Mobile! MyLab

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INTRODUCTION

The advancements in the technological world are being made at relativistic speed. The numbers of Smartphone users in every country are increasing day by day. For India, it is expected that by 2016, it will exceed 200 million Smartphone users, topping the US as the world's second-largest Smartphone market. The Smartphone does offer wonderful features mostly because of the sensors like GPS, accelerometer, magnetometer, etc. present in it. By clubbing several of these in an innovative way, a Smartphone can be used as a great tool in educating students at school as well as undergraduate level. In this direction, an effort has been made to design science experiments of high-school level using the smart features of a Smartphone. An android application 'Mobile My Lab!' has also been designed to support the same that includes easy-collection of data from the built-in sensors of the phone, adjusting the frequency and duration of data collection, and many more exciting features have been added.

HIGHLIGHTS

Smartphone As a Laboratory Tool

A Smartphone can be utilized as a versatile laboratory tool. The various embedded sensors or externally connected sensors in a Smartphone can be exploited to perform basic laboratory experiments. These sensors collect data which can be transferred to computer by a Bluetooth or a data cable for other sophisticated calculations.

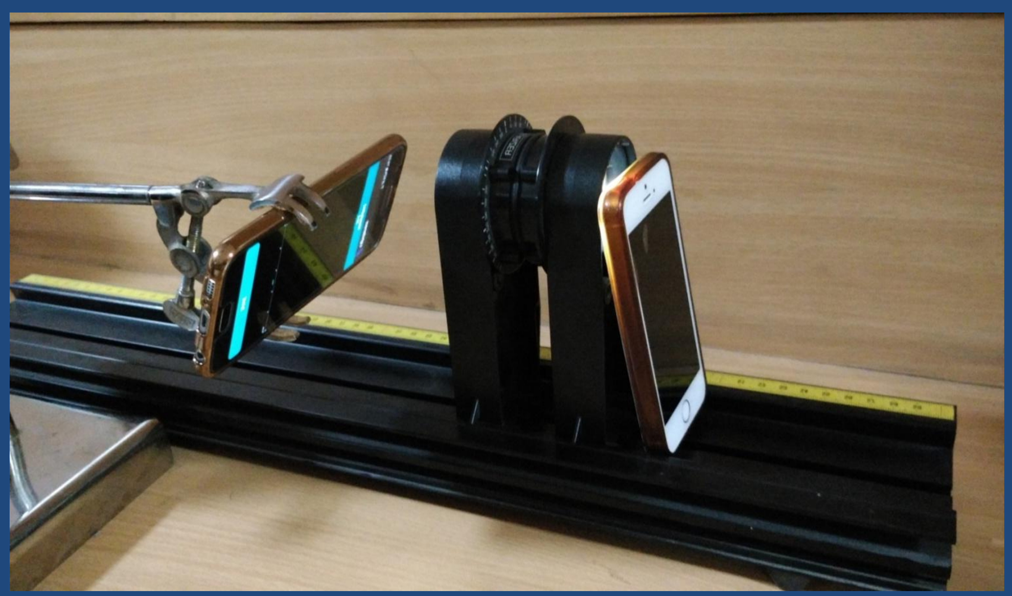

Fig.1 Light sensor in Smartphone used to verify Malus' Law. The set-up shows optical bench with two polaroids and Smartphones as a light source and a light intensity reader.

Our Very Own Android Application- 'MobileMyLab'

A team of computer science students from our college worked on the development of an original android application from the scratch. The result is our very own android app titled **'MobileMyLab'**. The app supports accelerometer, gyroscope, barometer, GPS, camera, light sensor, proximity and magnetic sensor with flexible number of readings recorded per sec.

