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Wildlife-Vehicle Collision Avoidance using Spectroscopy

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ABSTRACT

There have been many cases where numerous accident have been reported on vehicles colliding with wildlife and human being, especially while traveling at night or on highways. Despite this, there has been no proper solution to this problem. Developing a long range and efficient sensor which would alert the driver about the obstacle ahead would result in lesser number of such accidents. This paper is a review on the motivations to lower the rate of such accidents. The sensor uses spectrum waves to differentiate between humans, animals and other objects. The system uses real time data and try to mimic human reasoning thus prove promising accident control. We give an in depth study on the design, benefits and limitations of this technique.

Keywords: Smart Cities, Intelligent Accident Control, Spectroscopy, Human/Animal Detection.

I. INTRODUCTION

There are many highways and roads that run across protected wildlife areas. In places like that it is inevitable that the human beings or wild animals will enter the highways. This very often leads to fatal accidents resulting in loss of wildlife and also human

life. As of now there are no proper/autonomous systems to prevent accidents like these, especially at night time its gets tough to identify such obstacles. This project aims at developing a multifaceted system to prevent accidents like these. In this project humans and animals are detected near the human-animal environment overlap to avoid fatal accidents.

Man-animal conflict is seen across the world in a variety of forms, including monkey menace in the urban areas, depredation by elephants, animals walking on the roads, and cattle and human killing by tigers and leopards.

In places like national highways and roads it is inevitable that the wild animals will enter the highways and the railways.

II. EXISTING SOLUTIONS

Boundary walls and solar fences around the sensitive areas are built to prevent the wild animal attacks. Overhead or underground structures are built to divert the wild animals into a different path not interfering with vehicle traffic. But this system takes longer duration, labor and moreover not economical and they cannot totally prevent animals from entering the roads. There are no systems to avoid birds from sitting on the roads either.

Some devices of information technology, viz., radio collars with very high frequency, global positioning system and satellite uplink facilities, are being used by the research institutions to monitor the movement of lions, tigers, elephants, crocodiles and other wild animals to understand their movements and their use pattern of the habitat. But installation of the system becomes difficult and is not always possible.

III. PROPOSED SOLUTION 3.1 STRATEGY

The system is designed to prevent wildlife/human – vehicle collision within the highways as well as in city conditions. The sensor uses the principle of absorbance spectroscopy to detect and classify the obstacles. The sensor detects and classifies the type of obstacle ahead and sends a warning to the driver about the same and turns off the warning when the obstacle has been cleared.

3.2 Principle

Spectroscopy is the study of interaction between matter and electromagnetic radiation. Spectroscopy is the scientific measurement technique. It measures light that is emitted, absorbed or scattered by materials and can be used to study, identify and quantify those materials. Absorbance spectroscopy, commonly referred to as spectrophotometry, is the analytic technique based on measuring the amount of light absorbed by a sample at a given wavelength. The graph shows the absorption and reflectance pattern for each color. If orange light is emitted, blue is reflected. If red light is emitted, green light is reflected and so on.

3.3 Working

The absorption and reflectance is measured using a micro spectroscope. In order to achieve data with minimum error, we assume that the angle of incidence between the light source and the sample is 0°.

The light reflected from a skin sample is scattered in all possible directions of the viewing hemisphere. We are interested in measuring only that amount of the scattered light that is reaching a single viewpoint. The spectroscope is designed to measure the

Bidirectional Reflectance Distribution Function (BRDF) of various materials. The spectrograph uses a diffraction grating to disperse the light into its component wavelengths.

Photodiode arrays have almost an order of magnitude better signal to noise ratio than the corresponding CCD sensors.

The color of the reflected light depends on the color of incident light. Thus, the true descriptor of the spectral behavior of a material is the ratio of the light reflected from that material over the light that is incident on that material. For non-Lambertian surfaces this ratio changes as the angle of incidence and angle of reflectance change. The ultimate goal is to produce a complete BRDF for in-vivo human skin. Our current measurements are for a 0" angle of incidence and approximately 4" angle of reflectance. Thus, what we are measuring is:

$$BRDF(4,0;0,0;\lambda) = \frac{Reflected(4,0;0,0;\lambda)}{Incident(0,0;\lambda)} \qquad (1)$$

where BRDF() is the Bidirectional Reflectance Distribution Function, which is a five parameter function.

The following figures show the BRDF ratio plotted against the wavelength of the visible part of the electromagnetic spectrum.

