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Image Processing For Haze Removal

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Abstract: This paper focuses on implementing image processing for human understanding in low visibility using different image processing technologies, high-speed processors, employing the BBB board in designing embedded systems and protocols with their comparative study. We have proposed a system called as "image processing for human understanding in low visibility". The purpose of this application is to overcome the problem of Low-visibility conditions for Navigation of vehicles. Driving at night, in blizzards, in sand storms, or in fog form an obvious set of challenging conditions. The main aim is to solve the problem of low visibility by advanced image processing technique purpose to improve the perceptual quality of images that lack the contrast or color depth perceived by the human visual system. This paper provides the use of high-speed infrared cameras and advanced image processing techniques to deal with the problem of low visibility.

Keywords: Fog/haze, Beagle Bone Blackboard, LCD Screen, Infrared camera, Image Processing.

I. INTRODUCTION

Now a day's low visibility condition are a frequent occurrence. Due to fog and haze, visibility is impaired. Poor visibility causes flight delay, diversion, cancellation as well as automobile accidents. Driving at night in case of fog forms a challenging condition which may lead to a fatal accident. We have seen a drastic change in the environmental condition also pollution has aggravated the problem and proving to be fatal. This issue prevails on a larger scale in the industrial region but with the escalating development and industrialization, it won't take long to spread across the country. Thus, the problem is to deal with such situations in which human performance is limited by low visibility. The resolution of the human eye is 324 to 576 megapixels depending upon the angle of vision, but in the case of fog or other weather haze, the visibility is impaired. The system is designed to overcome this hazard. The system uses an infrared camera to obtain an enhanced image of the surrounding, which will help avoid accidents caused due to poor visibility. With their ability to visualize by detecting infrared rays irradiated from the subject, infrared cameras offer capabilities not available with visible-light cameras. Infrared camera with a multi-frame super-resolution processing function that uses software processing to increase the number of pixels and improves spatial resolution. Infrared cameras with high resolution are not only suitable for shooting subjects that are high and distant, they also enhance operation efficiency because they can shoot a wide area at once without decreasing spatial resolution. Beagle bone black used in a system is a low-cost ARM Cortex-A8 processor. Advanced image processing techniques are used to improve the perceptual quality of images that lack the contrast or color depth perceived by the human visual system.

II. EXISTING SYSTEM

Horizon detection in foggy aerial image

Vision-based automatically landing is important for micro Unmanned Aerial Vehicles (UAVs). The Horizon is a very useful clue. Most of the existing solutions for the problem can get accurate results in clear weather. However, for some images shoot in extreme environmental conditions like foggy or cloudy sky these methods are difficult in identifying the horizon correctly. In this paper, we propose a robust, vision-based horizon detection algorithm fit for this condition. The algorithm we put forward is based on a dark channel prior, which describes the depth of haze naturally. The horizon can be easily determined in dark channel property space.

We then verify our vision-based horizon detection algorithm with real flying data. The results indicate that the algorithm is robust to heavy foggy weather conditions. This algorithm can also be useful in synthetic vision system. Equipped with small video cameras and transmitters, UAVs have great potential for surveillance and monitoring tasks. In the military, one of the primary roles for UAVs will be as small-unit battlefield surveillance agents, which can reduce the risk to military personnel. UAVs can also be used in a number of civil missions, including inexpensive traffic and accident monitoring, border patrol, search and rescue, surveys of natural disaster areas, and even visual monitoring of volcanic activity. So, recently, substantial progress has been made towards designing, building and test-flying remotely piloted Micro Air Vehicles. [1]

Fog Detection System Based on Computer Vision Techniques
In this document, a real-time fog detection system using an on-board low cost Black and white camera, for a driving application, is presented. This system is based on two clues: estimation of the visibility distance, which is calculated from the camera projection equations and the blurring due to the fog. The probability of a correct detection is high, over than 85 %. Then, some errors are due to the sample time used for integrating the measurements. In some of the tested sequences, the system has given a false alarm, as the visibility distance is given by the algorithm is very short also sometimes brightness of the sun saturates the camera. Resulting in the failure of the segmentation process. The algorithm is fast enough to be embedded in a real-time system. This system lacks the accuracy for on point identification and detection.[2]

III. LITERATURE REVIEW

A Fast Single Image Haze Removal Algorithm Using Color Attenuation Prior
In this paper, a simple but powerful color attenuation prior to haze removal from a single input hazy image. With the depth map of the hazy image, one can easily estimate the transmission and restore the scene radiance via the atmospheric scattering model, and thus effectively remove the haze from a single image. Outdoor images were taken in bad weather (e.g., foggy or hazy) usually lose contrast and fidelity, resulting from the fact that light is absorbed and scattered by the turbid medium such as particles and water droplets in the atmosphere during the process of propagation. The technique used in this paper will facilitate proper processing of the image without any environmental factor being a hindrance. [3]

