

Thermal Sensor Based Human Detection

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I. INTRODUCTION

This project tackles the concept of recognizing and classifying heat patterns in order to detect humans. The heat data is collected from a thermal sensor attached to the ceiling of a room. It measures any object which emits heat. For example, the object could be an oven, human being or any other heat-emitting object. In order to detect humans, a model shall be created to distinguish heat patterns. The hypothesis of this research is that humans can be distinguished from other heat emitting objects using an thermal sensor. As such, the project is an object detection task.

II. DATA

Only raw, unlabeled data is available for this project. It consists of 32×32 infrared images which should be the input for the model (see Figure 1). The images are indoor images with humans present. The dataset contains 10,000 of these images which were taken with a sampling rate of 10 samples per second. But since two different sensors were used to record the same scene, only 5,000 unique data points are in the dataset. In addition to the image array, each data point includes information about the thermal sensor, with which the data was recorded, the current room temperature, the strength of the signal and the validity of the data point.

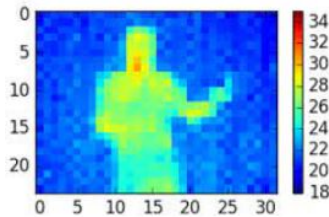


Fig. 1. Sample image of the 32×32 infrared image.

Since the dataset is not labelled, there is uncertainty regarding the complexity of the data as well as the problem which needs to be tackled during the project. For example, it is not clear whether the data of the two sensors should be fused or should be seen as separate entities. Moreover, the number of classes of objects that are sufficiently well detectable remains uncertain as of the beginning of the project.

III. PRELIMINARY ASSUMPTIONS

Certain preliminary assumptions can be made about the scenes that were recorded in order to narrow down the scope of the problem:

- The human body temperature will not exceed 40.0°C . Moreover, most of the body is covered with clothing, causing the measured temperatures to be even lower;
- The human body heats up the environment and air around it, so the area of hot pixels is larger than the actual body size;
- There is a measurable cool-down time for objects which were warmed up by humans. The cool-down time depends on the material of the object as well as the starting temperature;
- Overlaps between humans and other heat emitting objects may appear.

IV. DESCRIPTION OF THE METHODOLOGY

In order to prove this research's hypothesis, a methodology is defined to conduct experiments with the presented data. Initially, the raw data will be converted into 32×32 images. Unsupervised learning and classic statistical methods will be applied in order to get an initial estimate of the complexity of the data. When the data is too complex to be solved in an unsupervised manner, the images will then be labelled according to a to-be-determined ground truth. Having labelled the images, supervised learning methods will be applied in order to create a model which is able to distinguish humans from heat emitting objects, therefore proving the hypothesis to be correct. The model validation metrics to be used are precision, recall, F1-score and accuracy for supervised learning, and entropy and inter-intra cluster ratio for unsupervised learning.

V. EXPECTED OUTCOMES AND CONSTRAINTS

The aimed-at accuracy of the proposed model is more than 85% on the given validation set, considering the following constraints:

- Software that runs the model must be convertible to/runnable in C language;

- Model must fit into 1-core ARM MCU (STM32F4, nRF52840 or nRF9160);
- Model can be demonstrated on the PC compiling with GCC;
- Model has to be converted into MCU compatible format;
- Model should run with at least 1 FPS on selected MCU.