Fig. 1Absorbance Spectrum Chart

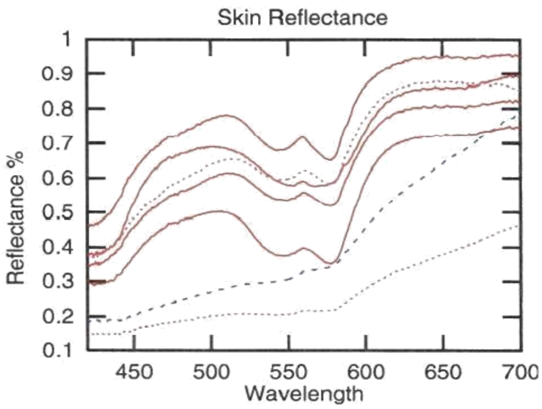

Fig2. Spectra of the back of the hand

Although the data collected, shows a diverse set of skin spectra, there is clearly a particular pattern that can be observed. A gradual increase with respect to wavelength can be immediately noticed, with a dip around 575nm.

The skin spectra of various races are interspersed and no clear classification can be done. There is one exception. One can observe that darker shaded skin, independent of race, reflects a smaller proportion of the incident light (which is how a darker surface can be described) and does not exhibit the curvature variation of the other plots. Hence, by dividing each reflectance distribution by the maximum value of that distribution we are ignoring the effect of the darkness of skin and are concentrating on the shape of the spectrum.

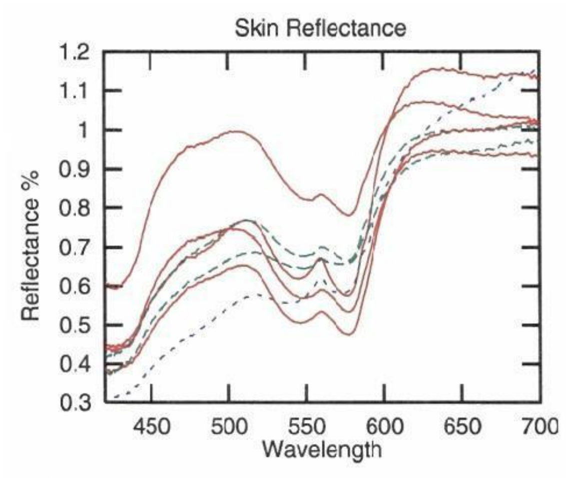

Fig. 3 Scaled spectra of the back of the hand

In order to test whether the variations of the shape of the skin spectra could be attributed to the local skin structure and to melanin, spectra of the palm is also considered. From the observed results, it is found that even palms exhibit similar properties to that of the back of the hand. Except, they exhibit a much reddish spectrum compared to the back of the hand, as expected. But in the spectrum of palm, it can be noted that all types of skin are almost identical shape and various spectra are closely clustered.

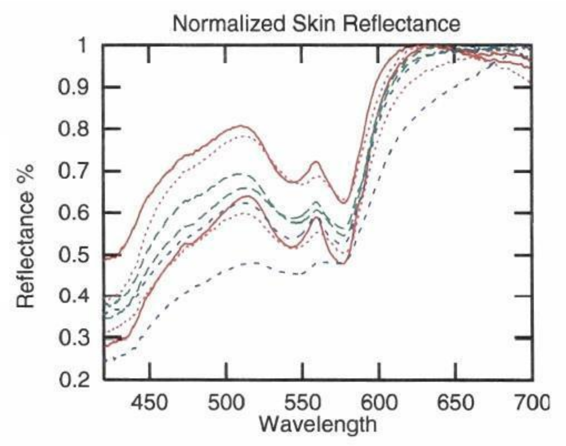

Fig. 4 Scaled spectra of the palm

It is to be noted that melanin plays a major role in reflectance and absorption. In the absence of melanin, the spectra are much closer to each other. It should also be noted that the amount of hair, pores, follicles, wrinkles, etc… also has a minor impact on the spectrum of the skin. The measured spectra demonstrate that there is a very specific pattern in the spectral distribution of the color of skin. Now, we should check whether this pattern is sufficiently unique to provide for the identification of human skin, especially when compared to a mannequin which comes the same key features with humans (lips, nose, eyes, arms, legs etc.)

