Smartphone als Sensorträger

Authors: Karl Heller / Bernhard Horlacher

Recommended year	*Grade 10-12 depending on school type*
Thematic block	*Technical Electronic*
Time framework	*2-4 hours*
Objectives and development of competences	*Students use smartphones to gather measurement data using an app. Physics ang chemical experiments are to be conducted using individual devices.*
Interdisciplinary (cross-curricular) relations	*The interaction between smartphone and science increases the willingness to deal with physics-chemistry technology.*

Methodical part:

Nowadays, smartphones are technological high-end product almost all teenagers have access to. Way beyond simply making phone calls and texting, the devices can be used for filming,

gaming and surfing the web. As a result of integrated sensors and countless apps these miniature computers are ideally suited for scientific experiments. They allow for experiment documentation and analysis. Each new device hitting the market presents itself with additional sensors and new apps at low or no cost are released online on a daily basis. An important piece of advice for teachers: Students are significantly more experienced with using smart phones. However, this fact should not keep us from using these devices but rather encourage us teachers to adopt new methods. For this purpose, we use the program „Sensor Kinetics Pro“, which can be purchased in the App Store and at Google Play for little money (2016: € 2.40). Furthermore, we will introduce the project Tracker which can be used to analyze video footage.

Experiments:

1. Determining, which sensors are available in the respective smartphone:

The app recognizes the following sensors, if they’re available in the smart phone (SP):
Acceleration sensor: senses that the SP is accellerated
Gyroskop: senses changes of direction within the three spacial directions
Magnetic field sensor: senses the Earth’s magnetic field (compass principle)
Proximity sensor: senses the SP getting close to an obstacle
Light sensor: senses brightness and its changes
Pressure sensor: senses pressure differences in the environment

2. Using the program on the exemplary smartphone HTC Experiment: Measuring the movement in an elevator

Task: measure the acceleration in an elevator and interprete the data.

The experiments were conducted in the television tower in Stuttgart with n elevator height of 150m. For this purpose the SP was laid down flat on the floor of the elevator and the measuring was started.

Result 1:

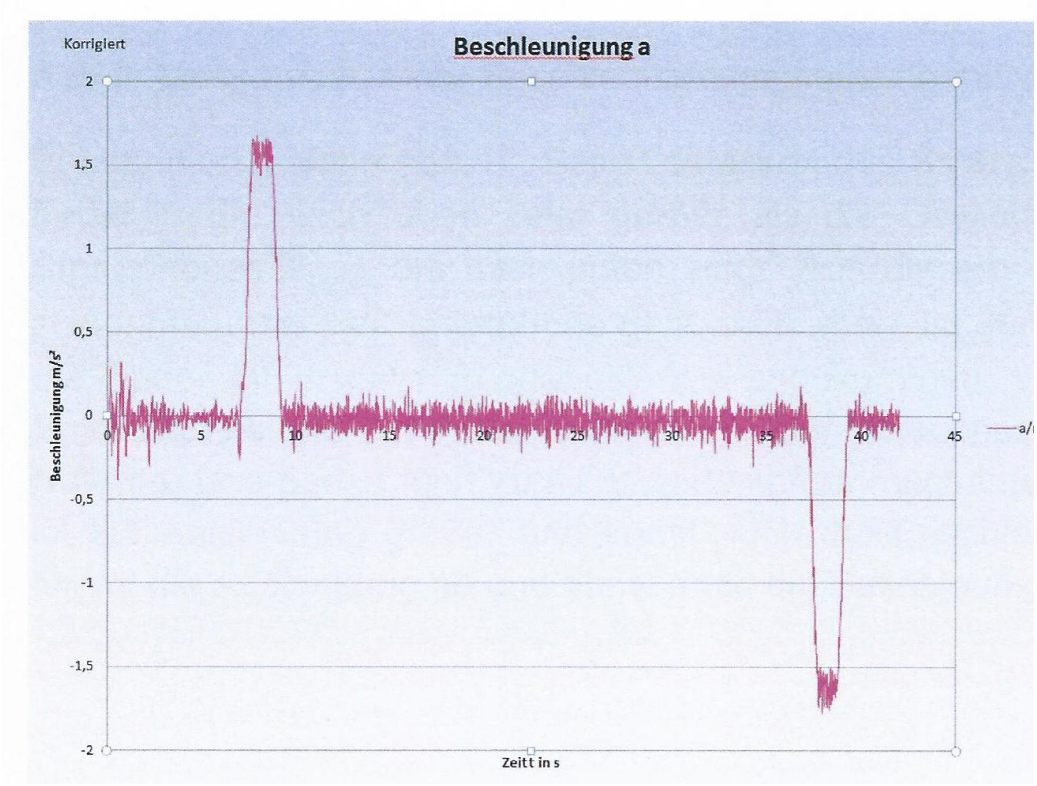


Diagram : Measuring the acceleration in the elevator at the television tower Stuttgart

Result 2:

Phase	Process	Acceleration	Speed
1	Elevator is at the bottom	0	0
2	Elevator accelerates	constant positive $a = 1{,}5\ m/s^2$	increases
3	Elevator is in motion	0	constant
4	Elevator slows down	constant negative $a = -\ 1{,}5 m/s^2$	decreases
5	Elevator is at the top	0	0

Using the program, different phases of the elevator process can be monitored very easily. The student has to interprete the data by himself.

