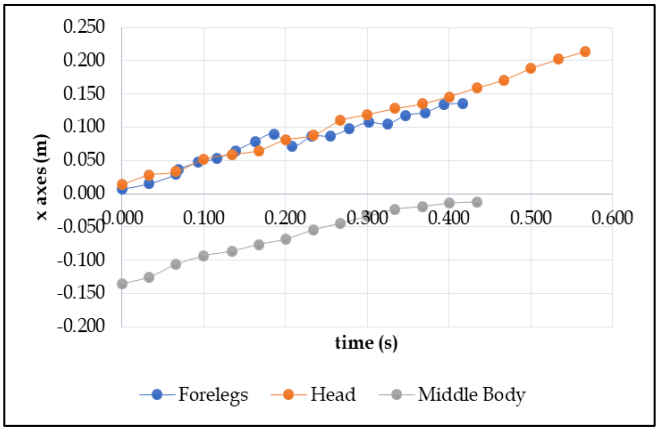


Figure 4. Graph of the Relationship of H, M and FL

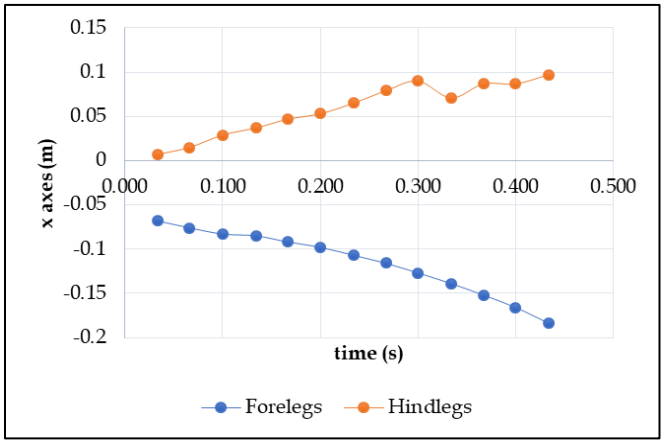


Figure 5. Graph of the relationship between FL and HL

Graph of the relationship between HL and FL against time

The graph of changes in the position of the hamster's forelegs and backlegs with time is shown in the Figure 5. Based on Figure 5 shows that the hamster's legs move in the opposite direction. When the rear foot moves backward, the front foot moves forward like climbing on a rolling wheel. Based on the velocity formed by the tracker, it shows that the front foot has a greater velocity (0.294 m/s) than the rear foot (-3.089 m/s), and rear leg motion indicates slowed motion. The hamster's leg motion can be seen in the X-ray image released by Attenborough (2020) on BBC Earth.

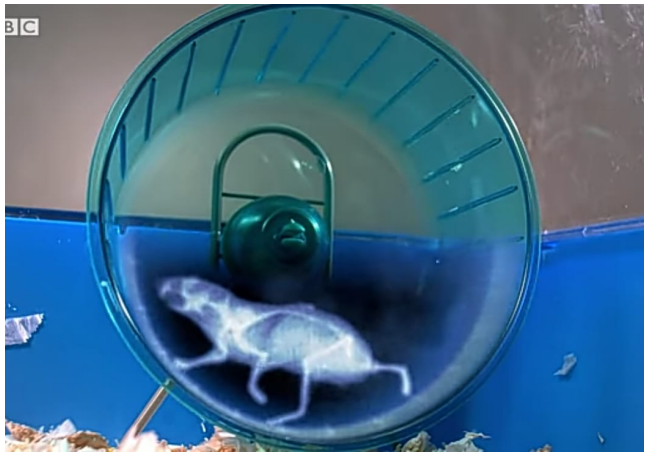


Figure 6. X-ray of Hamster Motion

The hamster's motion on the rolling wheel is a uniform linear motion, as seen from the graph and tracker showing the motion of the hamster on a straight line with an increasing velocity and constant acceleration. Serway and Jewett (2014) stated the velocity vector shows a function of time concerning constant acceleration in a dimension (Halliday et al., 2011; Wahid & Rahmadhani, 2019) and added that the distance formed in the uniform linear motion is velocity divided by time.

The velocity in Table 2 is the velocity obtained from the tracker application. The velocity shows the average

velocity. The average velocity is the ratio between the displacement and the time interval of the displacement (Prihatini et al., 2017). The velocity is then compared with manual calculations using the following equation 2.

$$\text{Average velocity} = \frac{\Delta x}{\Delta t} = \frac{x_2 - x_1}{t_2 - t_1} \quad (2)$$

The difference in velocity calculation by tracker and manual can be seen in table 2.

Table 2. Velocity of Hamster Motion

Point	Velocity (m/s)	
	Tracker Application	Manual
Hindlegs	-3.089	-2.892
Forelegs	0.2940	0.2842
Head	0.3196	0.3017
Middle body	0.2938	0.2817

Based on the results of data processing in Table 2, shows that the average velocity obtained from the tracker application and manual calculations are not significantly different. Hamster's motions resemble those of mice and their movements are highly stochastic, causing difficulties in accurate calculations. The mouse is characterized by a straight line and an ellipse, respectively (Liu et al., 2019).

In general, the average speed of the tracker application shows higher results than manual calculations. It can be caused by differences in the time and distance equations contained in the tracker and manual calculations, where the tracker application calculates the hamster's motion. While the manual calculation uses the same time for all reference points. It means that the tracker has credibility in determining better results than manual calculations.

Video analysis with Tracker application can be applied to data processing that get tables, graphs, sets hamster equations of motion (Kanga et al., 2021). Hockicko (2011) stated Tracker application can be used easily to find out the magnitudes of motion, such as changes in position, acceleration, and velocity concerning time. Through the use of Tracker application, it can save time in the learning process, free from geographical barriers, increase learning effectiveness, improve safety and quality of experiments (Fitriyanto & Sucahyo, 2016), and engage student's learning (Yusuf, 2016).

Conclusion

Tracker analysis video is an application made by open-source physics to analyze and investigates position changes, speed, motion, and acceleration. The hamsters' motion using a tracker shows that hamsters moving on a rolling wheel show uniform linear motion with constant acceleration. The change in top velocity is indicated by the head point. The motion of the front and rear legs shows the opposite direction with the result that the speed of the front foot is greater than the back foot. Video processing with the tracker application provides more specific results regarding the hamster's motion at four reference points. Trackers can interpret data and graphs of an animal's motion in the surrounding environment.

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