DRAWINGS

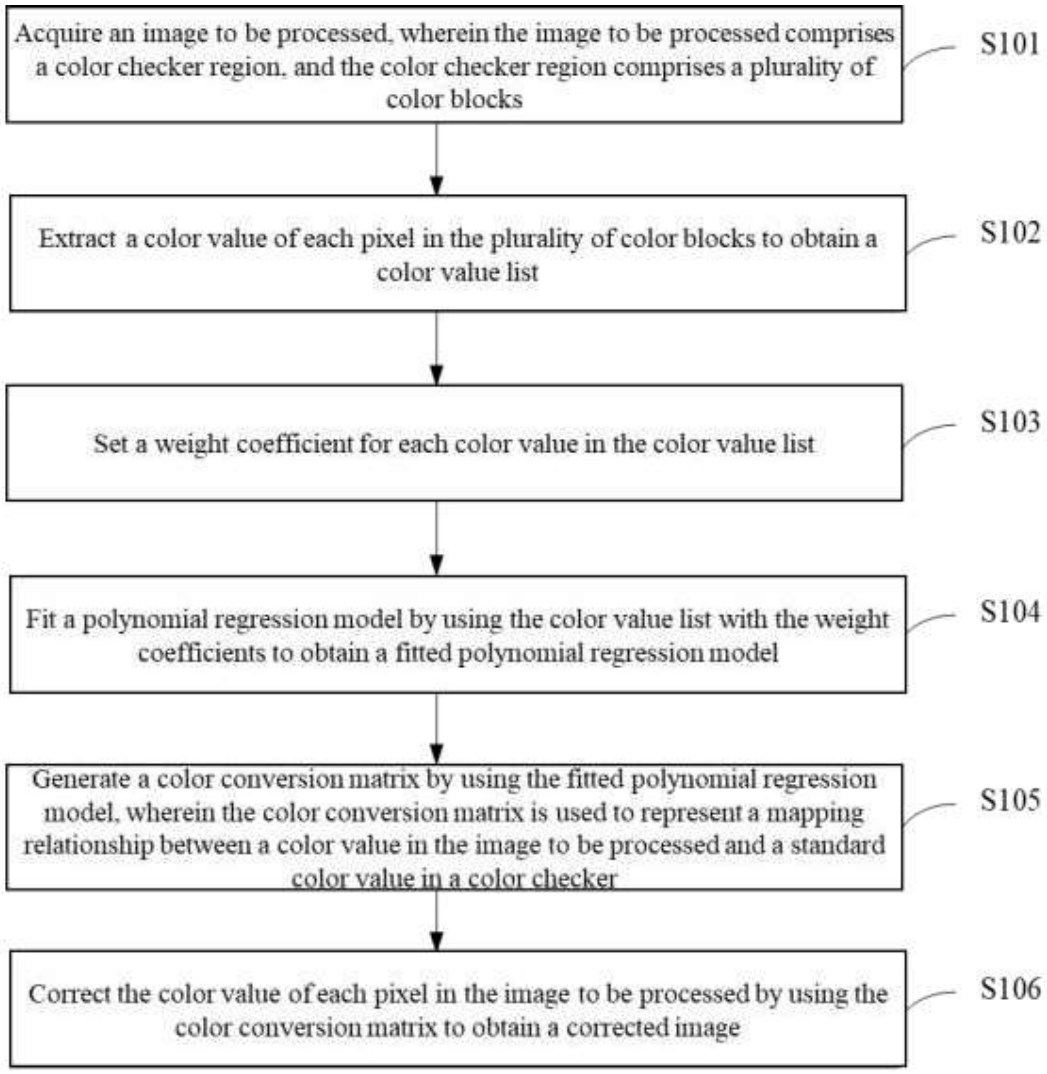

FIG. 1

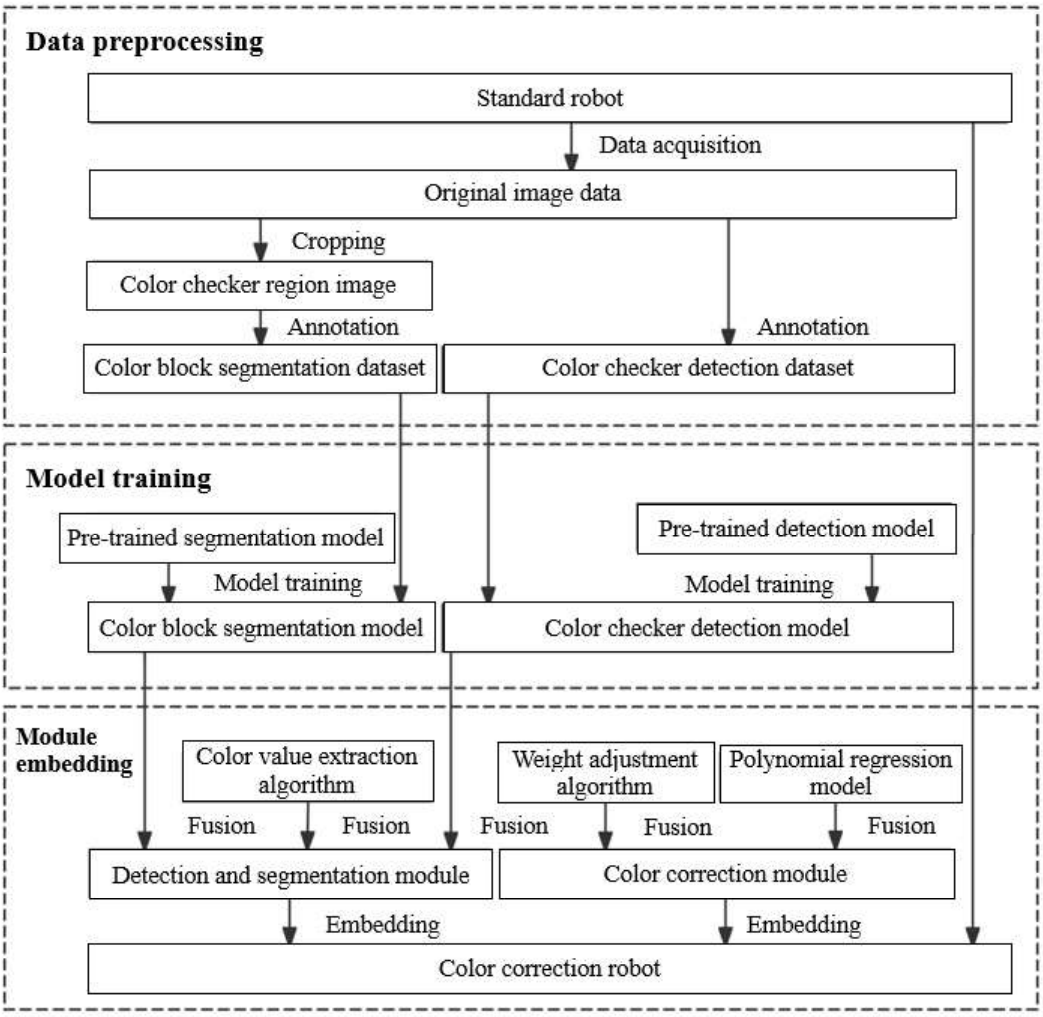
Data preprocessing
Standard robot
Data acquisition
Original image data
Cropping
Color checker region image
Annotation
Annotation
Color block segmentation dataset
Color checker detection dataset
Model training
Pre-trained segmentation model
Pre-trained detection model
Model training
Model training
Color block segmentation model
Color checker detection model
Module embedding
Color value extraction algorithm
Weight adjustment algorithm
Polynomial regression model
Fusion
Fusion
Fusion
Fusion
Fusion
Detection and segmentation module
Color correction module
Embedding
Embedding
Color correction robot