Experiment: Conservation of Angular Momentum during Circular Movements

Required prior knowledge: Impuls = mass x speed
Angular momentum = moment of inertia x angular velocity

Rule: the angular momentum persists! → the greater the moment of inertia the lower the angular velocity

Task: Use the acceleration sensor in your smartphone to demonstrate the priciple of conservation of angular momentum

The test person is sitting on a spinning office chair. The person alternates between stretching out and retracting his/her arms. The smartphone is attached to the chair horizontally.

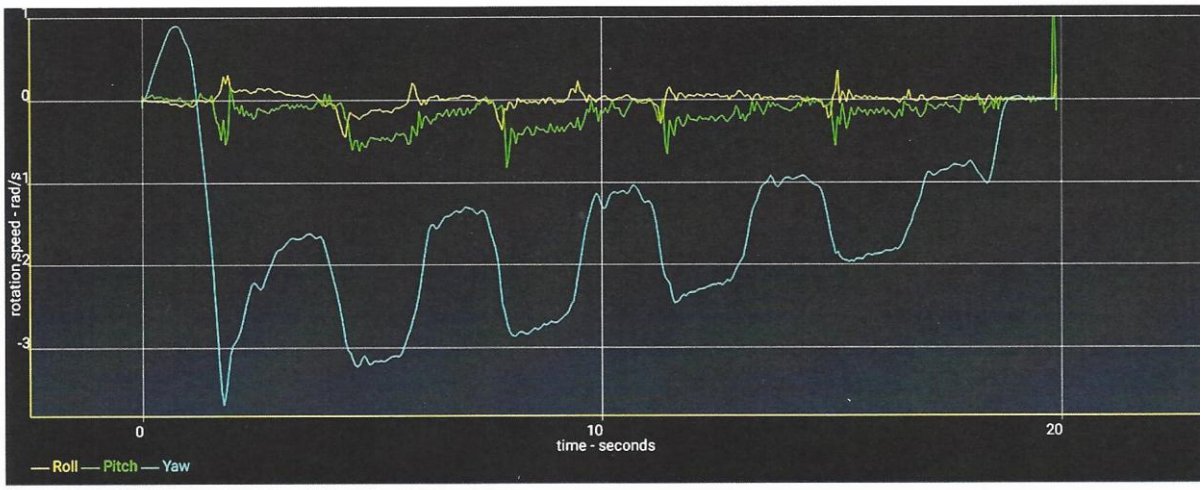


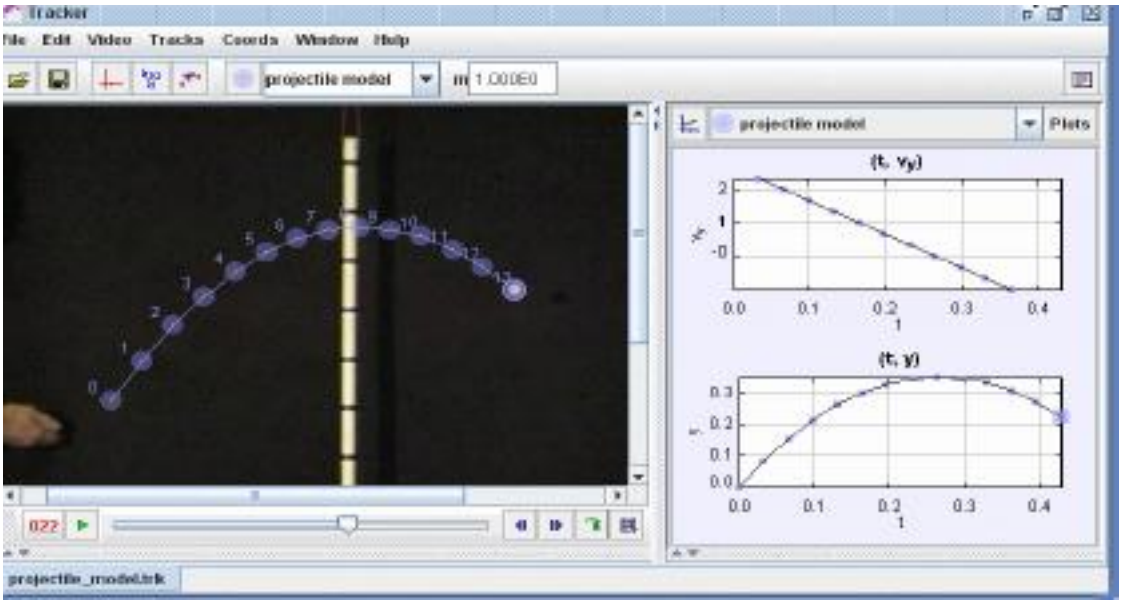
Abb.26: Winkelgeschwindigkeit bei abwechselndem Ausstrecken und Anziehen der Extremitäten auf einem Drehstuhl

Ergebnis:

Phase	Process	Rotation speed
1	Arms in	maximal
2	Arms stretched out	smaller
3	Arms in	higher
4	Arms stretched out	smaller
5	Arms in	higher

3. Video Analysis with Tracker

Tracker is a project of OSP = Open source physics and can be downloaded online for free. The smartphone can only be used to film shorter video sequences, which can subsequently be analysed on the computer. This is very motivating for students and allows to use this modern technology for scientific teaching. Screenshot of a throw (Video footage using a smartphone)



Task:

Film a throw and mark the points with the Tracker program and analyse the curve progression.