

## SYSTEM AND METHOD OF DETERMINING SURFACE CHARACTERISTICS USING INFRARED IMAGING

### TECHNICAL FIELD OF THE INVENTION

This invention relates to imaging systems and more particularly to a system and method for identifying certain characteristics of a surface from its infrared image.

### BACKGROUND OF THE INVENTION

It is now a common practice to identify surfaces, such as buildings, beaches, streets, etc., using various imaging techniques. These techniques, in essence, rely upon a prestored image or a data model, against which newly arriving image data is compared.

Techniques that use prestored images rely upon two basic givens, namely 1) that there is in fact the ability to create the pre-stored image in the first instance and 2) that a received image can be properly matched to the stored image.

In situations when a data model of objects is created, the following assumptions are made: 1) that an accurate model can be created and 2) that there are enough clues, or indices, in the stored data model and in the unknown image data to make a highly probable guess as to the identity of objects or surfaces in the image. Since dire results might occur if mistakes are made, particularly where such image comparisons are used for ordinance guidance, it is critically important that both of the above assumptions be true and that the pre-stored data be as accurate as possible.

In some situations, it is difficult at best to even generate the pre-stored image to the degree necessary for accurate error free subsequent image identification. One of these situations occurs when the image is subject to change over the course of time. A day and night infrared image of the same surface area would appear different because of the inherent difference in radiation conditions. Thus, when a factory is being imaged, that factory would have a different appearance in the infrared image depending upon the time of day and upon the ambient environmental conditions at the factory site. There are many other examples of images which have different characteristics at different points of time and it is not possible or feasible to obtain actual images of the same topography under all possible situations.

Thus, a need exists in the art for a system and method of generating pre-stored images representative of surfaces as they would appear under conditions other than when the image was actually generated.

A further need exists in the art for a system and method which can extract various indices from an image pertaining to the character of the surface, thereby increasing the probability of an accurate object identification from the image.

### SUMMARY OF THE INVENTION

I have taken advantage of the fact that the absorptivity and conductivity values of a surface are unique to that surface and can be used to provide indices for subsequent identification of the surface. I have also used these factors to devise a system and method of computing synthetic images from a given image where the synthetic image represents the same image at a later period of time as the environmental conditions change.

It is thus a technical advantage of my invention to provide a method and system for taking advantage of the heat balance equation of a surface by solving that heat balance equation to derive certain indices of the objects or surface in the image. Using these indices, then, a system of surface identification can be constructed.

It is a further technical advantage of my invention that the absorptivity and conductivity indices of a surface derived from an actual image can be used to generate a synthetic image of the surface at a different point in time.

It is a still further technical advantage to provide a method of generating indices of a surface for storage in a data base by generating from a single image of a surface a heat balance equation of the surface and by solving the equation to obtain the heat absorptivity and conductivity of said surface to establish said indices.

It is a still further technical advantage to provide a system for identifying physical objects from infrared images of the objects by the system having circuitry for deriving a heat balance equation of the objects; and having circuitry for generating indices of the objects pertaining to the infrared absorptivity and conductivity of the objects from said derived heat balance equation; and having circuitry for comparing the generated indices with prestored indices.

A system for identifying physical objects from infrared images of the objects of the present invention comprises circuitry for deriving a heat balance equation of the objects, circuitry for generating indices of the objects pertaining to the infrared absorptivity and conductivity of the objects from the derived heat balance equation, and circuitry for comparing the generated indices with prestored indices. Alternatively, a method of identifying physical objects from infrared images of the objects of the present invention comprises the steps of deriving a heat balance equation of the objects, generating indices of the objects pertaining to the infrared absorptivity and conductivity of the objects from the derived heat balance equation, and comparing the generated indices with prestored indices.

### BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing problems, solutions and technical advantages are shown in more detail with reference to the drawings in which:

FIG. 1 shows the heat balance conditions at a surface;

FIGS. 2 and 3 show synthetic inputs to illustrate the principles of the invention;

FIG. 4 shows the absorptivity values computed by the inventive method and system;

FIG. 5 shows the conductivity values computed by the inventive method and system;

FIG. 6 shows one illustrative example of a system using the inventive concepts.

### DETAILED DESCRIPTION OF THE INVENTION

First, we must derive a relationship between the various thermal radiation components and temperature distributions present at any surface in an outdoor scene. Consider the surface patch 10 shown in FIG. 1.  $I_{inc}$  is the incident solar radiation. At the surface, this radiation is subject to three effects: absorption, reflection, and transmission. Most objects occurring in outdoor scenes are opaque to infrared (IR) radiation and so the transmission effect is negligible. The body also emits