FIG. 2

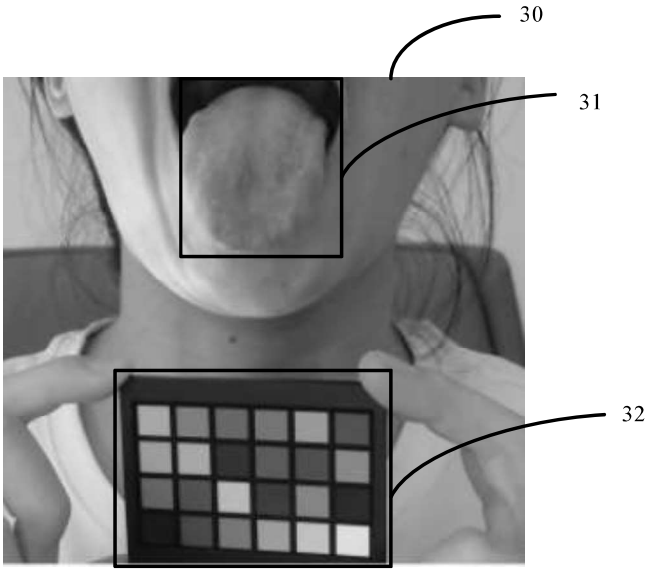
30
31
32

FIG. 3

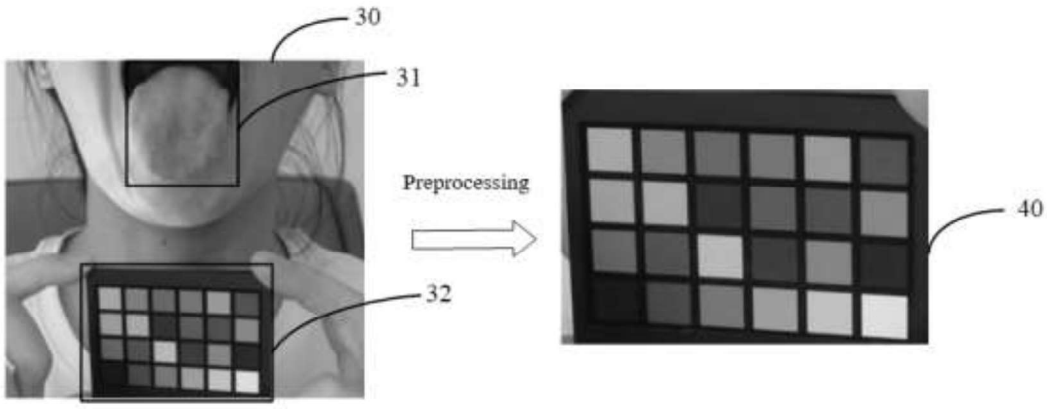

FIG. 4

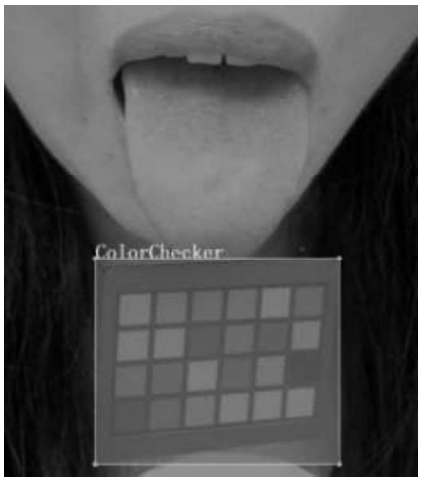

FIG. 5

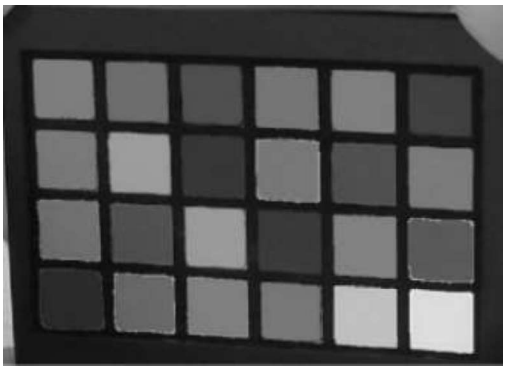

FIG. 6

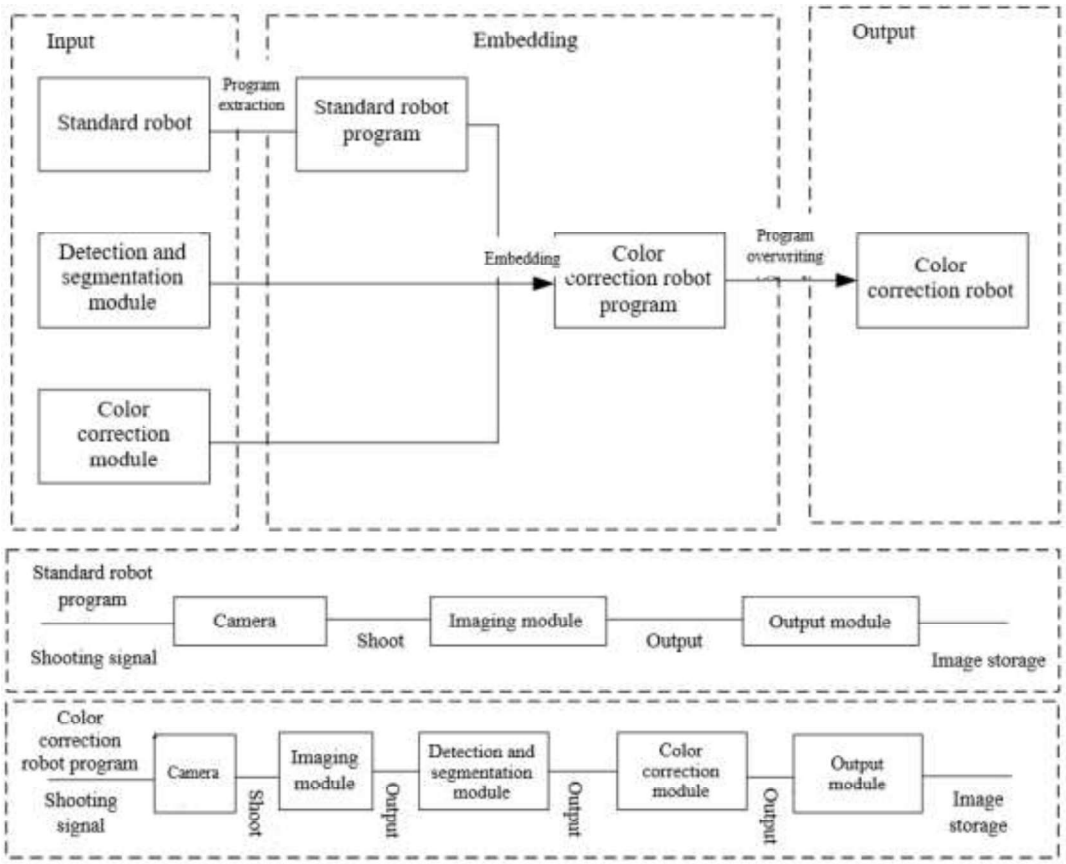
Input
Embedding
Output
Standard robot
Program extraction
Standard robot program
Detection and segmentation module
Color correction module
Embedding
Color correction robot program
Program overwriting
Color correction robot
Standard robot program
Shooting signal
Camera
Shoot
Imaging module
Output
Output module
Image storage
Color correction robot program
Shooting signal
