ABSTRACT

A method for recording a photographic density in the form of equi-density curves on a plane is described, in which alternate equi-density curves are depicted with different kinds of lines, and in which an equi-density curve corresponding to one particular density value serving as a reference is depicted with a line distinguishable from the other curves.
METHOD FOR RECORDING A PHOTOGRAPHIC DENSITY

The present invention relates to improvements in the method for recording a photographic density, in which the photographic density of an image is recorded by depicting equi-density curves.

The method for recording a photographic density by means of equi-density curves is very useful as in the analysis of X-ray photographs, and the apparatus for that purpose has been disclosed, for instance, in the technical journal "TOSHIHARA REVIEW" Vol. 24, No. 2 (1969) pp. 156-163 "Film Isodose Plotter" published by Tokyo Shibaura Electric Co., Ltd. in Japan, and in U.S. Pat. No. 3,424,534.

The method for recording a photographic density by means of equi-density curves is advantageous in that the density distribution of an image can be determined at a glance. However, according to such kind of methods in the prior art, there was a disadvantage that upon determination of the density distribution from the equi-density curves error could readily occur and also quantitative determination of the density was impossible. More particularly, in the aforementioned type of photographic density plotters in the prior art, since it is difficult to inscribe figures representing the value of density corresponding to each curve in view of the nature of the plotter in contrast to the case where contour lines are plotted on a map, by hand, two adjacent equi-density curves cannot indicate which one represents the higher density and which one represents the lower density. Therefore, from a group of equi-density curves arranged concentrically, one cannot determine whether the portion of pattern represents a hill of density or a vale of density.

In the above-cited known references, provision is made such that a plurality of pens are used in a plotter which can plot in different colors respectively, or that the equi-density curves are represented with lines of different depths in color within each unit group of curves whereby errors in determination of the density distribution may be obviated.

However, even with such types of improvements, the disadvantage that the quantitative determination of the density cannot be achieved, has been not yet eliminated.

Therefore, an object of the present invention is to overcome the aforementioned disadvantages in the prior art.

One feature of the present invention is to provide a method for recording a photographic density in which equi-density curves are depicted by plotting the points having equal densities while two-dimensionally scanning a photographic image, characterized in that alternate equi-density curves are depicted with different kinds of lines, and that one equi-density curve corresponding to one particular density value serving as a reference is depicted with a line distinguishable from the other curves.

Another feature of the present invention is to provide the above-featured method, further characterized in that said alternate equi-density curves are depicted with lines of different depths in color.

Still another feature of the present invention is to provide the above-featured method, further characterized in that said one equi-density curve is depicted with a line consisting of a series of pairs of dots for the respective plotting points, while said the other curves are depicted with a line consisting of a series of individual dots for the respective plotting points.

Yet another feature of the present invention is to provide an apparatus for recording a photographic density according to the above-featured method, comprising means for detecting a photographic density at each minute area on a photographic film, a recording sheet, means for recording a dot at each minute area on said recording sheet, synchronous scanning means for making said detecting means scan over said photographic film two-dimensionally and for making said recording means scan over said recording sheet two-dimensionally so that the corresponding points on said photographic film and said recording sheet, respectively, may be scanned simultaneously with said detecting means and said recording means, respectively, a plurality of discriminator means each having its input connected to the output of said detecting means for responding to a predetermined level of output signal from said detecting means to produce a discriminator output signal, a first amplifier having a higher amplification factor connected to alternate ones of said discriminator means and responsive to alternate ones of said predetermined levels of output signal from said detecting means for producing an impulse having a higher amplitude, a second amplifier having a lower amplification factor connected to the remaining alternate ones of said discriminator means and responsive to the remaining alternate ones of said predetermined levels of output signal from said detecting means for producing an impulse having a lower amplitude, a third amplifier connected to particular one of said discriminator means in place of said first or second amplifier and responsive to particular one of said predetermined levels of output signal serving as a reference level for producing a pair of impulses, and means connected to all of the outputs of said first, second and third amplifiers and responsive to the impulse applied thereto for supplying an appropriate intensity of actuating signal to said recording means.

These and other objects, features and advantages of the present invention will become apparent upon a perusal of the following specification taken in connection with the accompanying drawings, wherein:

FIG. 1 is a diagram representing a photographic density distribution along a straight line on a photographic film by means of an X-Y coordinate system.

FIG. 2 is a diagram of the photographic density distribution in FIG. 1 represented by means of equi-density curves according to the method in the prior art, wherein the pattern corresponding to said straight line in FIG. 1.

FIG. 3 is a diagram representing another photographic density distribution along a straight line on a photographic film by means of an X-Y coordinate system.

FIG. 4 is a diagram of the photographic density distribution in FIG. 3 represented by means of equi-density curves according to the method of the present invention, wherein the pattern corresponding to said straight line in FIG. 3.

