CLAIMS:

1. A variable-zoom imaging apparatus comprising:

imaging optics configured to form an image in an imaging area of an object positioned in an object area;

a light source configured to illuminate the object and thereby provide light to the imaging optics for forming the image of the object;

an adjustable aperture stop to adjustably set a numerical aperture *NA* for the image formed by the imaging optics;

an electronic detector comprising an array of detector elements positioned in the imaging area to detect the image; and

image processing circuitry coupled to the electronic detector to produce a digital representation of the image based on signals from at least some of the detector elements,

wherein the image processing circuitry produces the digital representation with a different magnification of the object m for each of a plurality of different numerical apertures for the image set by the adjustable aperture stop,

wherein the different magnifications m vary from a minimum magnification of $m=m_{min}$ to a maximum magnification of $m=m_{max}$ to define a zoom ratio $z=m/m_{min}$ and a maximum zoom ratio $z_{max}=m_{max}/m_{min}$,

wherein the sizes of the different numerical apertures set by the adjustable aperture stop increase with corresponding increases in the zoom ratio z for the digital representation,

wherein the imaging optics does not produce a diffraction-limited image over a full field area spanning all of the detector elements in the array when the adjustable aperture stop is set to the largest one of the plurality of different numerical apertures, and

wherein the imaging optics does produce a diffraction-limited image over the full field area when the adjustable aperture stop is set to the smallest one of the plurality of different numerical apertures.

2. The variable-zoom imaging apparatus of claim 1, wherein the imaging optics are fixed to provide a constant magnification of the object area to the image area.

3. The variable-zoom imaging apparatus of claim 1, the zoom ratio *z* for the digital representation varies inversely with a field area spanned by the detector elements to produce the digital representation.

4. The variable-zoom imaging apparatus of claim 3, wherein the sizes of the different numerical apertures set by the adjustable aperture stop increase with corresponding increases in the zoom ratio *z* for the digital representation.

5. The variable-zoom imaging apparatus of claim 4, wherein the sizes of the different numerical apertures set by the adjustable aperture stop increases linearly with corresponding increases in the zoom ratio *z* for the digital representation over a range of zoom ratios greater than 1.

6. The variable-zoom imaging apparatus of claim 4, wherein the numerical aperture *NA* for the image set by the adjustable aperture stop is given by $NA \propto \frac{\lambda}{2p\left(\frac{z_{max}}{z}\right)}$, where p is a maximum lateral dimension of a detector element and Σ is a central wavelength in light used to form the image on the detector.

7. The variable-zoom imaging apparatus of claim 4, wherein the digital representation comprises at least one intensity value at each pixel in an N_1 by N_2 array of pixels, where N_1 and N_2 are positive integers.

8. The variable-zoom imaging apparatus of claim 7, wherein N_1 and N_2 are each greater than or equal to 400.

9. The variable-zoom imaging apparatus of claim 7, wherein the array of detector elements for the electronic detector comprise an array at least as large as an $M \cdot N_1$ by $M \cdot N_2$ array, where M is a positive integer greater than or equal to z_{max}.

10. The variable-zoom imaging apparatus of claim 9, wherein z_{max} is greater than or equal to 3.

11. The variable-zoom imaging apparatus of claim 9, wherein the image processing circuitry produces the digital representation with a zoom ratio *z* by determining the intensity value for

each pixel in the N_1 by N_2 array from one or more of the signals from the detector elements in a corresponding sub-array of M/z by M/z of detector elements.

12. The variable-zoom imaging apparatus of claim 11, wherein the image processing circuitry produces the digital representation with a zoom ratio z by determining the intensity value for each pixel in the N_1 by N_2 array from only one of the signals from the detector elements in the corresponding sub-array of M/z by M/z of detector elements.

13. The variable-zoom imaging apparatus of claim 11, wherein the image processing circuitry produces the digital representation with a zoom ratio z by determining the intensity value for each pixel in the N_1 by N_2 array from a weighted average of the signals from the detector elements in the corresponding sub-array of M/z by M/z of detector elements.