Camera
Shoot
Imaging module
Output
Detection and segmentation module
Output
Color correction module
Output
Output module
Image storage

FIG. 7

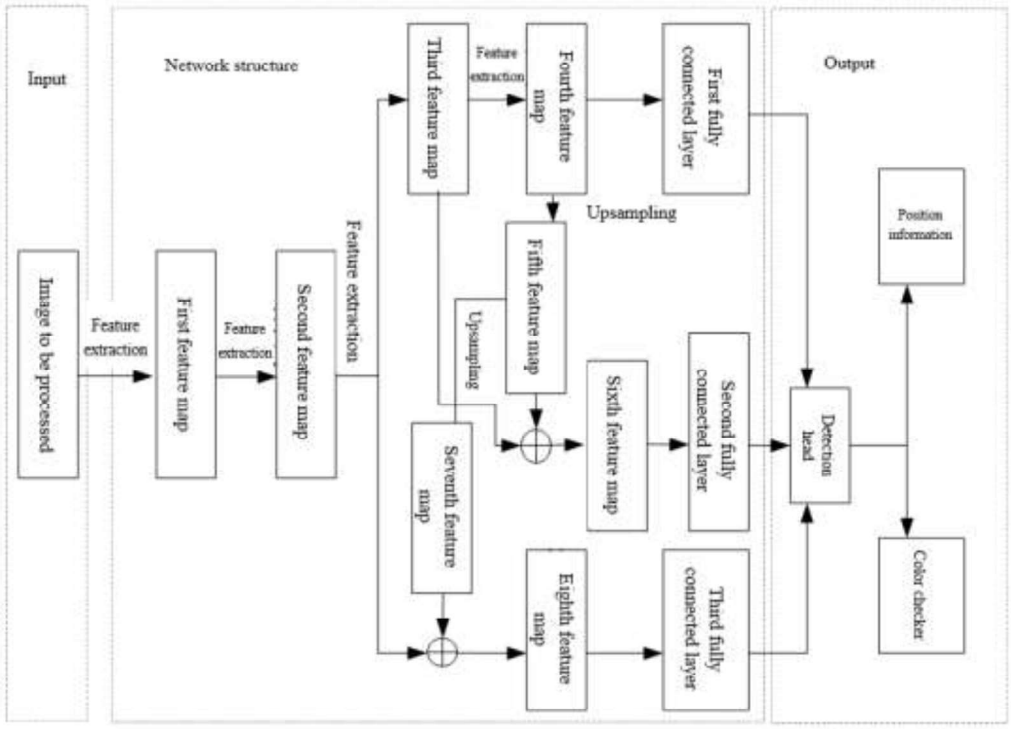
Input
Network structure
Output
Image to be processed
Feature extraction
First feature map
Feature extraction
Second feature map
Feature extraction
Third feature map
Feature extraction
Fourth feature map
First fully connected layer
Upsampling
Fifth feature map
Upsampling
Sixth feature map
Second fully connected layer
Seventh feature map
Eighth feature map
Third fully connected layer
Detection head
Position information
Color checker

