detection can be performed with high success considering all scenarios. In this section, information about the proposed framework, the dataset used and the methods used in the framework and performance metrics are given.

2.1. Proposed Framework

Fire can have different colors depending on the type of fuel [31]. The fact that the objects in the environment have the same colors as the flame is one of the most important factors that make it difficult to detect the flame with image processing techniques [32]. However, the fact that the flame is in motion reveals the difference between it and the objects. Apart from these, the presence of fire in the environment can be detected by using deep learning algorithms that can make sense of the entire image [33]. Considering all these factors, a 3-stage fire detection framework has been proposed. In Stage 1, a number of image processing techniques were used to detect the flame. These are, respectively, luminance reduction, HSL (Hue saturation luminance), YCbCr (Y: Luminance, Cb: Chroma (blue minus luma), Cr: Chroma (red

used in previous studies [29, 34, 35]. The frames obtained from the videos are also included in the created dataset [36]. The dataset contains 3041 images in total. 1900 of these images are natural images without fire zones. 1141 of them consist of images containing various fire zones. Although the number of images in the dataset is small, it has a wide variety of images. The cross-validation method was used for the reliability of the success of the models. The dataset is not divided into train and test parts. Examples of fire images with fire zones in the dataset and non-fire images without fire zones are shown in Figure 2.