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OPTICAL IMAGING LENS

Abstract

An optical imaging lens includes a first lens element to a seventh lens element. The first lens element, the fifth lens element and the sixth lens element are made of plastic. The optical axis region of the image-side surface of the second lens element is convex, the optical axis region of the image-side surface of the third lens element is convex, the optical axis region of the object-side surface of the fourth lens element is convex and the optical axis region of the image-side surface of the seventh lens element is concave to satisfy (T5+G56+T6)/(G23+T3+G34+T4+G45)≥1.200 by controlling the surface curvatures of each lens element to enlarge HFOV, to reduce the system length and to have good imaging quality.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS [0001] This application is a continuation application of U.S. application Ser. No. 18/496,934, filed on Oct. 30, 2023, which is a continuation application of U.S. application Ser. No. 17/968,807, filed on Oct. 19, 2022, which is a continuation application of U.S. application Ser. No. 17/117,122, filed on Dec. 10, 2020, which is a continuation application of U.S. application Ser. No. 16/150,273, filed on Oct. 3, 2018. The contents of these applications are incorporated herein by reference.

BACKGROUND OF THE INVENTION
1. Field of the Invention
[0002] The present invention generally relates to an optical imaging lens. Specifically speaking, the present invention is directed to an optical imaging lens for use in a portable electronic device such as a mobile phone, a camera, a tablet personal computer, or a personal digital assistant (PDA) for taking pictures or for recording videos.
2. Description of the Prior Art
[0003] An optical imaging lens develops concurrently to pursuit a lighter or thinner lens and a good imaging quality such as aberration or chromatic aberration is getting more and more important. To add more lens elements to an optical imaging lens increases a distance from the object-side surface of the first lens element to an image plane and is disadvantageous to a smaller size of a mobile phone, a digital camera or a lens for use in a vehicle.
[0004] In addition, how to enlarge a field of view is another important issue to design an optical imaging lens. Accordingly, it is always a target to provide a lighter and thinner optical imaging lens with good imaging quality and a larger field of view. Therefore, it is still needed to provide an optical imaging lens with good imaging quality, a shorter system length and a larger field of view to meet the market demand.
SUMMARY OF THE INVENTION
[0005] In the light of the above, the present invention proposes an optical imaging lens of seven lens elements which has reduced system length, ensured imaging quality, a larger field of view, good optical performance and is technically possible. The optical imaging lens of seventh lens elements of the present invention from an object side to an image side in order along an optical axis has a first lens element, a second lens element, a third lens element, a fourth lens element, a fifth lens element, a sixth lens element and a seventh lens element. Each first lens element, second lens element, third lens element, fourth lens element, fifth lens element, a sixth lens element and a seventh lens element respectively has an object-side surface which faces toward the object side and allows imaging rays to pass through as well as an image-side surface which faces toward the image side and allows the imaging rays to pass through.

[0006] In order to facilitate clearness of the parameters represented by the present invention and the drawings, it is defined in this specification and the drawings: T1 is a thickness of the first lens element along the optical axis; T2 is a thickness of the second lens element along the optical axis; T3 is a thickness of the third lens element along the optical axis; T4 is a thickness of the fourth lens element along the optical axis; T5 is a thickness of the fifth lens element along the optical axis; T6 is a thickness of the sixth lens element along the optical axis; and T7 is a thickness of the seventh lens element along the optical axis. G12 is an air gap between the first lens element and the second lens element along the optical axis; G23 is an air gap between the second lens element and the third lens element along the optical axis; G34 is an air gap between the third lens element and the fourth lens element along the optical axis; G45 is an air gap between the fourth lens element and the fifth lens element along the optical axis; G56 is an air gap between the fifth lens element and the sixth lens element along the optical axis; G67 is an air gap between the sixth lens element and the seventh lens element along the optical axis. ALT is a sum of thicknesses of all the seven lens elements along the optical axis. AAG is a sum of six air gaps from the first lens element to the seventh lens element along the optical axis. In addition, TTL is a distance from the object-side surface of the first lens element to an image plane along the optical axis, and that is the system length of the optical imaging lens; EFL is an effective focal length of the optical imaging lens; TL is a distance from the object-side surface of the first lens element to the image-side surface of the seventh lens element along the optical axis. BFL is a distance from the image-side surface of the seventh lens element to the image plane along the optical axis.

[0007] In one embodiment, the first lens element is made of plastic. An optical axis region of the image-side surface of the second lens element is convex. An optical axis region of the image-side surface of the third lens element is convex. An optical axis region of the object-side surface of the fourth lens element is convex. The fifth lens element is made of plastic. The sixth lens element is made of plastic. An optical axis region of the image-side surface of the seventh lens element is concave. Only the above-mentioned seven lens elements of the optical imaging lens have refracting power, and the optical imaging lens satisfies the relationship:

[00001] $(T5+G56+T6)/(G23+T3+G34+T4+G45)\geq 1.2$.

[0008] In another embodiment, the first lens element is made of plastic. An optical axis region of the image-side surface of the second lens element is convex. An optical axis region of the image-side surface of the third lens element is convex. An optical axis region of the object-side surface of the fourth lens element is convex. The fifth lens element is made of plastic. A periphery region of the image-side surface of the sixth lens element is convex. The seventh lens element is made of plastic. Only the above-mentioned seven lens elements of the optical imaging lens have refracting power, and the optical imaging lens satisfies the relationship:

[00002] $(T5+G56+T6)/(G23+T3+G34+T4+G45)\geq 1.2$.

[0009] In the optical imaging lens of the present invention, the embodiments can also selectively satisfy the following conditions: [0010] 1. ALT/AAG≥3.700; [0011] 2. AAG/(G12+G23+G34)≤2.300; [0012] 3. EFL/(T1+T2+T3)≤3.100; [0013] 4. BFL/(T5+G67)≤3.000; [0014] 5. TTL/BFL≤6.000; [0015] 6. ALT/(G56+T6)≥3.500; [0016] 7. TL/(T5+T6+T7)≤3.000; [0017] 8. TTL/(T4+T5)≤7.500; [0018] 9. (T4+G45+T5)/T3≤4.000; [0019] 10. ALT/(T6+G67)≥4.000; [0020] 11. AAG/(G12+G34+G56)≤1.900; [0021] 12. EFL/(G67+T7)≥2.800; [0022] 13. (G45+T5)/T4≥2.300; [0023] 14. EFL/AAG≥2.000; [0024] 15. (T1+T3)/(G12+G34)≤2.500; [0025] 16. (T2+T3)/G12≤2.500; [0026] 17. TL/(T7+BFL)≤3.200; [0027] 18. EFL/(T1+G12)≤3.600.

[0028] These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] FIGS. **1-5** illustrate the methods for determining the surface shapes and for determining an optical axis region and a periphery region of one lens element.

[0030] FIG. **6** illustrates a first embodiment of the optical imaging lens of the present invention.

[0031] FIG. **7**A illustrates the longitudinal spherical aberration on the image plane of the first embodiment.

[0032] FIG. **7**B illustrates the field curvature aberration on the sagittal direction of the first embodiment.

[0033] FIG. **7**C illustrates the field curvature aberration on the tangential direction of the first embodiment.