FIG. 8

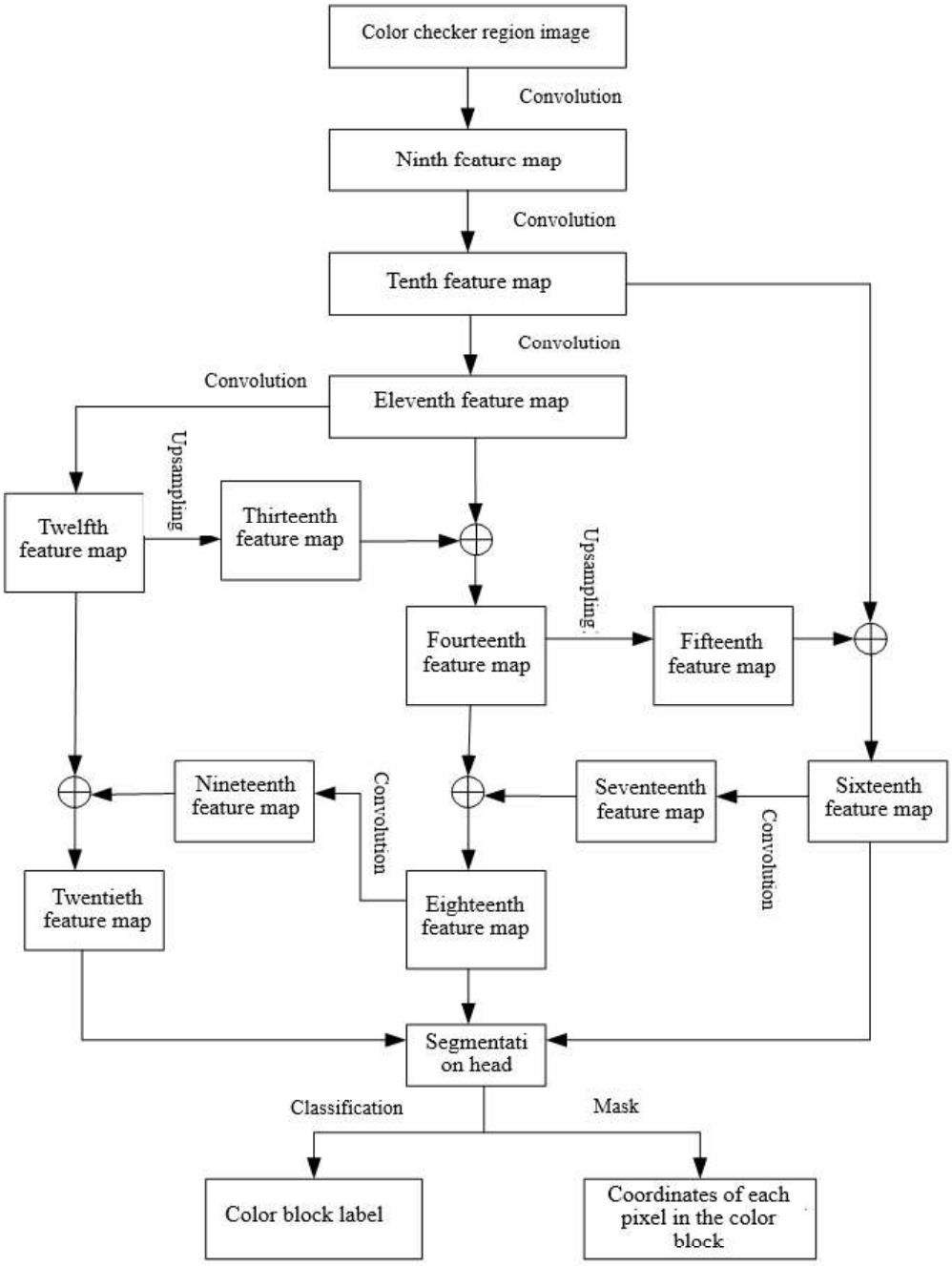
Color checker region image
Convolution
Ninth feature map
Convolution
Tenth feature map
Convolution
Convolution
Eleventh feature map
Upsampling
Twelfth feature map
Thirteenth feature map
Upsampling
Fourteenth feature map
Fifteenth feature map
Nineteenth feature map
Convolution
Seventeenth feature map
Sixteenth feature map
Convolution
Twentieth feature map
Eighteenth feature map
Segmentation head
Classification
Mask
Color block label
Coordinates of each pixel in the color block

