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ISSN 2080-9069
ISSN 2450-9221 online

„Edukacja – Technika – Informatyka" nr 2/28/2019
www.eti.rzeszow.pl
DOI: 10.15584/eti.2019.2.34

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Digital Literacy Development Through New Technologies for Measuring and Data Mining

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Abstract

The article is dedicated to the problematic of using new technologies at high schools and during the preparation of future teachers.

It is focused on using thermometric measurements in various fields of technics. The main emphasis is placed on forming the measuring methodology and the data mining application. A special set for thermometric measurements is developed for the didactic application. The set respects the newest teaching methodologies.

Keywords: digital literacy, technical education, thermo camera, data mining, thermometric measurements

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Introduction – innovation possibilities

Recently, the focus of the European Union has been placed on implementing new technologies into teaching. The EU primarily considers the education to be a source of economic growth and to a lesser extent, a source for the development of national culture, social justice and European identity. An effort of EU is to form so called European Education Area by 2025. In the spirit of this, the European Council has taken several challenges. One of them is the Digital Education Action Plan. There are 11 actions included in this plan to support the use of technologies and the development of digital competences in education. It is not just about the digital literacy, using mobile technologies, e-learning etc. If it stays only at the implementation of HW into schools, the quality of education would not increase much, as is proved by many researches. More and more schools and school systems prohibit pupils from using their own mobile phones and tablets at school. This is, especially, a preventive measure against cyber bullying. It is necessary to change the approach to the process of learning of pupils, teaching from the side of teachers. It is necessary to create sets of suitable education programs in accordance with the aims of learning on the levels of education system. That refers to the problematic of information technology education.

In the case of secondary technical schools and secondary vocational schools, the modern technology implementation into learning has got another aspect. The interest of pupils in the ninth grade in secondary technical and vocational schools is on a long-term basis low. How to increase interest of pupils in technical and vocational schools should be solved by the government (not only the Ministry of Education, Youth and Sports but other ministries as well) in a systematic way. Secondary and high schools play an important role in motivating pupils too. It is really important to apply modern education. Not just to use alternative educational methods (as the current teaching trends declare). The schools need to be standardly equipped with workshops and laboratories with modern tools. The tools which will be used in future real practice by school leavers according to their profession. A pleasant fact is that 3D imaging and scanning are commonly used and that the created designs are subsequently implemented in 3D printing. Most of technical and vocational schools are also equipped with a smaller numeric control machining center. However, modern technologies incline to zero-waste (low-waste) technologies. In machining, that means using laser devices. Yet, these devices and whole systems are for schools too expensive. This problem may be solved by purchasing a simulator or a simulation SW.

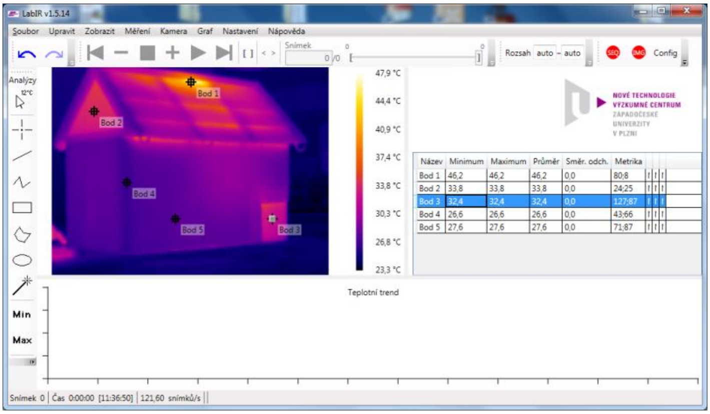
They are several grants which allow schools to gain finances for specific tools and equipment, which is positive. E.g. the grant program called "Zavádění nových technologií do středních a vyšších odborných škol" (Implementation of modern technologies into secondary and high technical schools). A specific example is the project "Tatra do škol" (tatra.cz, 2018). The Pilsen region buys a building set of a Tatra truck to the technical high school. Pupils will put the vehicle together bit by bit during their lessons. Then the car will be used by the region for the road maintenance. However, similar projects like this are not systematic. There is another possible solution to tightly cooperate with social partners of technical and vocational schools. The partners could support schools not only with professional training, but also with equipping them with the newest technologies.