[0034] FIG. **7**D illustrates the distortion aberration of the first embodiment.

[0035] FIG. **8** illustrates a second embodiment of the optical imaging lens of the present invention.

[0036] FIG. **9**A illustrates the longitudinal spherical aberration on the image plane of the second embodiment.

[0037] FIG. **9**B illustrates the field curvature aberration on the sagittal direction of the second embodiment.

[0038] FIG. **9**C illustrates the field curvature aberration on the tangential direction of the second embodiment.

[0039] FIG. **9**D illustrates the distortion aberration of the second embodiment.

[0040] FIG. **10** illustrates a third embodiment of the optical imaging lens of the present invention.

[0041] FIG. **11**A illustrates the longitudinal spherical aberration on the image plane of the third embodiment.

[0042] FIG. **11**B illustrates the field curvature aberration on the sagittal direction of the third embodiment.

[0043] FIG. **11**C illustrates the field curvature aberration on the tangential direction of the third embodiment.

[0044] FIG. **11**D illustrates the distortion aberration of the third embodiment.

[0045] FIG. **12** illustrates a fourth embodiment of the optical imaging lens of the present invention.

[0046] FIG. **13**A illustrates the longitudinal spherical aberration on the image plane of the fourth embodiment.

[0047] FIG. **13**B illustrates the field curvature aberration on the sagittal direction of the fourth embodiment.

[0048] FIG. **13**C illustrates the field curvature aberration on the tangential direction of the fourth embodiment.

[0049] FIG. **13**D illustrates the distortion aberration of the fourth embodiment.

[0050] FIG. **14** illustrates a fifth embodiment of the optical imaging lens of the present invention.

[0051] FIG. **15**A illustrates the longitudinal spherical aberration on the image plane of the fifth embodiment.

[0052] FIG. **15**B illustrates the field curvature aberration on the sagittal direction of the fifth embodiment.

[0053] FIG. **15**C illustrates the field curvature aberration on the tangential direction of the fifth embodiment.

[0054] FIG. **15**D illustrates the distortion aberration of the fifth embodiment.

[0055] FIG. **16** illustrates a sixth embodiment of the optical imaging lens of the present invention.

[0056] FIG. **17**A illustrates the longitudinal spherical aberration on the image plane of the sixth embodiment.

[0057] FIG. **17**B illustrates the field curvature aberration on the sagittal direction of the sixth

embodiment.
[0058] FIG. **17**C illustrates the field curvature aberration on the tangential direction of the sixth embodiment.
[0059] FIG. **17**D illustrates the distortion aberration of the sixth embodiment.
[0060] FIG. **18** illustrates a seventh embodiment of the optical imaging lens of the present invention.
[0061] FIG. **19**A illustrates the longitudinal spherical aberration on the image plane of the seventh embodiment.
[0062] FIG. **19**B illustrates the field curvature aberration on the sagittal direction of the seventh embodiment.
[0063] FIG. **19**C illustrates the field curvature aberration on the tangential direction of the seventh embodiment.
[0064] FIG. **19**D illustrates the distortion aberration of the seventh embodiment.
[0065] FIG. **20** illustrates an eighth embodiment of the optical imaging lens of the present invention.
[0066] FIG. **21**A illustrates the longitudinal spherical aberration on the image plane of the eighth embodiment.
[0067] FIG. **21**B illustrates the field curvature aberration on the sagittal direction of the eighth embodiment.
[0068] FIG. **21**C illustrates the field curvature aberration on the tangential direction of the eighth embodiment.
[0069] FIG. **21**D illustrates the distortion aberration of the eighth embodiment.
[0070] FIG. **22** illustrates a ninth embodiment of the optical imaging lens of the present invention.
[0071] FIG. **23**A illustrates the longitudinal spherical aberration on the image plane of the ninth embodiment.
[0072] FIG. **23**B illustrates the field curvature aberration on the sagittal direction of the ninth embodiment.
[0073] FIG. **23**C illustrates the field curvature aberration on the tangential direction of the ninth embodiment.
[0074] FIG. **23**D illustrates the distortion aberration of the ninth embodiment.
[0075] FIG. **24** illustrates a tenth embodiment of the optical imaging lens of the present invention.
[0076] FIG. **25**A illustrates the longitudinal spherical aberration on the image plane of the tenth embodiment.
[0077] FIG. **25**B illustrates the field curvature aberration on the sagittal direction of the tenth embodiment.
[0078] FIG. **25**C illustrates the field curvature aberration on the tangential direction of the tenth embodiment.
[0079] FIG. **25**D illustrates the distortion aberration of the tenth embodiment.
[0080] FIG. **26** shows the optical data of the first embodiment of the optical imaging lens.
[0081] FIG. **27** shows the aspheric surface data of the first embodiment.
[0082] FIG. **28** shows the optical data of the second embodiment of the optical imaging lens.
[0083] FIG. **29** shows the aspheric surface data of the second embodiment.
[0084] FIG. **30** shows the optical data of the third embodiment of the optical imaging lens.
[0085] FIG. **31** shows the aspheric surface data of the third embodiment.
[0086] FIG. **32** shows the optical data of the fourth embodiment of the optical imaging lens.
[0087] FIG. **33** shows the aspheric surface data of the fourth embodiment.
[0088] FIG. **34** shows the optical data of the fifth embodiment of the optical imaging lens.
[0089] FIG. **35** shows the aspheric surface data of the fifth embodiment.
[0090] FIG. **36** shows the optical data of the sixth embodiment of the optical imaging lens.
[0091] FIG. **37** shows the aspheric surface data of the sixth embodiment.

[0092] FIG. **38** shows the optical data of the seventh embodiment of the optical imaging lens.
[0093] FIG. **39** shows the aspheric surface data of the seventh embodiment.
[0094] FIG. **40** shows the optical data of the eighth embodiment of the optical imaging lens.
[0095] FIG. **41** shows the aspheric surface data of the eighth embodiment.
[0096] FIG. **42** shows the optical data of the ninth embodiment of the optical imaging lens.
[0097] FIG. **43** shows the aspheric surface data of the ninth embodiment.
[0098] FIG. **44** shows the optical data of the tenth embodiment of the optical imaging lens.
[0099] FIG. **45** shows the aspheric surface data of the tenth embodiment.
[0100] FIG. **46** shows some important ratios in the embodiments.
[0101] FIG. **47** shows some important ratios in the embodiments.

DETAILED DESCRIPTION

[0102] In the present disclosure, the optical system may comprise at least one lens element to receive imaging rays that are incident on the optical system over a set of angles ranging from parallel to an optical axis to a half field of view (HFOV) angle with respect to the optical axis. The imaging rays pass through the optical system to produce an image on an image plane. The term “a lens element having positive refracting power (or negative refracting power)” means that the paraxial refracting power of the lens element in Gaussian optics is positive (or negative). The term “an object-side (or image-side) surface of a lens element” refers to a specific region of that surface of the lens element at which imaging rays can pass through that specific region. Imaging rays include at least two types of rays: a chief ray Lc and a marginal ray Im (as shown in FIG. **1**). An object-side (or image-side) surface of a lens element can be characterized as having several regions, including an optical axis region, a periphery region, and, in some cases, one or more intermediate regions, as discussed more fully below.