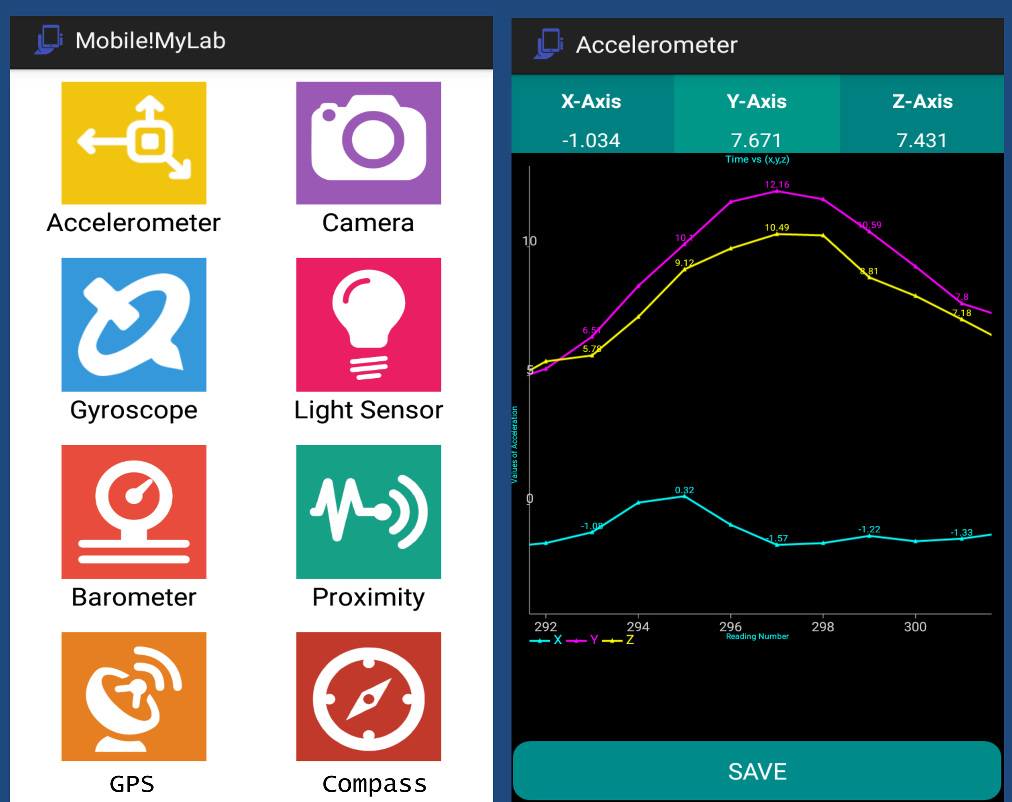

Fig 2. Two of the screens from our android app 'Mobile!MyLab'

Multidisciplinary Project

The experiments were performed from the disciplines of Physics, Chemistry and Botany with Computer Science students working on app development

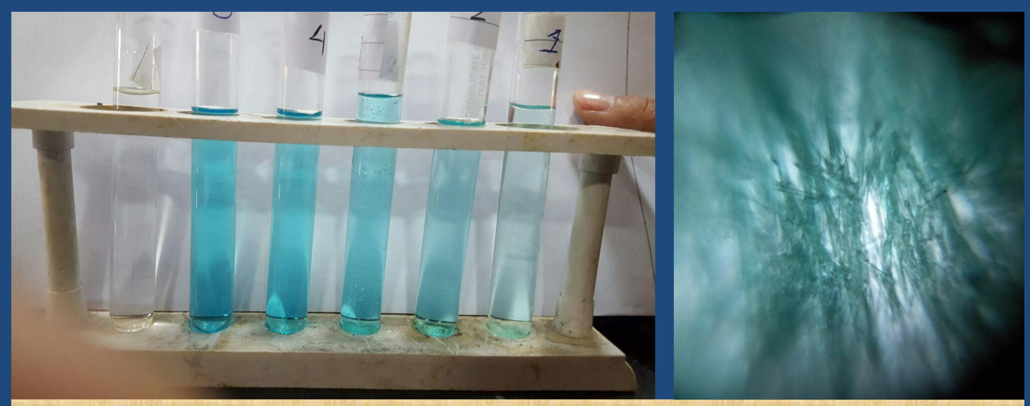

Fig. 3 (i)Copper(II) Sulphate aqueous solution with varying salt concentration used for spectroscopic analysis using Smartphone(camera) (ii) Crystals under foldscope with camera