Measurements and data processing - digital literacy development

Technical practice provides a wide range of data mining possibilities and at the same time, it offers a relatively wide portfolio of possibilities how to use and process them. In the area of a school technical practice, it is really complicated to obtain the true real data. Therefore we are dependent on using models, simulations or just their narrow spectrum. For example, when students measure Volt-Ampere characteristics of semiconductor elements, they are usually limited to a narrow interval of parameters, where they are never able to see the element behavior e.g. in extreme conditions (near the penetration of PN or high thermal strain). On top of that, a big amount of the data obtained from conventional measuring, that means implementing laboratory tasks, is usually limited to tens of records. On the other side, the reality of thermometric measurements is different. A big amount of thermo data linked to a specific place, a connection to graphic outputs, work with a database etc. All of that is predetermined for implementing effective administration and organization of information and for transforming digital content. The digital competences are (Ferrari, 2012, p. 4; team of authors, 2018, p 3) necessary for the analysis of a number of concomitant phenomena which are related to a number of technical and technological disciplines. New technologies of measuring provide new dimensions in the area of problem-solving processes with the use of ICT in combination with other sophisticated systems.

Problem solving and its didactical transformation

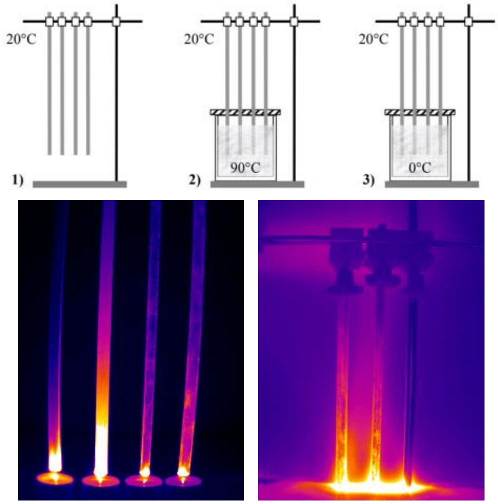
One of these new technologies is thermal imaging or shortly thermography, a modern contactless method for measuring and visualization of surface temperature. It makes electromagnetic waves with wavelengths about 10 micrometer, that human eye otherwise cannot see and that we perceive as infrared radiation (IR) or simply as heat, visible on the thermo graphic camera's screen. In recent years, thermo graphic cameras became much more reliable, whereas the resolution of the microbolometer sensor matrix has increased up to 640x480 pixels for most of today's semi-professional long wave thermo graphic camera types. Yet high resolution thermography images and videos are not only aesthetically impressive. They primary do help engineers from a wide variety of scientific fields and industry to precisely estimate the spatial temperature distribution on complex surfaces and also fast temperature changes in time for a better understanding of the underlying thermodynamic processes.



Picture 1. Application of thermal imaging in research at the Centre for New Technologies at the University of West Bohemia in Pilsen LabIR® (source: Thermo Camera Micro-Epsilon)

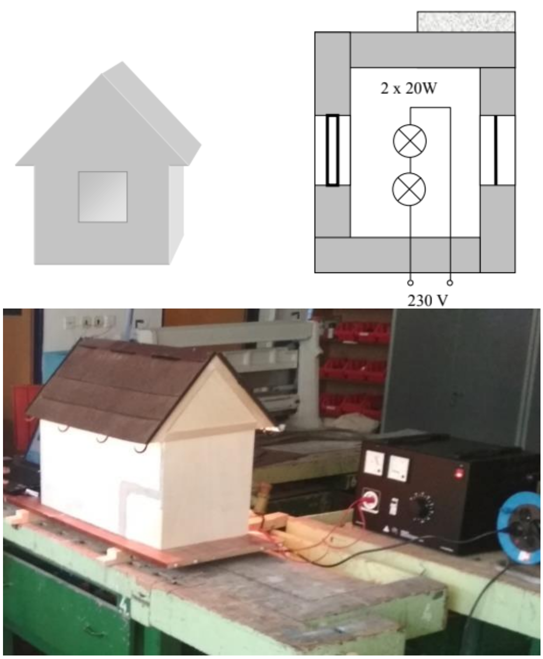
Technological applications of long wave infrared imaging in the industry reach from the development of new combustion engines, exhausts and mufflers, discs breaks or even tires in automotive industry to visualizations of current flow in electric circuits. Certainly, a simple infrared imaging has been used for temperature estimation in metallurgy and metal welding for decades. More recently, it became very popular in building construction and reconstruction as a method of seeking for thermal bridges and other heat leaks in houses.

