

Low-cost Prevention of the Spread of Viral Diseases Using Neural Networks

Katerina Prihodova^{1*}

¹ University of Pardubice, Faculty of Economics and Administration, Institute of System Engineering and Informatics, Studentska 84, 532 10 Pardubice, Czech Republic

Abstract

Research background: Globalization has both positive and negative consequences. For more than a year, the whole world has been feeling very strongly about one of the negative consequences of globalization. And that is the rapid spread of infectious diseases. Within a few months of the first COVID-19 diseases, a pandemic occurred. The most common symptoms of this disease are fever, muscle aches, fatigue, loss of appetite and difficulty breathing. Therefore, it is essential to control body temperature reliably. If the process of temperature monitoring takes place in closed spaces, and simultaneously, the identification of a person is necessary, we propose a low-cost solution. This consists of using a mobile device in combination with a thermal camera for capturing people and subsequent evaluation using classification methods.

Purpose of the article: The aim of this article is to create a model of a system for self-shooting. Follows recognition of elevated body temperature of persons and their identification to reduce the global impact of COVID-19 on the economy and society.

Methods: A mobile device (tablet) combined with a thermal camera is used as a sensor. This is followed by face detection in both visible and thermal images. Methods of artificial intelligence (convolutional neural networks) are used for subsequent classifications of individual persons.

Findings & Value added: The proposed model of self-sensing and subsequent identification of persons and their classification into groups (increased body temperature, normal temperature). In places where it is necessary to identify people, the system also detects elevated body temperature. This will help fight the spread of infectious diseases, which are characterized by fever.

Keywords: consequences of globalization, convolutional neural network, COV-19, classification

JEL Classification: *I18; Q56; C88*

* Corresponding author: katerina.prihodova@upce.cz

1 Introduction

In today's globalized world, there are many risks that are directly and indirectly linked to globalization. There are several perspectives on their division into groups, one of the ways to divide the risks associated with globalization is shown in Figure 1. We will then deal only with the group of societal risks, which is shown in orange in Figure 1 and include the risks: economic disparity, demographic challenges, migration, water and food security, infectious and chronic diseases (Helbing, 2013).