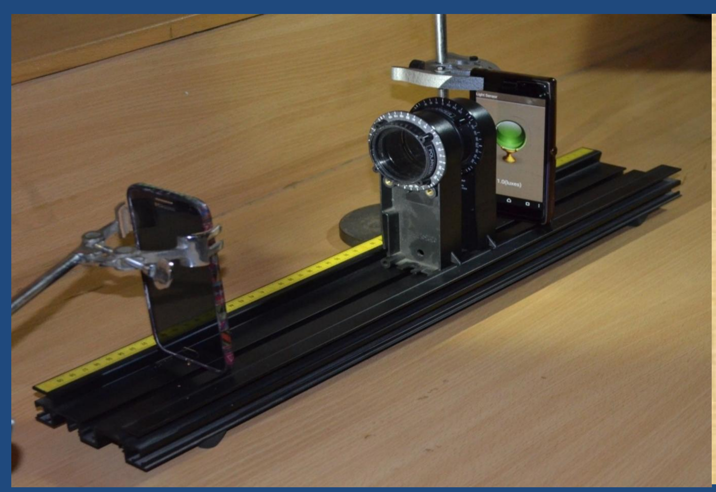

Fig. 4 Verification of Malus' Law using light sensor in Smartphone; figure shows the experimental set-up poloroids, light source and intensity detector (light sensor)

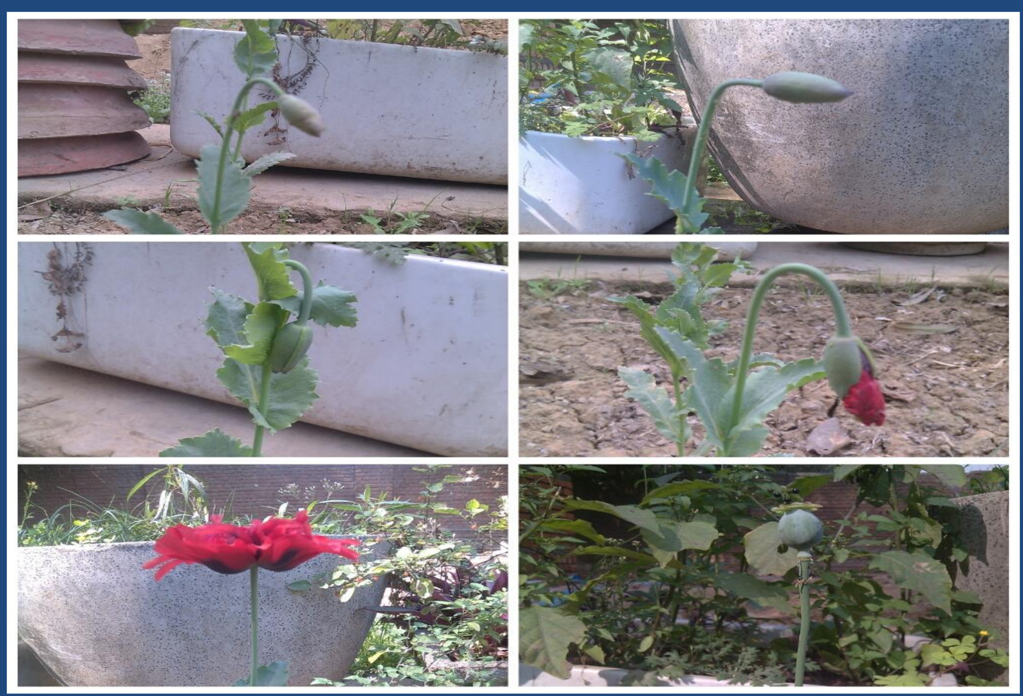

Fig. 5 The study of movement of the pedicel of Papaver rhoeas (ornamental poppy) bud when it prepares to open out : from day 1 to 5, and on the 7th day (captured by Smartphone camera)