Image Restoration Technique for Fog Degraded Image
This Research paper uses Image restoration and Image Enhancement technique for restoring the clear image from a fog degraded image. The overall objective of this paper is to propose an integrated technique which will integrate the nonlinear enhancement technique with the gamma correction and dynamic restoration technique. The mathematical processes involved will help minimize the probability of error. [4]

Enhancement of imagery in poor visibility conditions
Current still image and video systems are typical of limited use in poor visibility conditions such as in rain, fog, smoke, and haze. These conditions severely limit the range and effectiveness of imaging systems because of the severe reduction in contrast. The NASA Langley Research Center's Visual Information Processing Group has developed an image enhancement technology based on the concept of a visual servo that has direct applications to the problem of poor visibility conditions. This technology has been used in cases of severe image turbidity in the air as well as underwater with dramatic results. Use of this technology could result in the greatly improved performance of perimeter surveillance systems, military, security, and law enforcement operations, port security, both on land and below water, and air and sea rescue services, resulting in improved public safety. [5]

Image Processing for Human Understanding in Low-visibility
Advanced image processing techniques via contrast enhancement or tone mapping purport to improve the perceptual quality of images that lack the contrast or color depth perceived by the human eye. Applying such an algorithm intelligently to these low-visibility conditions gives us the ability to provide a perceptually usable assisted-vision system. [6]

Infrared Camera Image Processing Technology and Examples of Applications
The crux of this paper is the image processing technology used to obtain the higher resolution required for non-destructive inspection. Thanks to their ability to visualize by detecting infrared rays irradiated from the subject, infrared cameras offer capabilities not available with visible-light cameras. Infrared cameras are a critical component that helps to protect the safety and security of individuals and of society as a whole. [7]

IV. PROPOSED SYSTEMS

Our system consists of an Infrared camera to capture the images of the surrounding.Beagle bone Black is used as control unit having 1GHz ARM Cortex-A8 Processor supported with Neon Co-Processor. The perceptual quality of images that lack contrast or color depth are processed using image processing software and the resultant image will be displayed on the LCD screen which will be interfaced with beagle bone module. Our proposed model is, as shown in Fig. 1.

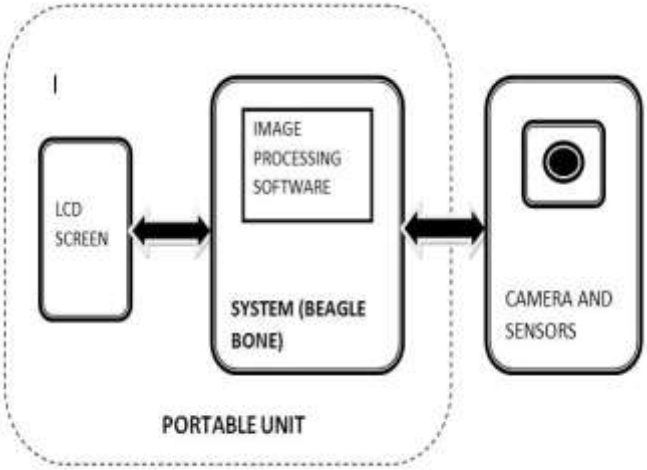

Fig. 1. Block diagram of proposed system

The infrared camera will capture the enhanced image of the surrounding. This Proposed System includes different image processing algorithm which is then applied to the images captured by the camera. To increase the processing speed Beagle Bone Black module having latest ARM Cortex-A8 processor is used. The processed images are then displayed on the LCD screen.

A. Beagle Bone Black

The Beagle Bone Black is the latest addition to the BeagleBoard.org family and like its predecessors is designed to address the Open Source Community, early adopters, and anyone interested in a low-cost ARM Cortex-A8 based processor. It has been equipped with a minimum set of features to allow the user to experience the power of the processor and is not intended as a full development platform as many of the features and interfaces supplied by the processor are not accessible from the Beagle Bone Black via onboard support of some interfaces. It is not a complete product designed to do any particular function. It is a foundation for experimentation and learning how to program the processor and to access the peripherals by the creation of your own software and hardware. It also offers access to many of the interfaces and allows for the use of add-on boards called capes, to add many different combinations of features. A user may also develop their own board or add their own circuitry. Beagle Bone Black is manufactured and warranted by Circuitco LLC in Richardson Texas for the benefit of the community and its supporters.

Comparative study of literature survey with our proposed model is as shown in Table 2.