[0103] FIG. **1** is a radial cross-sectional view of a lens element **100**. Two referential points for the surfaces of the lens element **100** can be defined: a central point, and a transition point. The central point of a surface of a lens element is a point of intersection of that surface and the optical axis I. As illustrated in FIG. **1**, a first central point CP1 may be present on the object-side surface **110** of lens element **100** and a second central point CP2 may be present on the image-side surface **120** of the lens element **100**. The transition point is a point on a surface of a lens element, at which the line tangent to that point is perpendicular to the optical axis I. The optical boundary OB of a surface of the lens element is defined as a point at which the radially outermost marginal ray Lm passing through the surface of the lens element intersects the surface of the lens element. All transition points lie between the optical axis I and the optical boundary OB of the surface of the lens element. If multiple transition points are present on a single surface, then these transition points are sequentially named along the radial direction of the surface with reference numerals starting from the first transition point. For example, the first transition point, e.g., TP1, (closest to the optical axis I), the second transition point, e.g., TP2, (as shown in FIG. **4**), and the Nth transition point (farthest from the optical axis I).

[0104] The region of a surface of the lens element from the central point to the first transition point TP1 is defined as the optical axis region, which includes the central point. The region located radially outside of the farthest Nth transition point from the optical axis I to the optical boundary OB of the surface of the lens element is defined as the periphery region. In some embodiments, there may be intermediate regions present between the optical axis region and the periphery region, with the number of intermediate regions depending on the number of the transition points.

[0105] The shape of a region is convex if a collimated ray being parallel to the optical axis I and passing through the region is bent toward the optical axis I such that the ray intersects the optical axis I on the image side A2 of the lens element. The shape of a region is concave if the extension line of a collimated ray being parallel to the optical axis I and passing through the region intersects the optical axis I on the object side A1 of the lens element.

[0106] Additionally, referring to FIG. **1**, the lens element **100** may also have a mounting portion

130 extending radially outward from the optical boundary OB. The mounting portion **130** is typically used to physically secure the lens element to a corresponding element of the optical system (not shown). Imaging rays do not reach the mounting portion **130**. The structure and shape of the mounting portion **130** are only examples to explain the technologies, and should not be taken as limiting the scope of the present disclosure. The mounting portion **130** of the lens elements discussed below may be partially or completely omitted in the following drawings.

[0107] Referring to FIG. **2**, optical axis region Z1 is defined between central point CP and first transition point TP1. Periphery region Z2 is defined between TP1 and the optical boundary OB of the surface of the lens element. Collimated ray **211** intersects the optical axis I on the image side A2 of lens element **200** after passing through optical axis region Z1, i.e., the focal point of collimated ray **211** after passing through optical axis region Z1 is on the image side A2 of the lens element **200** at point R in FIG. **2**. Accordingly, since the ray itself intersects the optical axis I on the image side A2 of the lens element **200**, optical axis region Z1 is convex. On the contrary, collimated ray **212** diverges after passing through periphery region Z2. The extension line EL of collimated ray **212** after passing through periphery region **22** intersects the optical axis I on the object side A1 of lens element **200**, i.e., the focal point of collimated ray **212** after passing through periphery region Z2 is on the object side A1 at point M in FIG. **2**. Accordingly, since the extension line EL of the ray intersects the optical axis I on the object side A1 of the lens element **200**, periphery region Z2 is concave. In the lens element **200** illustrated in FIG. **2**, the first transition point TP1 is the border of the optical axis region and the periphery region, i.e., TP1 is the point at which the shape changes from convex to concave.

[0108] Alternatively, there is another way for a person having ordinary skill in the art to determine whether an optical axis region is convex or concave by referring to the sign of "Radius" (the "R" value), which is the paraxial radius of shape of a lens surface in the optical axis region. The R value is commonly used in conventional optical design software such as Zemax and CodeV. The R value usually appears in the lens data sheet in the software. For an object-side surface, a positive R value defines that the optical axis region of the object-side surface is convex, and a negative R value defines that the optical axis region of the object-side surface is concave. Conversely, for an image-side surface, a positive R value defines that the optical axis region of the image-side surface is concave, and a negative R value defines that the optical axis region of the image-side surface is convex. The result found by using this method should be consistent with the method utilizing intersection of the optical axis by rays/extension lines mentioned above, which determines surface shape by referring to whether the focal point of a collimated ray being parallel to the optical axis I is on the object-side or the image-side of a lens element. As used herein, the terms "a shape of a region is convex (concave)," "a region is convex (concave)," and "a convex-(concave-) region," can be used alternatively.

[0109] FIG. **3**, FIG. **4** and FIG. **5** illustrate examples of determining the shape of lens element regions and the boundaries of regions under various circumstances, including the optical axis region, the periphery region, and intermediate regions as set forth in the present specification.

[0110] FIG. **3** is a radial cross-sectional view of a lens element **300**. As illustrated in FIG. **3**, only one transition point TP1 appears within the optical boundary OB of the image-side surface **320** of the lens element **300**. Optical axis region Z1 and periphery region Z2 of the image-side surface **320** of lens element **300** are illustrated. The R value of the image-side surface **320** is positive (i.e., R>0). Accordingly, the optical axis region Z1 is concave.

[0111] In general, the shape of each region demarcated by the transition point will have an opposite shape to the shape of the adjacent region(s). Accordingly, the transition point will define a transition in shape, changing from concave to convex at the transition point or changing from convex to concave. In FIG. **3**, since the shape of the optical axis region Z1 is concave, the shape of the periphery region Z2 will be convex as the shape changes at the transition point TP1.

[0112] FIG. **4** is a radial cross-sectional view of a lens element **400**. Referring to FIG. **4**, a first transition point TP1 and a second transition point TP2 are present on the object-side surface **410** of lens element **400**. The optical axis region Z1 of the object-side surface **410** is defined between the optical axis I and the first transition point TP1. The R value of the object-side surface **410** is positive (i.e., R>0). Accordingly, the optical axis region Z1 is convex.

[0113] The periphery region Z2 of the object-side surface **410**, which is also convex, is defined between the second transition point TP2 and the optical boundary OB of the object-side surface **410** of the lens element **400**. Further, intermediate region Z3 of the object-side surface **410**, which is concave, is defined between the first transition point TP1 and the second transition point TP2. Referring once again to FIG. **4**, the object-side surface **410** includes an optical axis region Z1 located between the optical axis I and the first transition point TP1, an intermediate region Z3 located between the first transition point TP1 and the second transition point TP2, and a periphery region Z2 located between the second transition point TP2 and the optical boundary OB of the object-side surface **410**. Since the shape of the optical axis region Z1 is designed to be convex, the shape of the intermediate region Z3 is concave as the shape of the intermediate region Z3 changes at the first transition point TP1, and the shape of the periphery region Z2 is convex as the shape of the periphery region **22** changes at the second transition point TP2.