PRESENT SENSORS AVAILABLE

TYPE	QUANTITY MEASURED
3-axis Gyroscope	Rotation in space-Roll, Pitch, Yaw
3-axis Magnetometer	Location direction (compass)
Accelerometer	Acceleration in the X, Y & Z axes; vibration
Ambient Light	Illuminance (brightness of light)
Camera	Images, video
GPS	Location
Humidity	Humidity
Microphone	Audio
Pressure	Pressure(due to altitude)
Proximity	Nearby objects, without any physical contact
Temperature	Temperature

METHODOLOGY

During experimentation Smartphone was replaced with one or more laboratory devices. In experiments with qualitative analysis, recording capacity of Smartphone was employed to obtain results with accuracy and ease. Experiments were performed on different devices and results were compared with standard techniques. The Smartphone was used as a data acquisition device and the data obtained could be transferred to computer via Bluetooth, data cable, etc. for more sophisticated calculations. The physics experiments utilized accelerometer, microphone, camera, light sensor, etc., while chemistry and botany experiments mainly dealt with camera.

FUTURE SMARTPHONE SENSORS

TYPE	QUANTITY MEASURED
6-dimensional micro-scale motion Accelerometer	Combination of accelerometer and gyroscope
9-axis motion sensor	Combination of accelerometer, compass and gyroscope
Biochemical	Biochemical agents

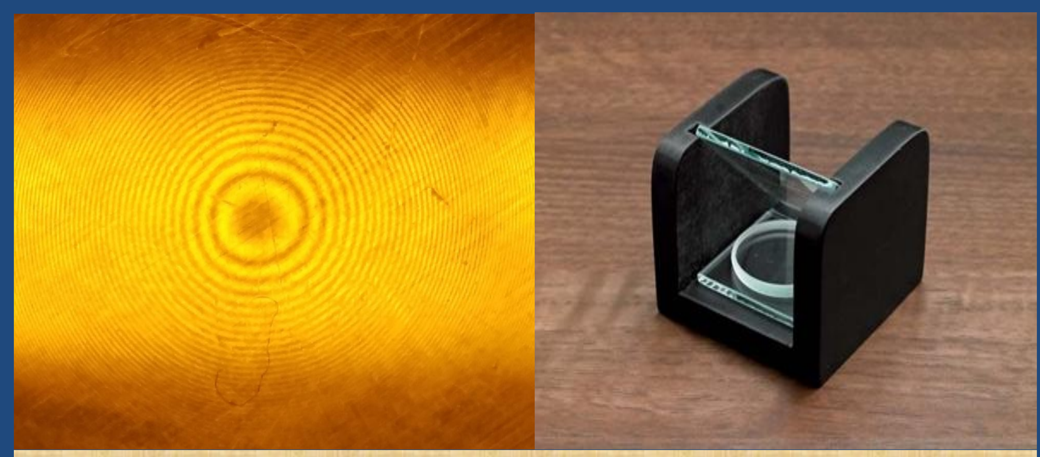

Fig. 6 (i)Newton's ring captured through Smartphone camera (ii) A plano-convex lens set-up

RESULTS AND DISCUSSIONS

The results obtained through Smartphone sensor collected data matched approximately with the results through conventional techniques.

Physics Experiments

1. Frequency of a Tuning fork

The values of the frequencies of the tuning forks analyzed by the Smartphone and computer based sensor (Vernier) were found to be closer to the known value of the frequency of the tuning fork.

2. Verification of Malus' Law

It was observed that the intensity of light through the analyzer (second polaroid) is approximately proportional to the cosine of the relative angle between the two polaroids.

3. Newton's Rings

In this experiment, the plot of the square of the diameter of the n^{th} bright fringe versus the number of the ring was observed to be a straight line. The slope of the plot was then used to find the radius of curvature of the plano-convex lens.

4. Demonstration of Beats

We get the envelopes demonstrating the phenomena of beats. Changing the beat frequency(by varying the frequency difference between the superimposed frequencies) reflects the change in the waveform. The data acquisition and pictorial representation feature helped to visualize and study the beat phenomena qualitatively. These waveforms can be used for doing further analysis.