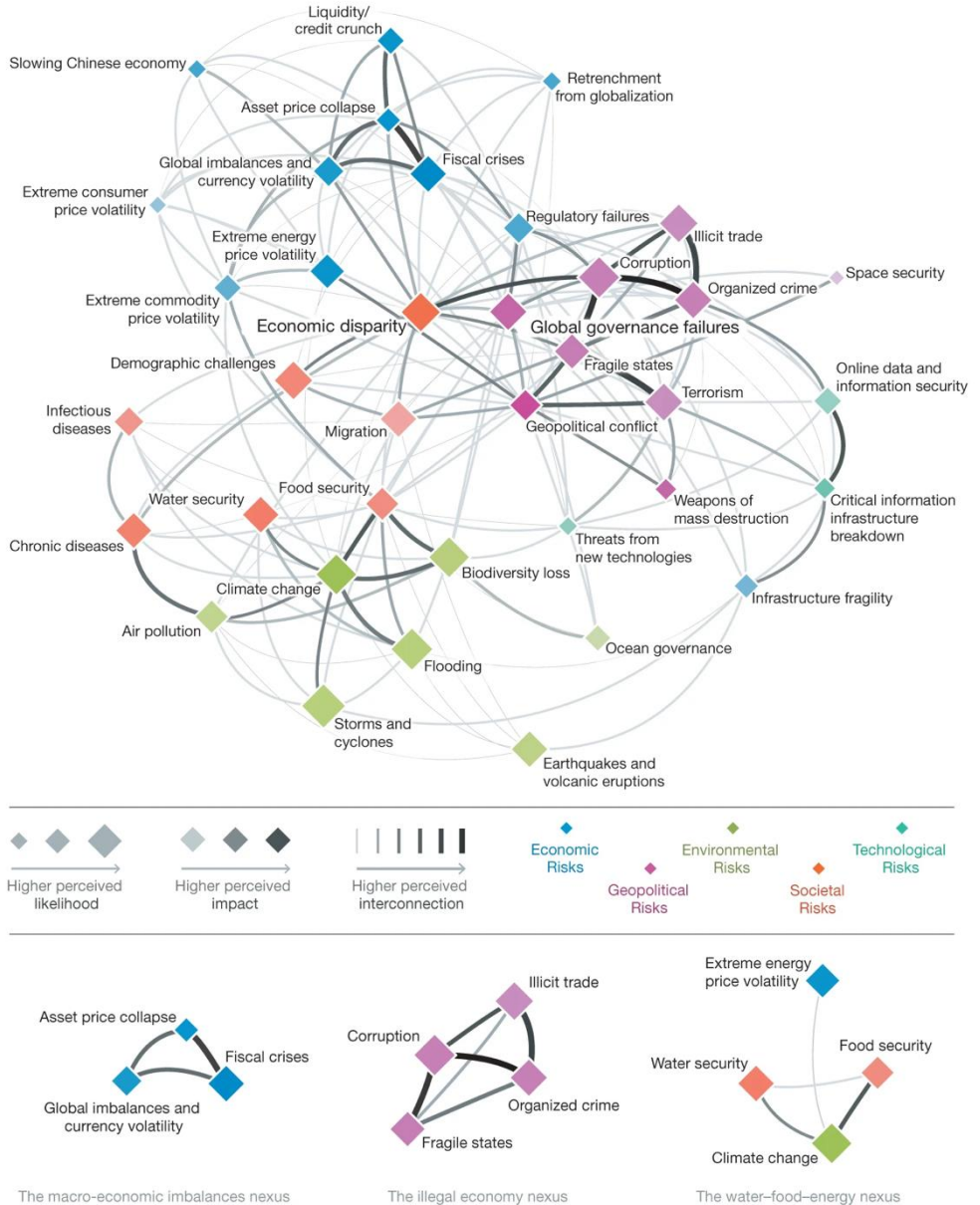


Figure 1. Risks Interconnection Map (Helbing, 2013).

In the last less than two years, we have been convinced of how big a global problem infectious disease can be. An infectious disease occurs when a parasite enters a host macro-organism and disrupts its internal environment. The most common parasites are bacteria, viruses, chlamydia, fungi. In addition, some of the infectious diseases can spread very quickly.

The impact of globalization on infectious diseases is considerable. The globalized world also has advantages, such as the rapid sharing of information about the disease. Disadvantages include the rapid spread of diseases and the emergence of mutations.

Among the very rapidly spreading infectious diseases, we can include the new disease COVID-19, which is caused by the coronavirus SARS-CoV2. This new type of coronavirus appeared in late 2019 in Wuhan, China (Antiroglu et al., 2021). Then it began to spread very quickly throughout Europe and America, followed by other continents. The virus spreads from person to person through droplets during sneezing, coughing, or body contact.

The disease has similar symptoms as other infectious diseases. The most common symptom is fever, which occurs in 83-99% of cases, followed by great fatigue and shortness of breath. Later, dry irritant cough or muscle and joint pain are added in 59% to 82%. There are also several patients who suffer from loss of smell (hence the taste) called anosmia in 15% to 30% of cases. (Mei et al., 2020)

There is currently no cure for COVID-19. There are only two ways to fight the disease, and these are vaccination and identification of infected people. The most common symptom, which is the increased body temperature, can be used to identify potentially infected people with the COVID-19 virus. (Malik et al., 2022)

Sometimes the need to identify potentially infected people is combined with the need to identify people. Person can be identified using biometric recognition. Biometric recognition is defined (Wayman, 2003) as: "Automatic identification or identity verification of an individual based on physiological and behavioural characteristics". Physiological characteristics are those with which we were born and include such features as the iris, face, fingerprints, palmprints, finger geometry and hand geometry (Prihodova and Hub, 2020; Jain et al., 2004). Behavioural characteristics include voice, handwriting, signature, and gait (Prihodova and Hub, 2020; Delac and Grgic, 2004).

To solve this double problem, it is possible to use facial images in the areas with access, which will be taken in two electromagnetic spectra (thermal and visible). Thermal images are obtained using an infrared camera, which measures and displays the emitted infrared radiation of the object. The fact that the radiation is a function of the surface temperature of the object allows the camera to calculate and display this temperature. However, the radiation measured by the camera depends not only on the temperature of the object, but also on the emissivity function. The thermogram can be further affected by radiation coming from the environment and its subsequent reflection, the radiation of the object can also affect the absorption of the atmosphere. For accurate temperature measurement, it is therefore necessary to compensate for the effects of a number of different radiation sources. Analysis of thermal facial scars can also be used as a method of identifying fraud. Because the stress caused by lying to a subject causes an increase in blood flow in some areas of the face, an increase in temperature in the carotid arteries and face (Zhumazhanova, 2018).