[0114] FIG. **5** is a radial cross-sectional view of a lens element **500**. Lens element **500** has no transition point on the object-side surface **510** of the lens element **500**. For a surface of a lens element with no transition point, for example, the object-side surface **510** the lens element **500**, the optical axis region Z1 is defined as the region between 0-50% of the distance between the optical axis I and the optical boundary OB of the surface of the lens element and the periphery region is defined as the region between 50%-100% of the distance between the optical axis I and the optical boundary OB of the surface of the lens element. Referring to lens element **500** illustrated in FIG. **5**, the optical axis region Z1 of the object-side surface **510** is defined between the optical axis I and 50% of the distance between the optical axis I and the optical boundary OB. The R value of the object-side surface **510** is positive (i.e., R>0). Accordingly, the optical axis region Z1 is convex. For the object-side surface **510** of the lens element **500**, because there is no transition point, the periphery region Z2 of the object-side surface **510** is also convex. It should be noted that lens element **500** may have a mounting portion (not shown) extending radially outward from the periphery region Z2.

[0115] As shown in FIG. **6**, the optical imaging lens **1** of seven lens elements of the present invention, sequentially located from an object side A1 (where an object is located) to an image side A2 along an optical axis I, has a first lens element **10**, a second lens element **20**, a third lens element **30**, a fourth lens element **40**, a fifth lens element **50**, a sixth lens element **60**, a seventh lens element **70**, a filter **90** and an image plane **91**. Generally speaking, the first lens element **10**, the second lens element **20**, the third lens element **30**, the fourth lens element **40**, the fifth lens element **50**, the sixth lens element **60** and the seventh lens element **70** may be made of a transparent plastic material but the present invention is not limited to this, and each lens element has an appropriate refracting power. In the present invention, lens elements having refracting power included by the optical imaging lens **1** are only the seven lens elements (the first lens element **10**, the second lens element **20**, the third lens element **30**, the fourth lens element **40**, the fifth lens element **50**, the sixth lens element **60** and the seventh lens element **70**) described above. The optical axis I is the optical axis of the entire optical imaging lens **1**, and the optical axis of each of the lens elements coincides with the optical axis of the optical imaging lens **1**.

[0116] Furthermore, the optical imaging lens **1** includes an aperture stop (ape. stop) **80** disposed in an appropriate position. In FIG. **6**, the aperture stop **80** is disposed between the first lens element **10** and the second lens element **20**. When light emitted or reflected by an object (not shown) which is located at the object side A1 enters the optical imaging lens **1** of the present invention, it forms a clear and sharp image on the image plane **91** at the image side A2 after passing through the first lens element **10**, the aperture stop **80**, the second lens element **20**, the third lens element **30**, the fourth lens element **40**, the fifth lens element **50**, the sixth lens element **60**, the seventh lens element **70**, and the filter **90**. In one embodiment of the present invention, the filter **90** may be a filter of various suitable functions to filter out light of a specific wavelength, for embodiment, the filter **90** may be an infrared cut filter (IR cut filter), placed between the image-side surface **72** of the seventh lens element **70** and the image plane **91**.

[0117] The first lens element **10**, the second lens element **20**, the third lens element **30**, the fourth lens element **40**, the fifth lens element **50**, the sixth lens element **60** and the seventh lens element **70** of the optical imaging lens **1** each has an object-side surface **11**, **21**, **31**, **41**, **51**, **61** and **71** facing toward the object side A1 and allowing imaging rays to pass through as well as an image-side surface **12**, **22**, **32**, **42**, **52**, **62** and **72** facing toward the image side A2 and allowing the imaging rays to pass through.

[0118] Each lens element in the optical imaging lens **1** of the present invention further has a thickness T along the optical axis I. For embodiment, the first lens element **10** has a first lens element thickness T1, the second lens element **20** has a second lens element thickness T2, the third lens element **30** has a third lens element thickness T3, the fourth lens element **40** has a fourth lens element thickness T4, the fifth lens element **50** has a fifth lens element thickness T5, the sixth lens element **60** has a sixth lens element thickness T6, and the seventh lens element **70** has a seventh lens element thickness T7. Therefore, a sum of thicknesses of all the seven lens elements in the optical imaging lens **1** along the optical axis I is ALT=T1+T2+T3+T4+T5+T6+T7.

[0119] In addition, between two adjacent lens elements in the optical imaging lens **1** of the present invention there may be an air gap along the optical axis I. In embodiments, there is an air gap G12 between the first lens element **10** and the second lens element **20**, an air gap G23 between the second lens element **20** and the third lens element **30**, an air gap G34 between the third lens element **30** and the fourth lens element **40**, an air gap G45 between the fourth lens element **40** and the fifth lens element **50**, an air gap G56 between the fifth lens element **50** and the sixth lens element **60** as well as an air gap G67 between the sixth lens element **60** and the seventh lens element **70**. Therefore, a sum of all six air gaps from the first lens element **10** to the seventh lens element **70** along the optical axis I is AAG=G12+G23+G34+G45+G56+G67.

[0120] In addition, a distance from the object-side surface **11** of the first lens element **10** to the image plane **91**, namely a system length of the optical imaging lens **1** along the optical axis I is TTL; an effective focal length of the optical imaging lens is EFL; a distance from the object-side surface **11** of the first lens element **10** to the image-side surface **72** of the seventh lens element **70** along the optical axis I is TL. A distance from the image-side surface **72** of the seventh lens element **70** to the filter **90** along the optical axis I is G7F; a thickness of the filter **90** along the optical axis I is TF; a distance from the filter **90** to the image plane **91** along the optical axis I is GFP; and a distance from the image-side surface **72** of the seventh lens element **70** to the image plane **91** along the optical axis I is BFL. Therefore, BFL=G7F+TF+GFP. ImgH is an image height of the optical imaging lens **1**.

[0121] Furthermore, a focal length of the first lens element **10** is f1; a focal length of the second lens element **20** is f2; a focal length of the third lens element **30** is f3; a focal length of the fourth lens element **40** is f4; a focal length of the fifth lens element **50** is f5; a focal length of the sixth lens element **60** is f6; a focal length of the seventh lens element **70** is f7; a refractive index of the first lens element **10** is n1; a refractive index of the second lens element **20** is n2; a refractive index of the third lens element **30** is n3; a refractive index of the fourth lens element **40** is n4; a refractive index of the fifth lens element **50** is n5; a refractive index of the sixth lens element **60** is n6; a refractive index of the seventh lens element **70** is n7; an Abbe number of the first lens element **10** is υ1; an Abbe number of the second lens element **20** is υ2; an Abbe number of the third lens element **30** is υ3; and an Abbe number of the fourth lens element **40** is υ4; an Abbe number of the fifth lens element **50** is υ5; an Abbe number of the sixth lens element **60** is υ6 and an Abbe number of the seventh lens element **70** is υ7.

First Embodiment

[0122] Please refer to FIG. **6** which illustrates the first embodiment of the optical imaging lens **1** of the present invention. Please refer to FIG. **7**A for the longitudinal spherical aberration on the image plane **91** of the first embodiment; please refer to FIG. **7**B for the field curvature aberration on the sagittal direction; please refer to FIG. **7**C for the field curvature aberration on the tangential direction; and please refer to FIG. **7**D for the distortion aberration. The Y axis of the spherical aberration in each embodiment is “field of view” for 1.0. The Y axis of the field curvature aberration and the distortion aberration in each embodiment stands for the “image height” (ImgH), which is 2.940 mm.