FIG. 9

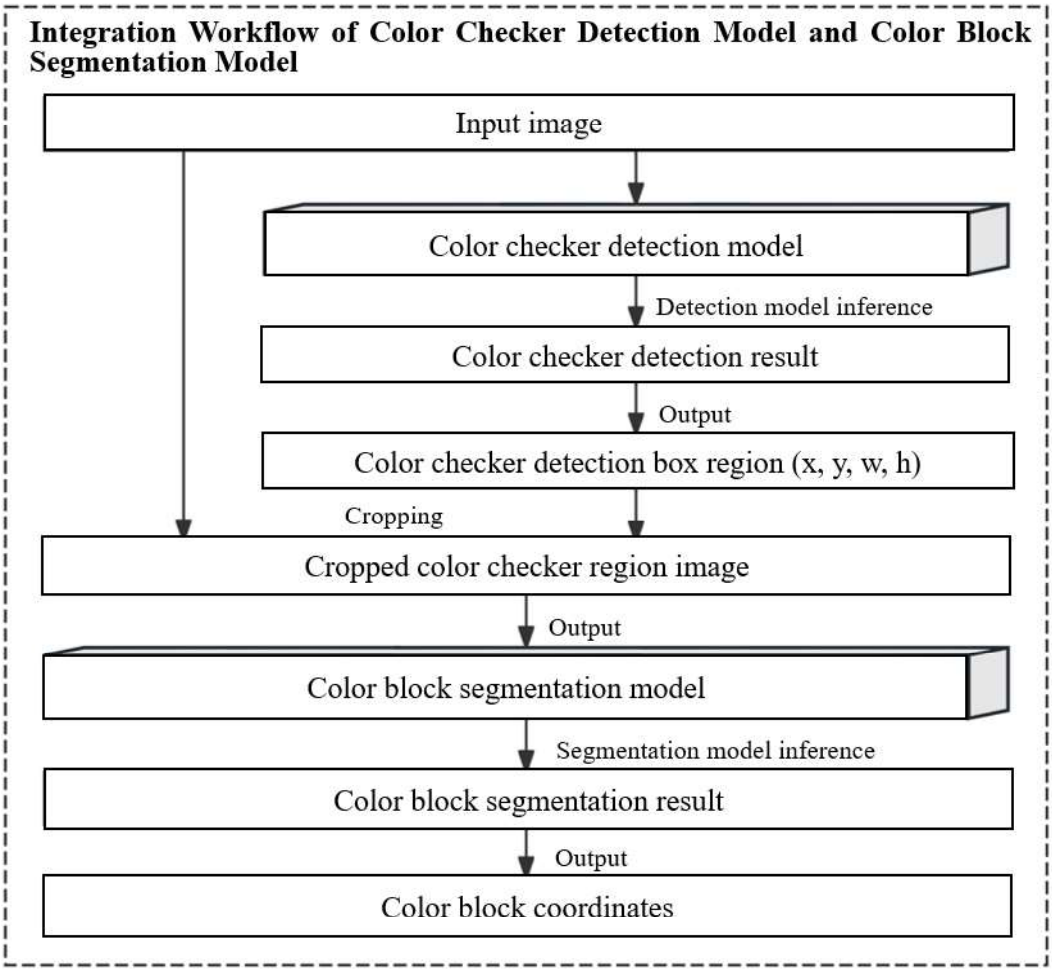
Integration Workflow of Color Checker Detection Model and Color Block Segmentation Model
Input image
Color checker detection model
Detection model inference
Color checker detection result
Output
Color checker detection box region (x, y, w, h)
Cropping
Cropped color checker region image
Output
Color block segmentation model
Segmentation model inference
Color block segmentation result
Output
Color block coordinates

FIG. 10

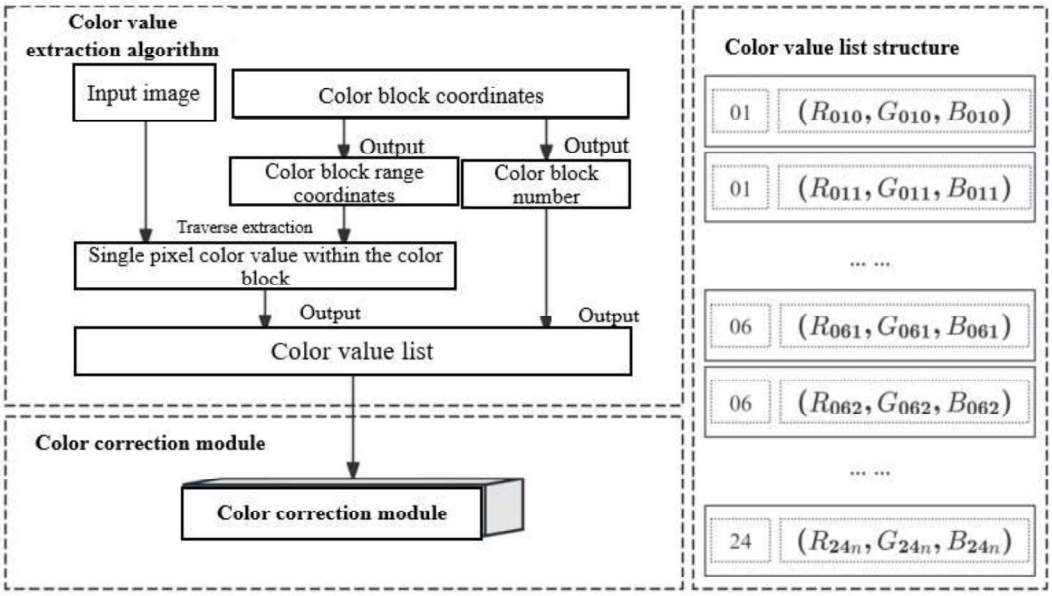
Color value extraction algorithm
Input image
Color block coordinates
Output
Output
Color block range coordinates
Color block number
Traverse extraction
Single pixel color value within the color block
Output
Output
Color value list
Color correction module
Color correction module
Color value list structure
01 $(R_{010}, G_{010}, B_{010})$
01 $(R_{011}, G_{011}, B_{011})$
... ...
06 $(R_{061}, G_{061}, B_{061})$
06 $(R_{062}, G_{062}, B_{062})$
... ...
24 $(R_{24n}, G_{24n}, B_{24n})$