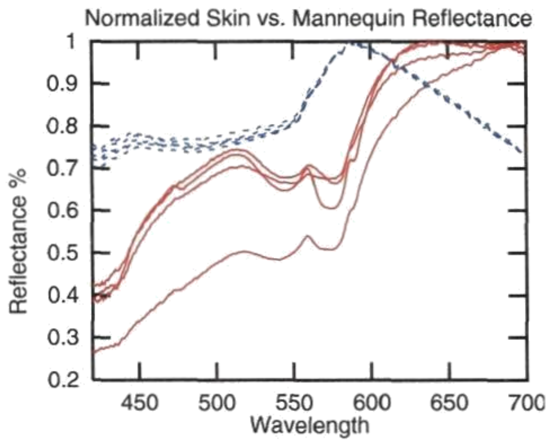

Fig. 5 Spectra of human hand versus mannequin

The graph showed the reflectance spectra of the mannequin versus that of the back of the hand, since that is more representative of the skin variations which are typically observed in humans. Notice the different shape of the spectral distributions between the two groups.

In the rescaled plots the existence of two separate spectra becomes evident.

3.4 Detection

Eye inspection of the reflectance data shows that there is a persistent pattern that seems to be unique to the human skin. All the measured reflectances, with the exception of the more tanned people, exhibit a localized " W pattern (two dips with a bump in the middle) in the middle of the visible spectrum.

The following algorithm can be used to automatically detect the pattern: "W" pattern detection algorithm:

1. Find all the local minima and maxima of the curve (places where the derivative is zero).
2. Find the two smallest local minima after 430nm.
They should be the two dips of the 'W" pattern.
3. Let h = wavelength of the leftmost dip.
4. Let % = wavelength of the rightmost dip.
6. If h3-h1<50nm,
Find the local max between hl and h3.
This should be the middle bump.
Let h2=wavelength of the middle bump.
Else,
No "W" pattern is present, because the two smallest local minima are not close to each other. While the "W" pattern identifies thehuman and animal skin effectively, we must also consider other factors such as: epidermis, dermis and hypodermis as they also play an important role in

absorbance and reflectance of the spectrum rays. In most individuals, the absorption of the epidermis is usually dominated by the absorption caused by melanin. The reflectivity (BRDF) of the skin at various wavelengths is mainly determined by the chromophores present in the various layers of the skin.

All the analysis thus far indicates that the existence of the "W" pattern implies the presence of live human skin.

IV. PRACTICAL MODEL

Block diagram for the proposed system:

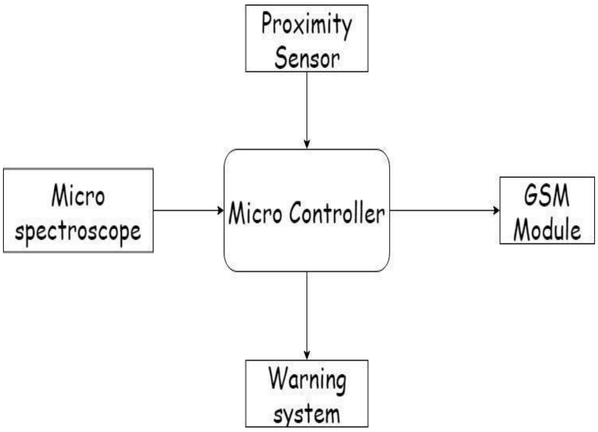

Fig. 6 Block diagram

The sensor can be retrofitted in any type of vehicle regardless of the make and size.

The data from the spectrograph is sent to the micro controller where we plot the graph and analyze the data. If there is a human or animal ahead, the warning system displays a message to the user of the obstacle ahead. Else no action will be taken.

In order to notify the respective authority in case of an accident, we embed a proximity sensor in the system. If there is an obstacle detected and if any collision takes place, the micro-controller sends a report to the nearest authority regarding the accident so that necessary actions can be taken immediately.

The system is flexible and can be embedded into any kind of vehicle easily. Since IR spectrum is being used, detection is possible even in dark.

V. CONCLUSION

We designed a spectroscopic sensor which identifies and classifies human beings/ animals and other miscellaneous obstacles. The sensor works on the principle of absorbance spectroscopy. From multiple samples, the behavior of skin on exposure to spectrum waves is observed. A spectrograph is used to record output data. After plotting the output in a graph we look for a "W" pattern in the recorded output to give a positive result. The calculation process is based on reflectance parameters (BRDF). On obtaining positive results, the microcontroller alerts the driver of the obstacle ahead and incase of any collision the system notifies the nearest authority for suitable action without delay. The mortality rate and accident rates of wildlife-vehicle collision can be significantly reduced using this method.

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