[0123] The optical imaging lens **1** of the first embodiment exclusively has seven lens elements **10**, **20**, **30**, **40**, **50**, **60** and **70** with refracting power. The optical imaging lens **1** also has an aperture stop **80**, a filter **90**, and an image plane **91**. The aperture stop **80** is provided between the first lens element **10** and the second lens element **20**. The filter **90** may be used for preventing specific wavelength light (such as the infrared light) reaching the image plane **91** to adversely affect the imaging quality.

[0124] The first lens element **10** has negative refracting power. An optical axis region **13** and a periphery region **14** of the object-side surface **11** of the first lens element **10** are convex. An optical axis region **16** and a periphery region **17** of the image-side surface **12** of the first lens element **10** are concave. Besides, both the object-side surface **11** and the image-side surface **12** of the first lens element **10** are aspherical surfaces, but it is not limited thereto.

[0125] The second lens element **20** has positive refracting power. An optical axis region **23** and a periphery region **24** of the object-side surface **21** of the second lens element **20** are convex. An optical axis region **26** and a periphery region **27** of the image-side surface **22** of the second lens element **20** are convex. Besides, both the object-side surface **21** and the image-side surface **22** of the second lens element **20** are aspherical surfaces, but it is not limited thereto.

[0126] The third lens element **30** has positive refracting power. An optical axis region **33** and a periphery region **34** of the object-side surface **31** of the third lens element **30** are concave. An optical axis region **36** and a periphery region **37** of the image-side surface **32** of the third lens element **30** are convex. Besides, both the object-side surface **31** and the image-side surface **32** of the third lens element **30** are aspherical surfaces, but it is not limited thereto.

[0127] The fourth lens element **40** has negative refracting power. An optical axis region **43** of the object-side surface **41** of the fourth lens element **40** is convex, and a periphery region **44** of the object-side surface **41** of the fourth lens element **40** is concave. An optical axis region **46** of the image-side surface **42** of the fourth lens element **40** is concave and a periphery region **47** of the image-side surface **42** of the fourth lens element **40** is convex. Besides, both the object-side surface **41** and the image-side surface **42** of the fourth lens element **40** are aspherical surfaces, but it is not limited thereto.

[0128] The fifth lens element **50** has positive refracting power. An optical axis region **53** and a periphery region **54** of the object-side surface **51** of the fifth lens element **50** are convex. An optical axis region **56** and a periphery region **57** of the image-side surface **52** of the fifth lens element **50** are convex. Besides, both the object-side surface **51** and the image-side surface **52** of the fifth lens element **50** are aspherical surfaces, but it is not limited thereto.

[0129] The sixth lens element **60** has positive refracting power. An optical axis region **63** and a periphery region **64** of the object-side surface **61** of the sixth lens element **60** are concave. An optical axis region **66** and a periphery region **67** of the image-side surface **62** of the sixth lens element **60** are convex. Besides, both the object-side surface **61** and the image-side surface **62** of the sixth lens element **60** are aspherical surfaces, but it is not limited thereto.

[0130] The seventh lens element **70** has negative refracting power. An optical axis region **73** of the object-side surface **71** of the seventh lens element **70** is convex, and a periphery region **74** of the object-side surface **71** of the seventh lens element **70** is concave. An optical axis region **76** of the image-side surface **72** of the seventh lens element **70** is concave, and a periphery region **77** of the image-side surface **72** of the seventh lens element **70** is convex. Besides, both the object-side surface **71** and the image-side **72** of the seventh lens element **70** are aspherical surfaces, but it is not limited thereto. The filter **90** is disposed between the image-side surface **72** of the seventh lens element **70** and the image plane **91**.

[0131] In the first lens element **10**, the second lens element **20**, the third lens element **30**, the fourth lens element **40**, the fifth lens element **50**, the sixth lens element **60** and the seventh lens element **70** of the optical imaging lens element **1** of the present invention, there are 14 surfaces, such as the object-side surfaces **11/21/31/41/51/61/71** and the image-side surfaces **12/22/32/42/52/62/72**. If a surface is aspherical, these aspheric coefficients are defined according to the following formula:

[00003] $$Z(Y) = \frac{Y^2}{R}\left(1 + \sqrt{1 - (1 + K)\frac{Y^2}{R^2}}\right) + \sum_{i=1}^{n} a_{2i} \times Y^{2i}$$

[0132] In which: [0133] R represents the curvature radius of the lens element surface; [0134] Z represents the depth of an aspherical surface (the perpendicular distance between the point of the aspherical surface at a distance Y from the optical axis I and the tangent plane of the vertex on the optical axis I of the aspherical surface); [0135] Y represents a vertical distance from a point on the aspherical surface to the optical axis I; [0136] K is a conic constant; and [0137] a.sub.21 is the aspheric coefficient of the 2i.sup.th order.

[0138] The optical data of the first embodiment of the optical imaging lens **1** are shown in FIG. **26** while the aspheric surface data are shown in FIG. **27**. In the present embodiments of the optical imaging lens, the f-number of the entire optical imaging lens is Fno, EFL is the effective focal length, HFOV stands for the half field of view of the entire optical imaging lens, and the unit for the radius, the thickness and the focal length is in millimeters (mm). In this embodiment, EFL=2.198 mm; HFOV=60.085 degrees; TTL=6.706 mm; Fno=1.85; ImgH=2.940 mm.

Second Embodiment

[0139] Please refer to FIG. **8** which illustrates the second embodiment of the optical imaging lens **1** of the present invention. It is noted that from the second embodiment to the following embodiments, in order to simplify the figures, only the components different from what the first embodiment has, and the basic lens elements will be labeled in figures. Other components that are the same as what the first embodiment has, such as a convex surface or a concave surface, are omitted in the following embodiments. Please refer to FIG. **9**A for the longitudinal spherical aberration on the image plane **91** of the second embodiment, please refer to FIG. **9**B for the field curvature aberration on the sagittal direction, please refer to FIG. **9**C for the field curvature aberration on the tangential direction, and please refer to FIG. **9**D for the distortion aberration. The components in this embodiment are similar to those in the first embodiment, but the optical data such as the refracting power, the radius, the lens thickness, the aspheric surface or the back focal length in this embodiment are different from the optical data in the first embodiment. Besides, in this embodiment, the optical axis region **53** of the object-side surface **51** of the fifth lens element **50** is concave.

[0140] The optical data of the second embodiment of the optical imaging lens are shown in FIG. **28** while the aspheric surface data are shown in FIG. **29**. In this embodiment, EFL=1.827 mm; HFOV=60.087 degrees; TTL=5.132 mm; Fno=1.85; ImgH=2.940 mm. In particular, 1) the longitudinal spherical aberration of the optical imaging lens in this embodiment is better than that of the optical imaging lens in the first embodiment, and 2) the distortion aberration of the optical imaging lens in this embodiment is better than that of the optical imaging lens in the first embodiment.