FIG. 11

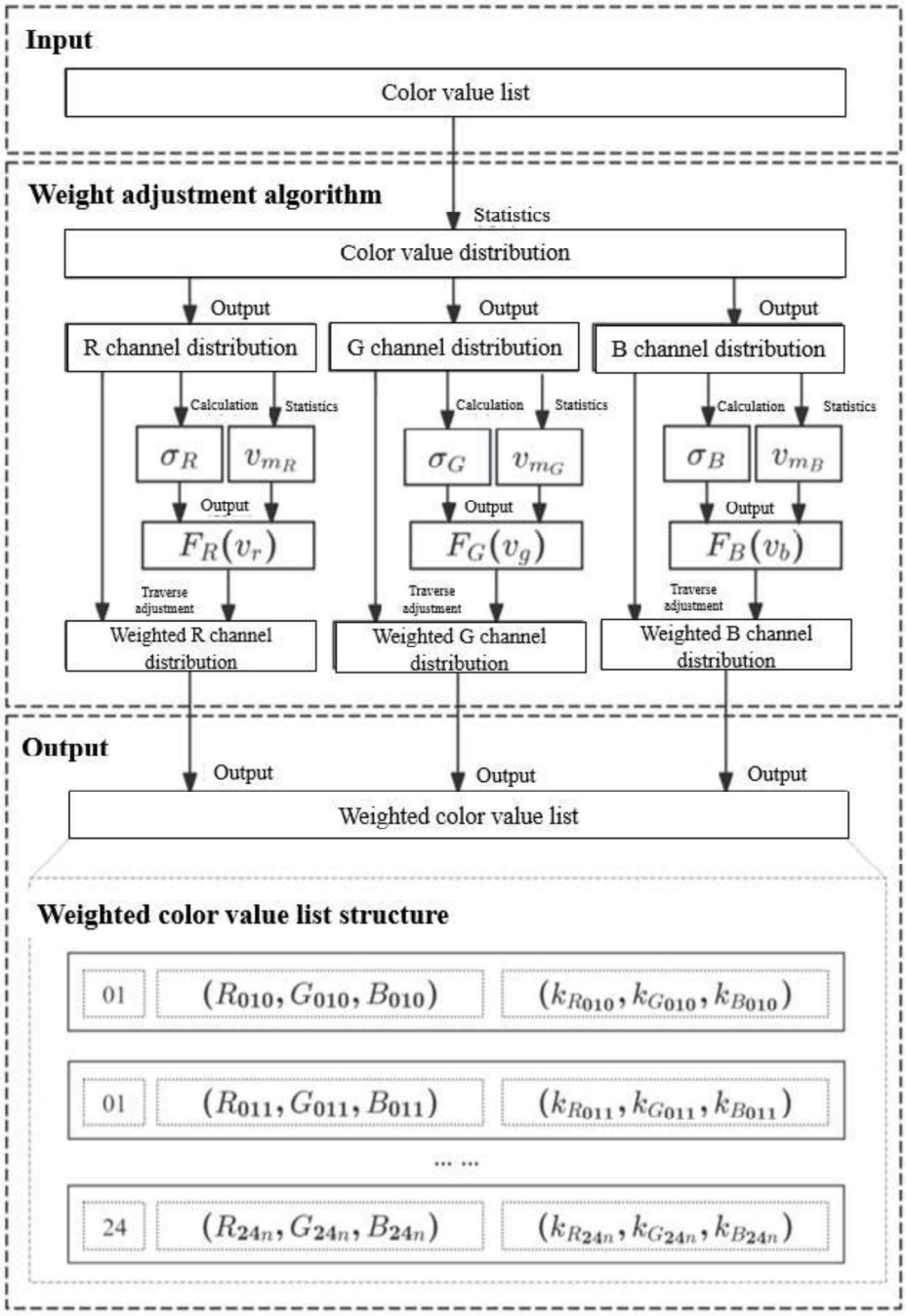
Input
Color value list
Weight adjustment algorithm
Statistics
Color value distribution
Output
Output
Output
R channel distribution
G channel distribution
B channel distribution
Calculation
Statistics
Calculation
Statistics
Calculation
Statistics
σ_R
v_{mR}
σ_G
v_{mG}
σ_B
v_{mB}
Output
Output
Output
$F_R(v_r)$
$F_G(v_g)$
$F_B(v_b)$
Traverse adjustment
Traverse adjustment
Traverse adjustment
Weighted R channel distribution
Weighted G channel distribution
Weighted B channel distribution
Output
Output
Output
Output
Weighted color value list
Weighted color value list structure
01
$(R_{010}, G_{010}, B_{010})$
$(k_{R010}, k_{G010}, k_{B010})$
01
$(R_{011}, G_{011}, B_{011})$
$(k_{R011}, k_{G011}, k_{B011})$
... ...
24
$(R_{24n}, G_{24n}, B_{24n})$
$(k_{R24n}, k_{G24n}, k_{B24n})$

FIG. 12

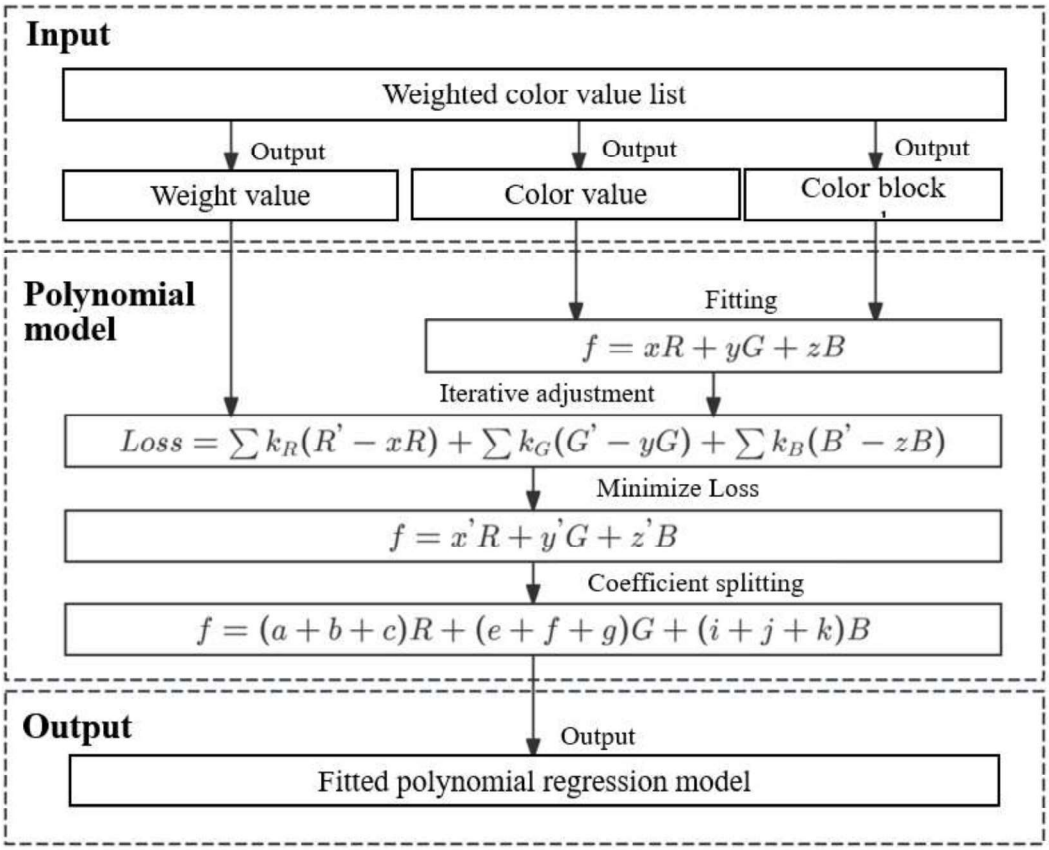
Input
Weighted color value list
Output
Output
Output
Weight value
Color value
Color block
Polynomial model
Fitting
$f = xR + yG + zB$
Iterative adjustment
$Loss = \sum k_R(R' - xR) + \sum k_G(G' - yG) + \sum k_B(B' - zB)$
Minimize Loss
$f = x'R + y'G + z'B$
Coefficient splitting
$f = (a+b+c)R + (e+f+g)G + (i+j+k)B$
Output
Output
Fitted polynomial regression model