5. Determination of Spring Constant

The spring mass oscillations were analyzed using Smartphone's accelerometer and computer based sensors. The plot of acceleration versus time was found to be sinusoidal in both the cases which shows that the motion of the spring mass system is simple harmonic. The spring constant of the spring was then calculated in both the cases.

Chemistry Experiments

1. Slow Motion Analysis

Sodium Jump, magnetic fluid, iodine-clock reaction were studied in slow motion for analysis.

2. Crystal Structure at Microscopic Level

Crystal Structure of various salt crystals were analyzed using foldscope (folding microscope) and Smartphone camera**.**

3. Spectroscopic Analysis of colored solutions and flame tests

Various colored solutions and salts were analyzed.

Botany Experiments

1. Deplasmolysis in distilled water was observed and analyzed.
2. Comparison of the cell structure of epidermal peel mounts of *Rhoeo discolor* leaf under a microscope and a foldscope.
3. Bud opening in Delphinium from day 1-6 was observed.
4. The movement of pedicel of ornamental poppy from day 1-7 was observed.

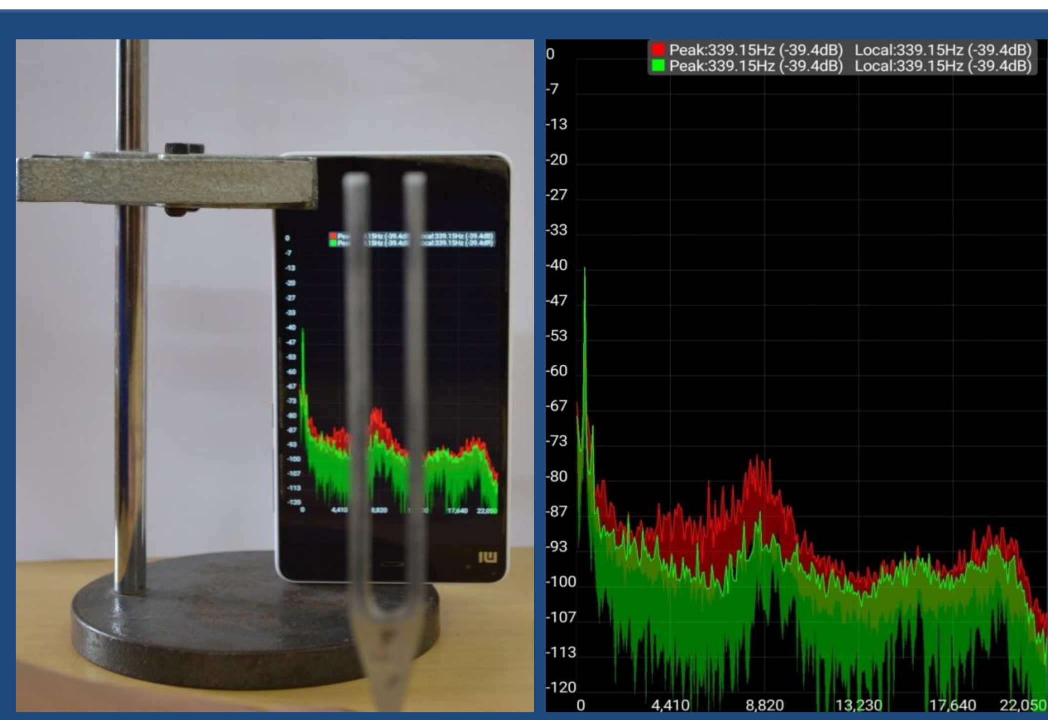

Fig. 7 Determination of frequency of a tuning fork by Smartphone(microphone) (i) Experimental set-up (ii) Fast fourier transform (fft) curve by Spectrum Analyzer App

Fig. 8. Smartphone as an accelerometer and weight in determination of spring constant