2 Methods

The aim of this article is to create a model of a system for self-shooting. Follows recognition of elevated body temperature of persons and their identification to reduce the global impact of COVID-19 on the economy and society. In the article a model will be designed that uses mobile device (iPad) with a thermal camera, and deep learning methods are used for subsequent image processing and classification.

The Flir ONE PRO camera, which connects to an iOS mobile device (iPhone or iPad), was chosen as the sensor. The FLIR ONE PRO is a combination of a thermal and a visual camera. The camera with basic information is shown in Figure 3. Its thermal resolution is 160×120 pixels, temperature range $-20\text{ }^{\circ}\text{C}$ to $+400\text{ }^{\circ}\text{C}$ and spectral range 8mm to 14 mm. Temperature sensitivity is set at up to 70 mK. Its visual resolution is 1440×1080 . (FLIR, 2021) Using a combination of iPad and a selected thermal camera is a cheap, compact, easily portable solution to the problem of identifying people and determining body temperature.

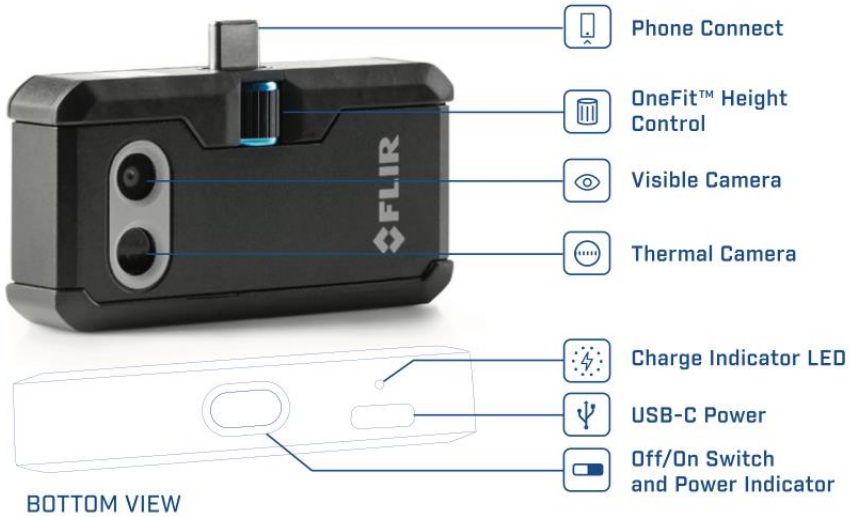


Figure 2. The Flir ONE PRO Camera (FLIR, 2021).

The face was chosen for biometric recognition and classification (normal temperature and elevated temperature) for practical reasons. Face recognition is at a high level in practical applications. Facial analysis has been used for the identification of persons, gender recognition, ethnic origin, age estimation in last years (Carletti, et al., 2020; Prihodova and Jech 2019).

The intelligent method of recognizing people at the same time as recognizing elevated body temperature is based on the use of a pre-learned AlexNet network (Krizhevsky et al. 2012, Krizhevsky 2019). The structure of the AlexNet network is shown in Figure 3.

During one shot, the camera acquires a classic image as well as a thermal image. The thermal image will be used to detect elevated and normal body temperatures. The visible image will be used to identify the person.



Figure 3. Structure AlexNet Network (author).

2.1 Visible Images – Identification of Person

After obtaining the facial image, the image needs to be pre-processed. Since the image will be further processed using convolutional neural networks, it is necessary to adjust the size of the input image. The proposed model will use the convolutional neural network AlexNet for features extraction. The required input image size is $227 \times 227 \times 3$.

The database of visible images was divided into a ratio of 70% training data and 30% test data. The pre-learned AlexNet with primary weight settings will be used for features extraction. Features will be extracted from fc7, it is a fully interconnected AlexNet layer. The features extracted in this way will be the input for the support vector machine (SVM) classifier. SVM is used as a classifier in the part of the model that ensures the identification of persons, in order to prevent overtraining of the convolutional neural network (currently it is not possible to provide a sufficient amount of data). The training will be followed by testing the model, in the same way using 30% of the test data.