FIG. 13

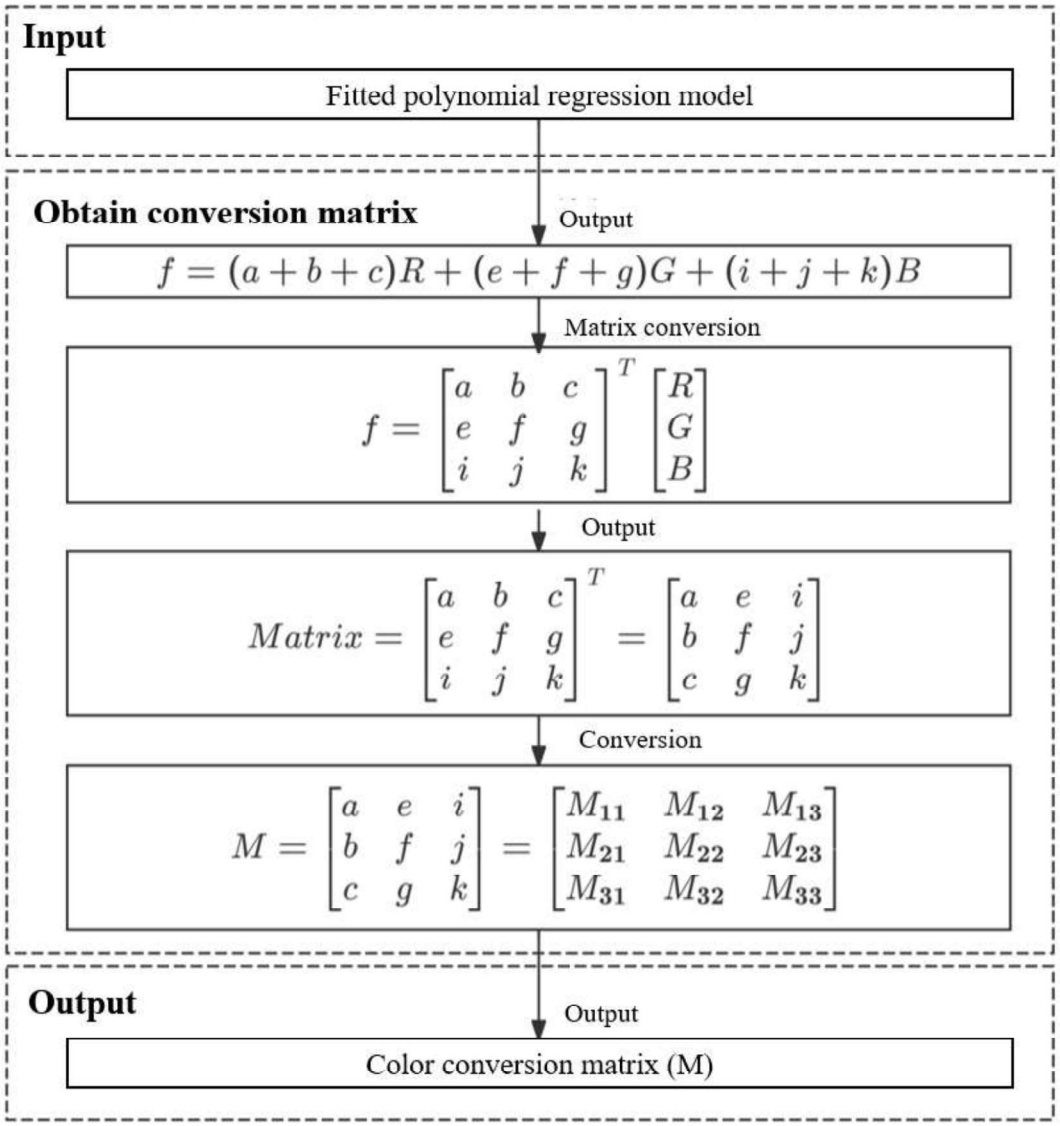
Input
Fitted polynomial regression model
Obtain conversion matrix
Output
$f = (a+b+c)R + (e+f+g)G + (i+j+k)B$
Matrix conversion
$f = \begin{bmatrix} a & b & c \\ e & f & g \\ i & j & k \end{bmatrix}^T \begin{bmatrix} R \\ G \\ B \end{bmatrix}$
Output
$Matrix = \begin{bmatrix} a & b & c \\ e & f & g \\ i & j & k \end{bmatrix}^T = \begin{bmatrix} a & e & i \\ b & f & j \\ c & g & k \end{bmatrix}$
Conversion
$M = \begin{bmatrix} a & e & i \\ b & f & j \\ c & g & k \end{bmatrix} = \begin{bmatrix} M_{11} & M_{12} & M_{13} \\ M_{21} & M_{22} & M_{23} \\ M_{31} & M_{32} & M_{33} \end{bmatrix}$
Output
Output
Color conversion matrix (M)