14. The variable-zoom imaging apparatus of claim 11, wherein the sub-arrays of detector elements corresponding to the pixels in the digital representation are repetitively spaced from one another within the field area spanned by the detector elements to produce the digital representation.

15. The variable-zoom imaging apparatus of claim 7, wherein the image processing circuitry produces the digital representation with a zoom ratio z by determining the intensity value for each pixel in the N_1 by N_2 array from one or more of the signals from the detector elements in a corresponding sub-array of one or more detector elements, wherein the number of detector elements in each of the corresponding sub-arrays decreases with the increasing numerical aperture NA adjustably set by the aperture stop.

16. The variable-zoom imaging apparatus of claim 1, wherein the imaging optics comprise a first set of optics to direct light from the object to a pupil defined by the aperture stop and a second set of optics to direct light from the pupil to image area.

17. The variable-zoom imaging apparatus of claim 1, further comprising interferometer components including a beam splitter and a reference surface, and wherein the light source is also configured to illuminate the reference surface and the beam splitter is configured to coherently combine light from the object and the reference surface so that the imaged formed by the imaging optics on the imaging area is an interferometric image.

18. The variable-zoom imaging apparatus of claim 1 wherein the light source is a coherent laser.

19. The variable-zoom imaging apparatus of claim 1, wherein the area of the array of detector elements is between 0.25 cm^2 and 10 cm^2.

20. The variable-zoom imaging apparatus of claim 1, wherein the minimum magnification is between 1/10 and 1/5.

21. The variable-zoom imaging apparatus of claim 1, wherein the minimum magnification is between ½ and 5.

22. The variable-zoom imaging apparatus of claim 1, wherein an area of the object area imaged onto the array of detector elements is between .04 cm^2 and 10,000 cm^2.

23. The variable-zoom imaging apparatus of claim 1, wherein the adjustable aperture stop is continuously adjustable.

24. The variable-zoom imaging apparatus of claim 1, wherein the adjustable aperture stop is discretely adjustable to each of a plurality of discrete settings.

25. The variable-zoom imaging apparatus of claim 1, wherein the adjustable aperture stop a mechanical aperture stop.

26. The variable-zoom imaging apparatus of claim 1, wherein the adjustable aperture stop is an electronic aperture stop.

27. The variable-zoom imaging apparatus of claim 1, further comprising a user-control interface configured to electronically adjust the adjustable aperture stop in response to a user-input for the zoom ratio.

28. The variable-zoom imaging apparatus of claim 27, wherein the user-control interface also causes the image control circuitry to set the magnification of the object by the detector in response to the user-input for the zoom ratio.

29. The variable-zoom imaging apparatus of claim 28, wherein image control circuitry is configured to set the magnification of the object by the detector by adjusting the sampling of the detector elements used to produce the digital representation.

30. The variable-zoom imaging apparatus of claim 1, where the aperture stop provides a nominally circular opening to define the numerical aperture.

31. The variable-zoom imaging apparatus of claim 1, where the aperture stop provides a nominally rectangular opening to define the numerical aperture.

32. The variable-zoom imaging apparatus of claim 1, wherein the imaging optics are not sufficiently large in diameter to pass all light ray trajectories from the object for a full field area of the object corresponding a full field area spanning all of the detector elements in the array when the adjustable aperture stop is set to the largest one of the plurality of different numerical apertures.

33. The variable-zoom imaging apparatus of claim 32, the imaging optics are sufficiently large in diameter to pass all light ray trajectories from the object for the full field area of the object when the adjustable aperture stop is set to the smallest one of the plurality of different numerical apertures.

34. The variable-zoom imaging apparatus of claim 1, wherein the imaging optics does produce a diffraction-limited image over a maximum-zoomed field area equal to an area of the full field area divided by z_{max} when the adjustable aperture stop is set to the largest one of the plurality of different numerical apertures.

35. The variable-zoom imaging apparatus of claim 34, wherein the imaging optics producing a diffraction-limited image for the numerical aperture NA over a given field of view in the image area ("FOV") means that the imaging optics can produce a feature in the image area with a spatial period d as small as $d = \frac{\lambda}{NA}$ anywhere in the FOV for coherent illumination.