Fuel burn reduction in commercial aviation using Mathematical Morphology

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ABSTRACT

In aviation, transportation is a direct connection between the fuel consumed by aircrafts and carbon dioxide emissions. A new solution for determination of the necessary aircraft fuel will lead to companies' savings and environment protection. The proposed method considers the commercial passenger aviation. The software developed by International Civil Aviation (ICAO) use a methodology for simulation of necessary fuel and for computing carbon emissions. A part of this methodology uses fixed value for passenger's weight determination. Not all passengers from a flight have the same weight and, thus, the proposed method could replace the fixed value. Based on mathematical morphology operators, the new algorithm will improve the accuracy of aircraft fuel consumption with significant results on environmental protection.

INTRODUCTION

Transportation of people or merchandise all over the world is a developing activity year by year. With this activity, one of the natural resources, respectively the oil, is extracted and refined to be used for thermal engines. The oil is not unlimited and the consumption of each liter of oil impacts the climate. Therefore, it is necessary to take measures to mitigate these issues. Factors as demand and instability (as currently the war in Ukraine) affect the fuel price.

In the latest years there is no doubt that the climate is changing, having multiple negative effects on ecosystems, human lives and economies. There are consistent international efforts to limit the CO2 emissions. An increasing numbers of governments are converging on a goal of net-zero emissions by 2050. This is in line with recommendations by the Intergovernmental Panel on Climate Change (IPCC), and the goals of the Paris Agreement in 2015 to keep the average global temperature rise "well below 2°C above pre-industrial levels" and to "pursue efforts" to limit the rise to 1.5°C (UNFCCC, 2015). Fossil fuel and aviation are one of the most pollutant and there is tremendous pressure to find solutions to limit the emissions and become sustainable

ALGORITHM DESCRIPTION

The algorithm consists in several steps. Firstly, in the image processing stage, mathematical morphology operator was used in order to detect the boundaries of the human body. The next step is to calculate the irregular area of each human body detected. The human body density is close to 1000 kg/m^3 similar to the density of water. According to the modelling of the global fuel consumption for commercial aviation, for each passenger one considers a weight of 100 kilograms per passenger.

Experiment and results

The processed image was converted into a binary image to remove the noise that could affect the weight determination (Figure 1).

Figure 1. Original image and segmented image

The mathematical morphology operator used in the proposed algorithm is erosion:

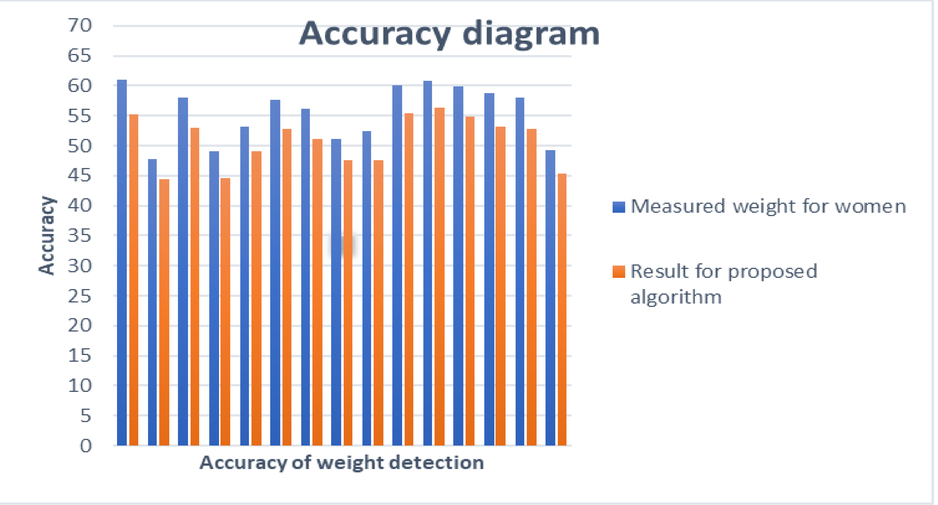
$$A \ominus B = \{x | Bx \subseteq A\}$$

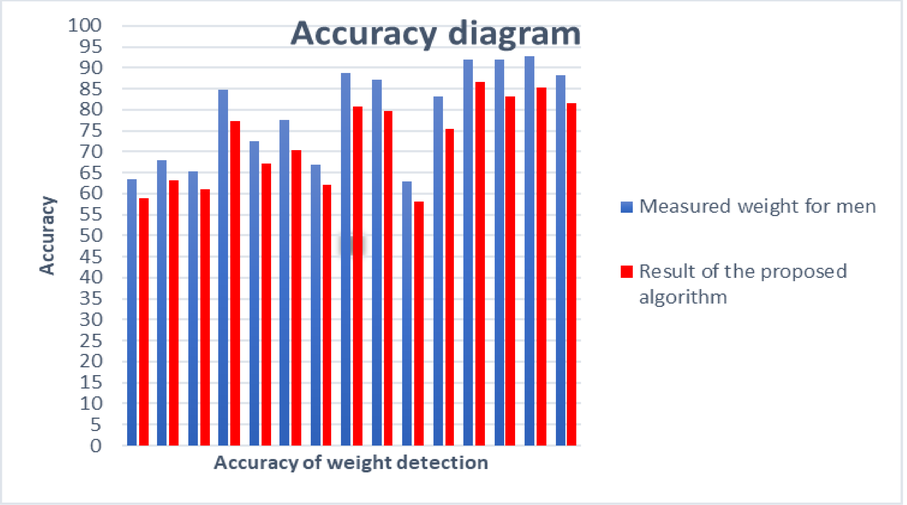
Using the erosion operator, the irregular boundaries of the human body detected will be as thin as possible. A thin layer of pixels will ensure the errors decrease when computing the area (Figure 2).

Figure 2. Processed image with erosion mathematical morphology

Conclusions

Using the elliptical tube volume formula in the bellow figures is presented the accuracy of weight detection for women and for men.





Using the proposed algorithm for passenger weight determination it was observed that extra fuel consumed by the airplanes can be reduced thus resulting in reduction of CO2 emissions.

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