Third Embodiment

[0141] Please refer to FIG. **10** which illustrates the third embodiment of the optical imaging lens **1** of the present invention. Please refer to FIG. **11**A for the longitudinal spherical aberration on the image plane **91** of the third embodiment; please refer to FIG. **11**B for the field curvature aberration on the sagittal direction; please refer to FIG. **11**C for the field curvature aberration on the tangential direction; and please refer to FIG. **11**D for the distortion aberration. The components in this embodiment are similar to those in the first embodiment, but the optical data such as the refracting power, the radius, the lens thickness, the aspheric surface or the back focal length in this embodiment are different from the optical data in the first embodiment. Besides, in this embodiment, the periphery region **47** of the image-side surface **42** of the fourth lens element **40** is concave, and the periphery region **54** of the object-side surface **51** of the fifth lens element **50** is concave.

[0142] The optical data of the third embodiment of the optical imaging lens are shown in FIG. **30** while the aspheric surface data are shown in FIG. **31**. In this embodiment, EFL=2.106 mm; HFOV=60.085 degrees; TTL=5.408 mm; Fno=1.85; ImgH=2.940 mm. In particular, 1) the longitudinal spherical aberration of the optical imaging lens in this embodiment is better than that of the optical imaging lens in the first embodiment, and 2) the distortion aberration of the optical imaging lens in this embodiment is better than that of the optical imaging lens in the first embodiment.

Fourth Embodiment

[0143] Please refer to FIG. **12** which illustrates the fourth embodiment of the optical imaging lens **1** of the present invention. Please refer to FIG. **13**A for the longitudinal spherical aberration on the image plane **91** of the fourth embodiment; please refer to FIG. **13**B for the field curvature aberration on the sagittal direction; please refer to FIG. **13**C for the field curvature aberration on the tangential direction; and please refer to FIG. **13**D for the distortion aberration. The components in this embodiment are similar to those in the first embodiment, but the optical data such as the refracting power, the radius, the lens thickness, the aspheric surface or the back focal length in this embodiment are different from the optical data in the first embodiment. Besides, in this embodiment, the optical axis region **73** of the object-side surface **71** of the seventh lens element **70** is concave.

[0144] The optical data of the fourth embodiment of the optical imaging lens are shown in FIG. **32** while the aspheric surface data are shown in FIG. **33**. In this embodiment, EFL=1.989 mm; HFOV=60.087 degrees; TTL=5.057 mm; Fno=1.85; ImgH=2.940 mm. In particular, the distortion aberration of the optical imaging lens in this embodiment is better than that of the optical imaging lens in the first embodiment.

Fifth Embodiment

[0145] Please refer to FIG. **14** which illustrates the fifth embodiment of the optical imaging lens **1** of the present invention. Please refer to FIG. **15**A for the longitudinal spherical aberration on the image plane **91** of the fifth embodiment; please refer to FIG. **15**B for the field curvature aberration on the sagittal direction; please refer to FIG. **15**C for the field curvature aberration on the tangential direction, and please refer to FIG. **15**D for the distortion aberration. The components in this embodiment are similar to those in the first embodiment, but the optical data such as the refracting power, the radius, the lens thickness, the aspheric surface or the back focal length in this embodiment are different from the optical data in the first embodiment.

[0146] The optical data of the fifth embodiment of the optical imaging lens are shown in FIG. **34** while the aspheric surface data are shown in FIG. **35**. In this embodiment, EFL=2.073 mm; HFOV=60.086 degrees; TTL=5.847 mm; Fno=1.85; ImgH=2.940 mm. In particular, 1) the longitudinal spherical aberration of the optical imaging lens in this embodiment is better than that of the optical imaging lens in the first embodiment, 2) the field curvature aberration on the tangential direction of the optical imaging lens in this embodiment is better than that of the optical imaging lens in the first embodiment, and 3) the distortion aberration of the optical imaging lens in this embodiment is better than that of the optical imaging lens in the first embodiment.

Sixth Embodiment

[0147] Please refer to FIG. **16** which illustrates the sixth embodiment of the optical imaging lens **1** of the present invention. Please refer to FIG. **17**A for the longitudinal spherical aberration on the image plane **91** of the sixth embodiment; please refer to FIG. **17**B for the field curvature aberration on the sagittal direction; please refer to FIG. **17**C for the field curvature aberration on the tangential direction, and please refer to FIG. **17**D for the distortion aberration. The components in this embodiment are similar to those in the first embodiment, but the optical data such as the refracting power, the radius, the lens thickness, the aspheric surface or the back focal length in this embodiment are different from the optical data in the first embodiment. Besides, in this embodiment, the optical axis region **73** of the object-side surface **71** of the seventh lens element **70** is concave.

[0148] The optical data of the sixth embodiment of the optical imaging lens are shown in FIG. **36** while the aspheric surface data are shown in FIG. **37**. In this embodiment, EFL=2.041 mm; HFOV=60.089 degrees; TTL=5.650 mm; Fno=1.85; ImgH=2.940 mm. In particular, 1) the field curvature aberration on the tangential direction of the optical imaging lens in this embodiment is better than that of the optical imaging lens in the first embodiment, and 2) the distortion aberration of the optical imaging lens in this embodiment is better than that of the optical imaging lens in the first embodiment.

Seventh Embodiment

[0149] Please refer to FIG. **18** which illustrates the seventh embodiment of the optical imaging lens **1** of the present invention. Please refer to FIG. **19**A for the longitudinal spherical aberration on the image plane **91** of the seventh embodiment; please refer to FIG. **19**B for the field curvature aberration on the sagittal direction; please refer to FIG. **19**C for the field curvature aberration on the tangential direction, and please refer to FIG. **19**D for the distortion aberration. The components in this embodiment are similar to those in the first embodiment, but the optical data such as the refracting power, the radius, the lens thickness, the aspheric surface or the back focal length in this embodiment are different from the optical data in the first embodiment.

[0150] The optical data of the seventh embodiment of the optical imaging lens are shown in FIG. **38** while the aspheric surface data are shown in FIG. **39**. In this embodiment, EFL=2.051 mm; HFOV=60.085 degrees; TTL=5.089 mm; Fno=1.85; ImgH=2.940 mm. In particular, 1) the longitudinal spherical aberration of the optical imaging lens in this embodiment is better than that of the optical imaging lens in the first embodiment, and 2) the distortion aberration of the optical imaging lens in this embodiment is better than that of the optical imaging lens in the first embodiment.

Eighth Embodiment

[0151] Please refer to FIG. **20** which illustrates the eighth embodiment of the optical imaging lens **1** of the present invention. Please refer to FIG. **21**A for the longitudinal spherical aberration on the image plane **91** of the eighth embodiment; please refer to FIG. **21**B for the field curvature aberration on the sagittal direction; please refer to FIG. **21**C for the field curvature aberration on the tangential direction, and please refer to FIG. **21**D for the distortion aberration. The components in this embodiment are similar to those in the first embodiment, but the optical data such as the refracting power, the radius, the lens thickness, the aspheric surface or the back focal length in this embodiment are different from the optical data in the first embodiment. Besides, in this embodiment, the optical axis region **73** of the object-side surface **71** of the seventh lens element **70** is concave.