So why is thermography not being taught at secondary schools? The answer is simple. Even the cheapest semiprofessional thermo graphic cameras are still too expensive for most of the schools and if there is one, pupils have mostly limited access to it, because it's too valuable and fragile. Therefore, our aim at the University Pilsen is to bring thermal imaging to schools within specially designed experimental sets with reliable, robust and simple to use long wave infrared cameras. The aim is not only one or two thermography cameras per class, but enough of them for pupils and students to work in small groups of maximally four students with one thermography camera. These thermography cameras and the measurement acquisition software are currently being developed at the University of West Bohemia in Pilsen at the Centre for New Technologies (NTC). In the upcoming months, these in-house designed thermo graphic cameras based on the Flir Lepton chip with a resolution of 160 x 120 pixels will be tested during teacher trainings at the department of technical education at the Faculty of Education at the University of West Bohemia in Pilsen and the University of South Bohemia in Ceske Budejovice and at selected schools as a part of experimental sets for physic lessons, laboratory exercises and practical education.



Picture 2. Design of the "heat conduction" experiment and possible solutions

These education experiments are intended to be rented to schools for a short period of time as complete sets in transport boxes each and will be shipped together with the educational long wave infrared cameras as an all in one package including all needed manuals and worksheets. Teachers will not need to prepare another parts or equipment; everything needed is in the box. Just open the boxes and begin the lesson. We will successively offer experiment sets for exploring heat conductivity, heat convection, heat radiation, friction, thermodynamic of gas and changes of state of matter. The proposed experiments are based on the publication of M. Vollmer, K.P. Möllmann - Infrared Thermal Imaging (2010), which is dedicated to the problematic of thermometric solutions from the technical and didactical view.



Picture 3. A model of a house with wall insulation, design of experiment and real measurement

For the experiments is used a setup, which helps students to explore the phenomena by themselves as far as possible. In the manual, students are guided through the experiment by heuristic questions which trigger students curiousness. There are no black boxes. Everything is quite simple to be easily understandable. In this way students learn the fundamental difference between temperature and heat. This seems to be clear at first glance, but even students at the university are often confused. So what does the thermal imaging measure? Is it really the surface temperature? Not directly. Infrared cameras are using the microbolometer principle where the absorbed radiation heat changes the electric resistance. The signal from a matrix of such elements is subsequently visualized as a gray or color scale. So it is the radiated thermal energy, what a thermo graphic camera does capture. The exact temperature information can be calculated only if we know the emission coefficient of the surface. And that is often the trouble with thermography. Students learn in the experiments step by step how to interpret the images, how to set up the infrared camera correctly and how to calculate the accurate surface temperature.

As an example of experiments developed by our team at the department for teacher training in Pilsen, let's have a look at the chapter about heat conduction. The motivation for these experiments is the thermal insulation for houses and public buildings like schools to reduce heating costs and ecological, sustainable architecture. Long wave thermography is used for visualizing heat losses in the building construction. We start with simple experiments with heat conduction (picture 2) in metal rods made of steel, aluminum, copper and brass heated in hot water and cooled in melting ice, where students compare the thermography images with feeling the heat transfer by touching the rods with their hands. We go on with building materials like concrete, brick, mortar and plaster in two different setups, one of them being a house model heated with hot wire light bulbs (picture 3).

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