2.2 Thermal Images – Classification (Elevated x Normal Body Temperature)

Like classic images, they require pre-processing and thermal images. The AlexNet neural network will also be used for classification into two groups (increased body temperature x normal body temperature). It is therefore necessary to adjust the size of the input image to $227 \times 227 \times 3$.

The database of visible images was divided into a ratio of 70% training data and 30% test data. We will learn the AlexNet network using 70% of the data (training data). We will test this part of the model with the help of test data.

3 Results

In the proposed model of recognizing persons with a symptom of an infectious disease and at the same time identifying a person, a thermal image of the face and a visible image of the face are used. These images are acquired during one shot. Subsequently, the images are

processed separately. The visible image of the face (for personal identification) is processed and then the functions are extracted with the help of convolutional neural network. Classification is performed using SVM. The result is a person's identity.

In the second stream, the thermal image of the face is processed and classified by convolutional neural network into two groups according to body temperature. If a person has a fever, he is classified as having a symptom of an infectious disease. If a person has a normal body temperature, he is classified as a person without a symptom of an infectious disease. This principle is illustrated by the flowchart in Figure 4.

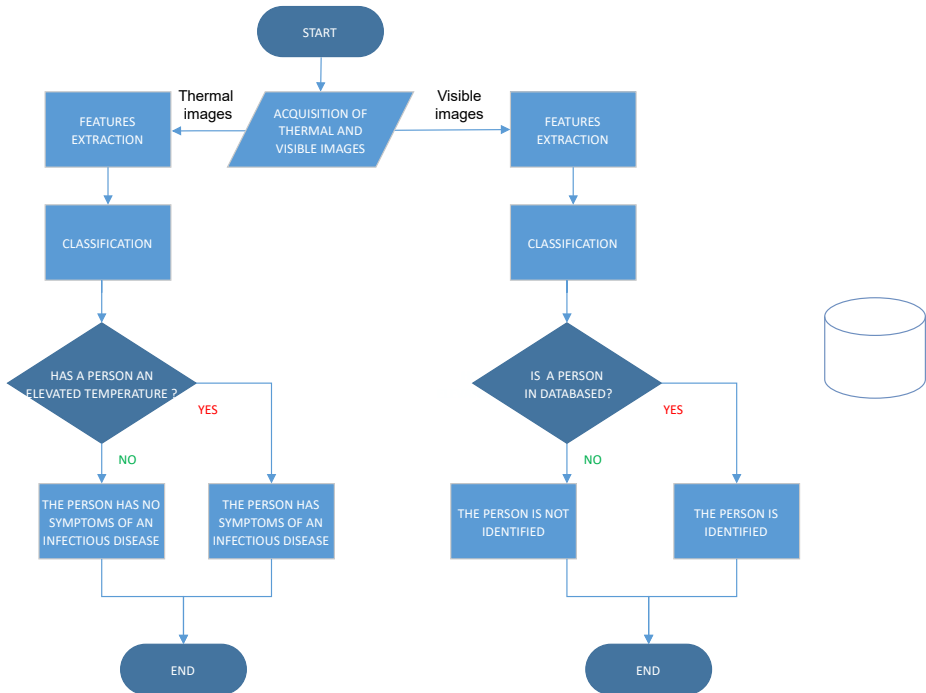


Figure 4. Flow Chart of the Proposed Model (author).

4 Discussion

In this article, a small thermal camera in combination with an iPad was used as a scanning device, which is a cheap and at the same time mobile variant of the sensor. As already mentioned, the use of a thermal camera that captures both thermal images and visible images at the same time makes it possible in real applications to simultaneously identify a person and at the same time identify a person with a fever that is a symptom of many infectious diseases. Which can be used to control attendance and at the same time to protect employees from the spread of infectious diseases.

Subsequently, thermal images of the face are classified into two groups (elevated body temperature, normal body temperature) using a convolutional neural network. Visible facial images are used to identify people, using SVM for character extraction and convolutional neural networks for classification.

Further research may be focused on the pre-processing of thermal images so that the convolutional neural network achieves better classification results.

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