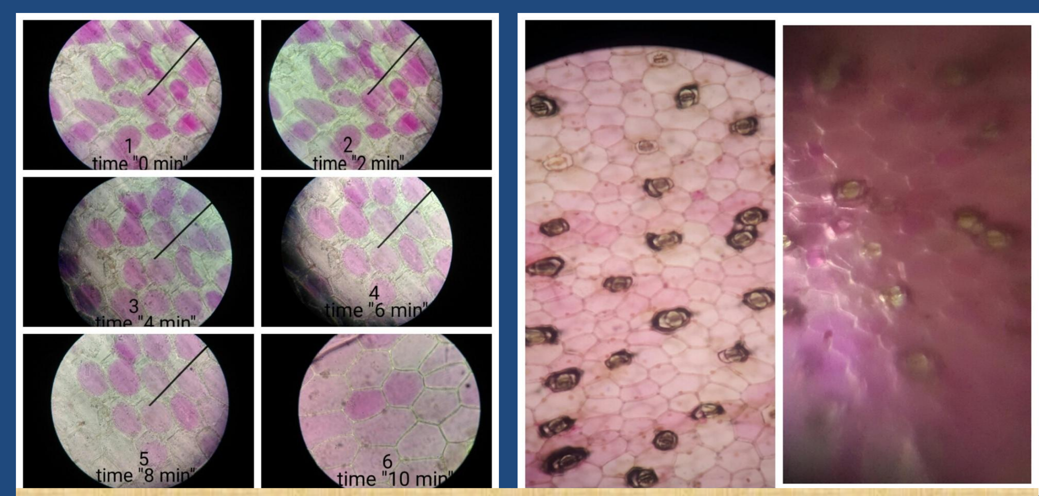

Fig. 9 (i) Deplasmolysis in distilled water observed under a microscope (ii) Epidermal peel mounts of Rhoeo discolor leaf under a microscope and a foldscope, respectively (camera)

Fig. 10 (i) Generation of beat frequency of 2Hz and (ii) 5Hz using two Smartphones: one as a dual source frequency generator (source) and the other as a receiver.

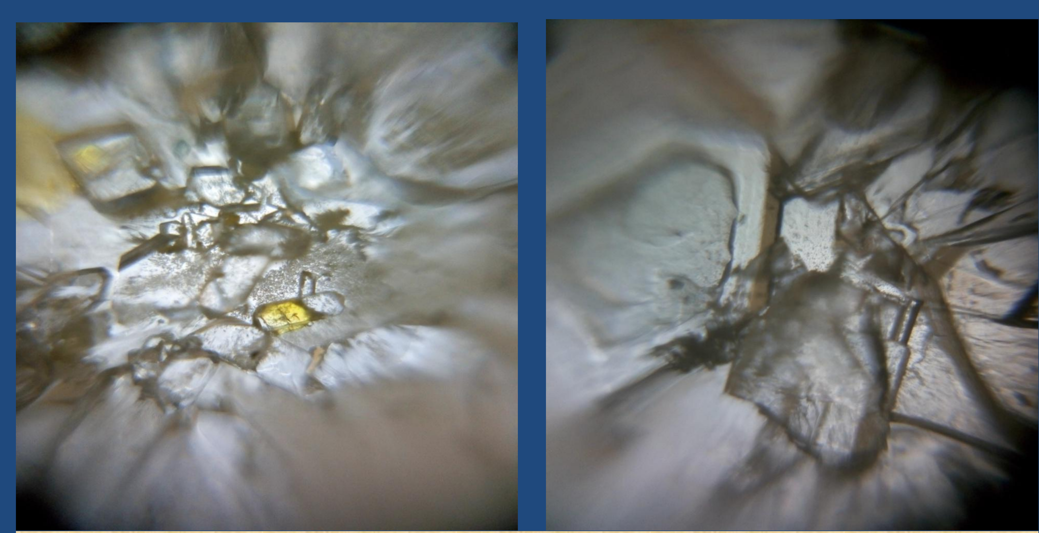

Fig. 11 Crystal structures of various compounds as seen under a foldscope and captured with a Smartphone camera.

CONCLUSION

The experimental results obtained through data recorded by Smartphone sensors are similar to results through conventional laboratory methods. The improved sensitivity of these sensors in future Smartphones shall result in better outcome. A Smartphone, thus, can definitely be used as an educational tool to motivate young learners. It can prove to be really beneficial to students at remote areas with no easy access to laboratories.