[0152] The optical data of the eighth embodiment of the optical imaging lens are shown in FIG. **40** while the aspheric surface data are shown in FIG. **41**. In this embodiment, EFL=2.048 mm; HFOV=60.087 degrees; TTL=5.042 mm; Fno=1.85; ImgH=2.940 mm. In particular, 1) the longitudinal spherical aberration of the optical imaging lens in this embodiment is better than that of the optical imaging lens in the first embodiment, 2) the field curvature aberration on the tangential direction of the optical imaging lens in this embodiment is better than that of the optical imaging lens in the first embodiment, and 3) the distortion aberration of the optical imaging lens in this embodiment is better than that of the optical imaging lens in the first embodiment.

Ninth Embodiment

[0153] Please refer to FIG. **22** which illustrates the ninth embodiment of the optical imaging lens **1** of the present invention. Please refer to FIG. **23**A for the longitudinal spherical aberration on the image plane **91** of the ninth embodiment; please refer to FIG. **23**B for the field curvature aberration on the sagittal direction; please refer to FIG. **23**C for the field curvature aberration on the tangential direction, and please refer to FIG. **23**D for the distortion aberration. The components in this embodiment are similar to those in the first embodiment, but the optical data such as the refracting power, the radius, the lens thickness, the aspheric surface or the back focal length in this embodiment are different from the optical data in the first embodiment.

[0154] The optical data of the ninth embodiment of the optical imaging lens are shown in FIG. **42** while the aspheric surface data are shown in FIG. **43**. In this embodiment, EFL=2.025 mm; HFOV=60.088 degrees; TTL=5.283 mm; Fno=1.85; ImgH=2.940 mm. In particular, 1) the longitudinal spherical aberration of the optical imaging lens in this embodiment is better than that of the optical imaging lens in the first embodiment, and 2) the distortion aberration of the optical imaging lens in this embodiment is better than that of the optical imaging lens in the first embodiment.

Tenth Embodiment

[0155] Please refer to FIG. **24** which illustrates the tenth embodiment of the optical imaging lens **1** of the present invention. Please refer to FIG. **25**A for the longitudinal spherical aberration on the image plane **91** of the tenth embodiment; please refer to FIG. **25**B for the field curvature aberration on the sagittal direction; please refer to FIG. **25**C for the field curvature aberration on the tangential direction, and please refer to FIG. **25**D for the distortion aberration. The components in this embodiment are similar to those in the first embodiment, but the optical data such as the refracting power, the radius, the lens thickness, the aspheric surface or the back focal length in this embodiment are different from the optical data in the first embodiment.

[0156] The optical data of the tenth embodiment of the optical imaging lens are shown in FIG. **44** while the aspheric surface data are shown in FIG. **45**. In this embodiment, EFL=2.129 mm; HFOV=59.677 degrees; TTL=5.252 mm; Fno=1.85; ImgH=2.940 mm. In particular, the distortion aberration of the optical imaging lens in this embodiment is better than that of the optical imaging lens in the first embodiment.

[0157] Some important parameters and ratios in each embodiment are shown in FIG. **46** and in FIG. **47**.

[0158] The applicants found that by the following designs, the lens configuration of the present invention has the following features and corresponding advantages:

[0159] 1. The lens configuration in each embodiment of the present invention has the designs, for example: the optical axis region **26** of the image-side surface **22** of the second lens element **20** is convex, the optical axis region **36** of the image-side surface **32** of the third lens element **30** is convex, the optical axis region **43** of the object-side surface **41** of the fourth lens element **40** is convex, the above lens configuration may further to go with that the optical axis region **76** of the image-side surface **72** of the seventh lens element **70** is concave or the periphery region **67** of the image-side surface **62** of the sixth lens element **60** is convex to effectively correct the spherical aberration and the field curvature aberration and to reduce the distortion aberration of the optical imaging lens **1** of the present invention.

[0160] 2. If the condition of $(T5+G56+T6)/(G23+T3+G34+T4+G45)\geq 1.200$ can be satisfied, it is beneficial for increasing the field of view of the optical imaging lens system. The preferable range is $1.200\leq(T5+G56+T6)/(G23+T3+G34+T4+G45)\leq 2.500$.

[0161] 3. If a lens element is made of a plastic material, it is beneficial for reducing the cost and the weight of the optical imaging lens.

[0162] 4. In order to reduce the system length of the optical imaging lens **1** along the optical axis I, the thickness of each lens element or the air gaps should be appropriately adjusted and the assembly or the manufacturing difficulty should be taken into consideration to ensure the imaging quality. If the following numerical conditions are selectively satisfied, they facilitate better arrangements: [0163] 1) ALT/AAG≥3.700, the preferable range is 3.700≤ALT/AAG≤4.500; [0164] 2) AAG/(G12+G23+G34)≤2.300, the preferable range is 1.000≤AAG/(G12+G23+G34)≤2.300; [0165] 3) EFL/(T1+T2+T3)≤3.100, the preferable range is 1.100≤EFL/(T1+T2+T3)≤3.100; [0166] 4) BFL/(T5+G67)≤3.000, the preferable range is 0.800≤BFL/(T5+G67)≤3.000; [0167] 5) TTL/BFL≤6.000, the preferable range is 3.500≤TTL/BFL≤6.000; [0168] 6) ALT/(G56+T6)≥3.500, the preferable range is 3.500≤ALT/(G56+T6)≤6.500; [0169] 7) TL/(T5+T6+T7)≤3.000, the preferable range is 1.700≤TL/(T5+T6+T7)≤3.000; [0170] 8) TTL/(T4+T5)≤7.500, the preferable range is 4.700≤TTL/(T4+T5)≤7.500; [0171] 9) (T4+G45+T5)/T3≤4.000, the preferable range is 1.800≤(T4+G45+T5)/T3≤4.000; [0172] 10) ALT/(T6+G67)≥4.000, the preferable range is 4.000≤ALT/(T6+G67)≤9.200; [0173] 11) AAG/(G12+G34+G56)≤1.900, the preferable range is 1.000≤AAG/(G12+G34+G56)≤1.900; [0174] 12) EFL/(G67+T7)≥2.800, the preferable range is 2.800≤EFL/(G67+T7)≤4.500; [0175] 13) (G45+T5)/T4≥2.300, the preferable range is 2.300≤(G45+T5)/T4≤4.000; [0176] 14) EFL/AAG≥2.000, the preferable range is 2.000≤EFL/AAG≤2.800; [0177] 15) (T1+T3)/(G12+G34)≤2.500, the preferable range is 0.500≤(T1+T3)/(G12+G34)≤2.500; [0178] 16) (T2+T3)/G12≤2.500, the preferable range is 0.800≤(T2+T3)/G12≤2.500; [0179] 17) TL/(T7+BFL)≤3.200, the preferable range is 2.000≤TL/(T7+BFL)≤3.200; [0180] 18) EFL/(T1+G12)≤3.600, the preferable range is 1.500≤EFL/(T1+G12)≤3.600.

[0181] In the light of the unpredictability of the optical imaging lens, the present invention suggests the above principles to preferably have a shorter system length of the optical imaging lens, a smaller F-number available, improved imaging quality or a better fabrication yield to overcome the drawbacks of prior art.