TABLE I

Development Platform	CPU	Connectivity	Memory
Tiny Duino	Atmel Atmega328p	Bluetooth, Wi-Fi	2k RAM
Arduino Uno	Atmel Atmega328p	Bluetooth, Wi-Fi,Gsm	2k RAM
RF Duino	Nordic 32bit ARM CortexM0 Processor	Bluetooth	16k RAM
Xinorf	Atmel Atmega328p	Wireless	2kb RAM
Openkontrol gateway	Atmel Atmega328p	Ethernet,Gsm,RF module,Wi-Fi	32k RAM
Pinocchio	Atmel Atmega256	802.15.4, Wi-Fi	32k RAM
Rasberry Pi	ARM1176jzfs	Ethernet, sd card, Hdmi, Wi-Fi, Gsm	512B RAM
Beagle BoneBlack	AM335x 1GHz ARM Cortex-A8	Ethernet	2GB RAM

B. Infrared Camera

An infrared camera is a non-contact device that detects infrared energy (heat) and converts it into an electronic signal, which is then processed to produce a thermal image on a video monitor and perform temperature calculations. Heat sensed by an infrared camera can be very precisely quantified, or measured, allowing you to not only monitor thermal performance but also identify and evaluate the relative severity of heat-related problems.IR cameras are functioning like normal digital cameras: They have a sighting area, the so-called field of view (FOV). The farther the object is away, the larger the observed area will be. But also the part of the image is increasing which is representing a single pixel. The good thing about it is that the radiation density is independent of the distance considering sufficient large measuring areas. Therefore, to a wide extent temperature measurements are not influenced by the distance to a measuring object. Infrared energy is just one part of the electromagnetic spectrum, which encompasses radiation from gamma rays, x-rays, ultraviolet, a thin region of visible light, infrared, terahertz waves, microwaves, and radio waves. These are all

related and differentiated in the length of their wave (wavelength). All objects emit a certain amount of black body radiation as a function of their temperatures.

Removal of fog provides us a clear image or real view of the picture, which help us to deal with many problems such as accidents. Thus, various fog removal algorithm is developed for this purpose. These algorithms are beneficial for numerous vision applications. It has been seen that many most of the existing algorithms lags in some of the basic problems like reducing the noise issue, smoothening of the images and this problem to some extent gets overcome by using Dark Channel Prior technique[8] of removal of fog from images.

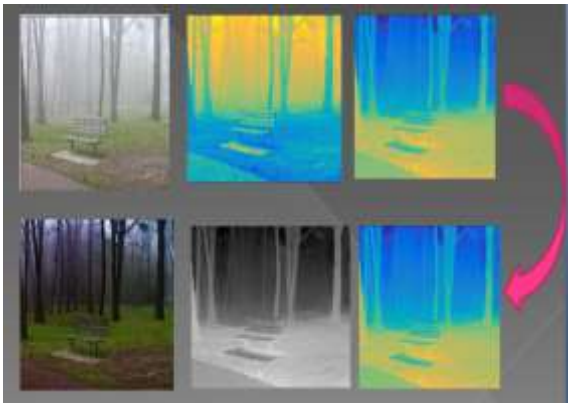

FIG 2. Removal of Fog

FIG.3 Flowchart for Fog removal algorithm

FIG.3 explains the basic algorithm applied for the processing of the image. By applying the Dark Channel algorithm the RGB image is converted to a grey image for processing. This method is used for one color channel (that's why conversion in grey scale is done) that have very low intensity at few pixels. Due to fog (airtight), a foggy image is brighter that the original/real image. That's why the dark channel of the foggy image will have higher intensities in the region with higher fog. Thus it gives us a rough estimation of the thickness of fog. After the dark channel, we need to estimate transmission parameter for proceeding further with a solution. Then Laplacian operator is applied. Laplacian operator helps in the sharpening of images. Its uses highlight grey level discontinuities in an image and try to de-emphasize regions with slowly varying gray levels. This operation in result produces such images which have grayish edge lines and other discontinuities in dark background. This produces inward and outward edges in an image thus by subtracting the resultant image from the original image we get sharpened image. Thus the output hazed image is obtained.

V. DISCUSSION AND CONCLUSIONS

In this paper, we have presented the study of fog/haze removal algorithm for image processing using the Dark Channel prior technique. Fog removal algorithm is beneficial for numerous vision applications and many algorithms is proposed so far for efficient fog removal. But dark channel prior provided quite promising results as it intensified the region with a higher concentration of fog with higher intensities and which gives us a rough estimation of the thickness of fog. After this, we use estimate transmission for processing further with the solution to get haze image. The existing techniques have neglected the use of dark channel prior to reducing the noise and unevenly illuminated problem. While in our algorithm we use this technique to overcome from that problem and obtained noise free image. We have already processed the video using MATLAB. Our future work is to implement this algorithm on Beagle bone and to obtain Haze free real-time video as output. Fig. illustrate the haze removal results. First one is input foggy image and second is processed hazed image.

FIG.4 Resulting Image

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