FIG. 5 is a diagram representing still another photographic density distribution along a straight line on a photographic film by means of an X-Y coordinate system.

FIG. 6 is a diagram of the photographic density distribution in FIG. 5 represented by means of equi-density curves according to the method of the present invention, wherein the pattern corresponding to said straight line in FIG. 5.

FIG. 7 is a schematic view partially in a block form of a photographic density recording apparatus employing the method of the present invention, and

FIG. 8 is a block diagram showing the details of a voltage discriminator in the photographic density recording apparatus in FIG. 7 together with a discharge recorder in the same apparatus.

Referring now to FIGS. 1 and 2 of the drawings, a photographic density distribution and the corresponding equi-density curves depicted accordingly to the prior art method are shown in order to illustrate the disadvantage of the prior art method.

The photographic density distribution along a certain straight line as illustrated in FIG. 1, may be represented, for example, by the equi-density curves in FIG. 2, assuming that the density distribution in FIG. 1 is taken along a straight line I—I passing through the center points A and B, respectively, of the two groups of concentric curves in FIG. 2. The same assumption is also true of a photographic film in FIG. 1, wherein the center points A and B may correspond to the equi-density curves as illustrated in FIG. 2. In addition, since the equi-density curves are depicted by plotting equi-
density points while scanning over a photographic film two-
dimensionally, and since in such a process it is substantially
impossible to inscribe a scale of density onto the diagram in
view of the functional restriction the plotter, it is not known a
curve representing what density value is a certain curve, and
therefore, quantitative determination of a density cannot be
obtained from the equi-density curves. This is a disadvantage
caused by the quite different condition for depicting the
curves from that for depicting contours of a map where the
scale indicating a height may be easily printed together.

Now, at first, a photographic density recording apparatus
employing the method of the present invention as illustrated in
FIGS. 7 and 8 will be explained, and the correspondence
between the density distribution and the equi-density curves
obtained according to the present invention as illustrated in
FIGS. 3 and 4 as well as in FIGS. 5 and 6 will be explained
later.

FIG. 7 generally shows a photographic density recording ap-
paratus embodying the present invention, in which the appar-
atus for measuring the photographic density and recording
the same consists of a light projector 1, a photometer 2, a volt-
age discriminator 3, a discharge recorder 4, and a discharge
recording sheet 5.

A photographic film 6 whose photographic density is to be
measured, is placed between the light projector 1 and the
photometer 2, and the photographic film 6 and recording
sheet 5 are moved while maintaining a predetermined mutual
positional relation.

The photographic film 6 is scanned two-dimensionally by
the light projector 1 and the photometer 2 in combination to
generate a voltage corresponding to the photographic density
of the photographic film 6 from the photometer 2. This volt-
age is discriminated by the voltage discriminator 3 so that a
signal may be generated from the voltage discriminator 3 and
to the discharge recorder 4 when the voltage coincides with
voltages preset in the voltage discriminator 3. This output
signal is converted by the discharge recorder 4 into a voltage
adapted for discharge recording to record the signal on the
recording sheet 5.

Now the construction of the discriminator 3 will be
described in more detail with reference to FIG. 8.

In FIG. 8, reference numerals 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7,
and 7 represent voltage discriminator circuitries, respectively, reference
numerals 8, 9 and 10 represent preamplifier circuitrys, respective-
tively, reference numeral 11 represents an amplifier, and reference
numeral 12 represents a discharge recording stylus.

The preamplifier circuit 8 is a circuit for amplifying the signal from
the discriminator circuitry 7, or 7, but has a higher ampli-
ification factor, and accordingly, the discharge record made
by the signal from the discriminator circuitry 7, or 7, is so in-
tense that the depth in color of the dots plotted on the recording
sheet 5 through this channel is large. Whereas, the pream-
plifier circuit 9 is a circuit for amplifying the signal from the
discriminator circuitry 7, or 7, but has a lower amplification
factor, and accordingly, the depth in color of the dots on the
recording sheet 5 plotted in accordance with the output of the
discriminator circuitry 7 or 7 is small. On the other hand, the
preamplifier 10 is an amplifier circuit for processing and am-
plifying the output signal from the discriminator circuitry 7,
so as to produce two amplified pulses. Therefore, upon discharge
recording due to the pulse from the preamplifier 10, in
response to the output signal from the discriminator circuit 7,
two dots are recorded on the recording sheet 6. The dis-
riminator circuitries 7, 7, 7, 7, 7, 7, and 7 are preset so that
they may respectively to the photographic densities 1, 2, 3, 4,
and 5, respectively, in FIGS. 3 and 5. In
other words, the method for recording by means of the dis-
riminator illustrated in FIG. 8, is the method in which the
equi-density curves are depicted so as to have different depths
in color alternately and also in which one of the group of equi-
density curves is made distinguishable from the other curves.