[0182] In addition, any arbitrary combination of the parameters of the embodiments can be selected to increase the lens limitation so as to facilitate the design of the same structure of the present invention. In addition to the above ratios, one or more conditional formulae may be optionally combined to be used in the embodiments of the present invention and the present invention is not limit to this. The curvatures of each lens element or multiple lens elements may be fine-tuned to result in more fine structures to enhance the performance or the resolution. The above limitations may be selectively combined in the embodiments without causing inconsistency.

[0183] The numeral value ranges within the maximum and minimum values obtained from the combination ratio relationships of the optical parameters disclosed in each embodiment of the invention can all be implemented accordingly.

[0184] Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

Claims

1. An optical imaging lens, from an object side to an image side in order along an optical axis comprising: a first lens element, a second lens element, a third lens element, a fourth lens element, a fifth lens element, a sixth lens element and a seventh lens element, the first lens element to the seventh lens element each having an object-side surface facing toward the object side and allowing imaging rays to pass through as well as an image-side surface facing toward the image side and allowing the imaging rays to pass through, wherein: the second lens element has positive refracting power and a periphery region of the object-side surface of the second lens element is convex; a periphery region of the image-side surface of the third lens element is convex; the fourth lens element has negative refracting power and a periphery region of the image-side surface of the fourth lens element is convex; an optical axis region of the image-side surface of the fifth lens element is convex and a periphery region of the image-side surface of the fifth lens element is convex; and the sixth lens element has positive refracting power; wherein only the above-mentioned seven lens elements of the optical imaging lens have refracting power; wherein, ALT is a sum of thicknesses of all the seven lens elements along the optical axis, G56 is an air gap between the fifth lens element and the sixth lens element along the optical axis and T6 is a thickness of the sixth lens element along the optical axis, and the optical imaging lens satisfies the relationship: $ALT/(G56+T6)\geq 3.500$.

2. The optical imaging lens of claim 1, satisfying (T5+G56+T6)/(G23+T3+G34+T4+G45)≥1.200, wherein T3 is a thickness of the third lens element along the optical axis, T4 is a thickness of the fourth lens element along the optical axis, T5 is a thickness of the fifth lens element along the optical axis, G23 is an air gap between the second lens element and the third lens element along the optical axis, G34 is an air gap between the third lens element and the fourth lens element along the optical axis and G45 is an air gap between the fourth lens element and the fifth lens element along the optical axis.

3. The optical imaging lens of claim 1, satisfying ALT/AAG≥3.700, wherein AAG is a sum of six air gaps from the first lens element to the seventh lens element along the optical axis.

4. The optical imaging lens of claim 1, satisfying AAG/(G12+G23+G34)≤2.300, wherein AAG is a sum of six air gaps from the first lens element to the seventh lens element along the optical axis, G12 is the air gap between the first lens element and the second lens element along the optical axis, G23 is an air gap between the second lens element and the third lens element along the optical axis and G34 is an air gap between the third lens element and the fourth lens element along the optical axis.

5. The optical imaging lens of claim 1, satisfying EFL/(T1+T2+T3)≤3.100, wherein EFL is an effective focal length of the optical imaging lens, T1 is a thickness of the first lens element along the optical axis, T2 is the thickness of the second lens element along the optical axis and T3 is a thickness of the third lens element along the optical axis.

6. The optical imaging lens of claim 1, satisfying BFL/(T5+G67)≤3.000, wherein BFL is a distance from the image-side surface of the seventh lens element to an image plane along the optical axis, T5 is a thickness of the fifth lens element along the optical axis and G67 is an air gap between the sixth lens element and the seventh lens element along the optical axis.

7. The optical imaging lens of claim 1, satisfying TTL/BFL≤6.000, wherein TTL is a distance from the object-side surface of the first lens element to an image plane along the optical axis and BFL is a distance from the image-side surface of the seventh lens element to an image plane along the optical axis.

8. The optical imaging lens of claim 1, satisfying TL/(T5+T6+T7)≤3.000, wherein TL is a distance from the object-side surface of the first lens element to the image-side surface of the seventh lens element along the optical axis, T5 is a thickness of the fifth lens element along the optical axis and T7 is a thickness of the seventh lens element along the optical axis.

9. The optical imaging lens of claim 1, satisfying TTL/(T4+T5)≤7.500, wherein TTL is a distance from the object-side surface of the first lens element to an image plane along the optical axis, T4 is a thickness of the fourth lens element along the optical axis and T5 is a thickness of the fifth lens element along the optical axis.

10. The optical imaging lens of claim 1, satisfying (T4+G45+T5)/T3≤4.000, wherein T3 is the thickness of the third lens element along the optical axis, T4 is a thickness of the fourth lens element along the optical axis, T5 is a thickness of the fifth lens element along the optical axis and G45 is an air gap between the fourth lens element and the fifth lens element along the optical axis.

11. The optical imaging lens of claim 1, satisfying ALT/(T6+G67)≥4.000, wherein G67 is an air gap between the sixth lens element and the seventh lens element along the optical axis.

12. The optical imaging lens of claim 1, satisfying AAG/(G12+G34+G56)≤1.900, wherein AAG is a sum of six air gaps from the first lens element to the seventh lens element along the optical axis, G12 is an air gap between the first lens element and the second lens element along the optical axis and G34 is an air gap between the third lens element and the fourth lens element along the optical axis.

13. The optical imaging lens of claim 1, satisfying EFL/(G67+T7)≥2.800, wherein EFL is an effective focal length of the optical imaging lens, G67 is an air gap between the sixth lens element and the seventh lens element along the optical axis and T7 is a thickness of the seventh lens element along the optical axis.

14. The optical imaging lens of claim 1, satisfying (G45+T5)/T4≥2.300, wherein T4 is a thickness of the fourth lens element along the optical axis, T5 is a thickness of the fifth lens element along the optical axis and G45 is an air gap between the fourth lens element and the fifth lens element along the optical axis.

15. The optical imaging lens of claim 1, satisfying EFL/AAG≥2.000, wherein EFL is an effective focal length of the optical imaging lens and AAG is a sum of six air gaps from the first lens element to the seventh lens element along the optical axis.

16. The optical imaging lens of claim 1, satisfying (T1+T3)/(G12+G34)≤2.500, wherein T1 is a thickness of the first lens element along the optical axis, T3 is the thickness of the third lens element along the optical axis, G12 is the air gap between the first lens element and the second lens element along the optical axis and G34 is an air gap between the third lens element and the fourth lens element along the optical axis.

17. The optical imaging lens of claim 1, satisfying (T2+T3)/G12≤2.500, wherein T2 is a thickness of the second lens element along the optical axis, T3 is a thickness of the third lens element along the optical axis and G12 is an air gap between the first lens element and the second lens element along the optical axis.

18. The optical imaging lens of claim 1, satisfying TL/(T7+BFL)≤3.200, wherein TL is a distance from the object-side surface of the first lens element to the image-side surface of the seventh lens element along the optical axis, T7 is the thickness of the seventh lens element along the optical axis and BFL is a distance from the image-side surface of the seventh lens element to an image plane along the optical axis.

19. The optical imaging lens of claim 1, satisfying EFL/(T1+G12)≤3.600, wherein EFL is an effective focal length of the optical imaging lens, T1 is a thickness of the first lens element along the optical axis and G12 is an air gap between the first lens element and the second lens element along the optical axis.