FIG. 14

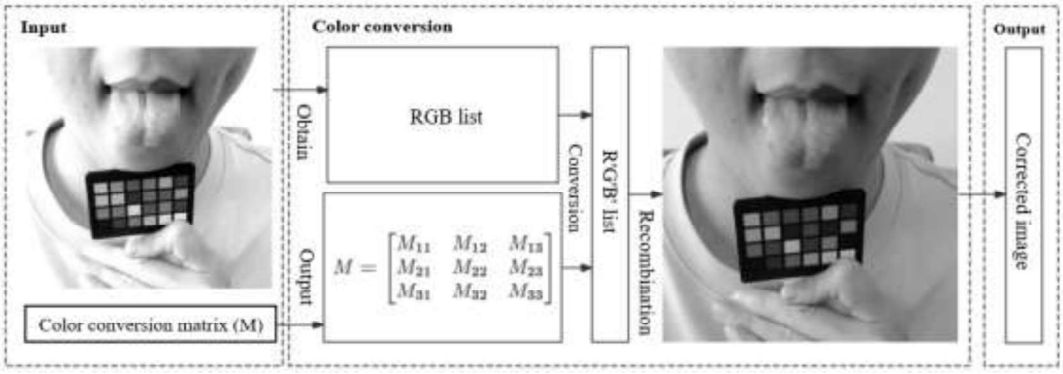
Input
Color conversion
Output
Obtain
RGB list
Conversion
R'G'B' list
Recombination
Corrected image
Output
$M = \begin{bmatrix} M_{11} & M_{12} & M_{13} \\ M_{21} & M_{22} & M_{23} \\ M_{31} & M_{32} & M_{33} \end{bmatrix}$
Color conversion matrix (M)

FIG. 15

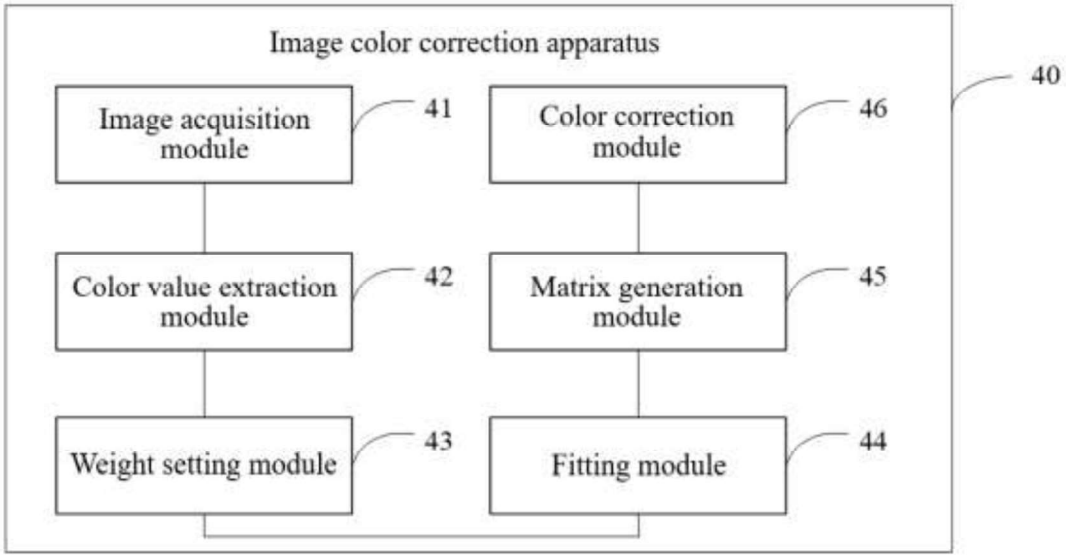
Image color correction apparatus
40
Image acquisition module
41
Color correction module
46
Color value extraction module
42
Matrix generation module
45
Weight setting module
43
Fitting module
44

FIG. 16

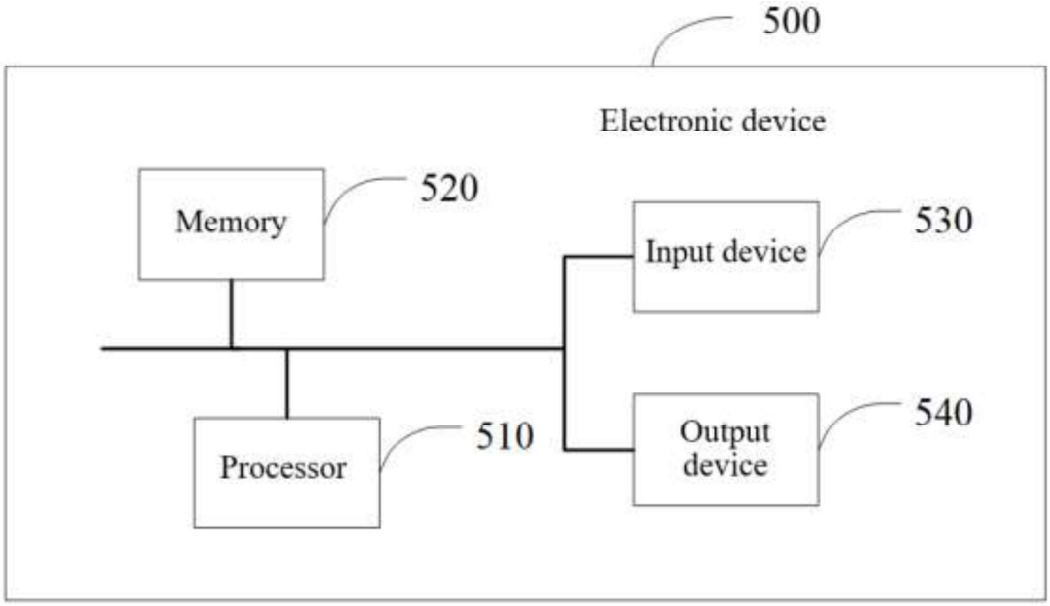
500
Electronic device
Memory
520
Input device
530
Processor
510
Output device
540

FIG. 17