CLAIMS

1. An apparatus for surface inspection, the apparatus comprising:

a terahertz emitter oriented to emit energy in a terahertz frequency range toward a surface and configured to rotate and move in a plurality of search patterns while emitting the energy in the terahertz frequency range, the surface having a surface layer disposed on the surface to be in proximity of a surface feature coupled to the surface;

a detector positioned to receive the energy in the terahertz frequency range from the terahertz emitter that is reflected by the surface; and

a computing device in signal receiving communication with the detector, wherein the computing device is configured to detect a geometry of the surface feature using a signal from the detector,

wherein:

the signal from the detector for detecting the geometry of the surface feature is based on the plurality of search patterns, and

the geometry of the surface feature comprises one of an edge and a center of the surface feature.

2. The apparatus of claim 1, wherein the computing device is configured to identify a location of the geometry of the surface feature using the signal from the detector.

3. The apparatus of claim 1, wherein the computing device is configured to identify a degradation of the surface proximal the surface feature using the signal from the detector.

4. The apparatus of claim 1, wherein the signal from the detector identifies at least one of:

a location at which energy in the terahertz frequency range is received by the detector;

a time of flight of the energy in the terahertz frequency range from the terahertz emitter to the detector;

a change in frequency of the energy in the terahertz frequency range;

an attenuation in the energy in the terahertz frequency range; and

a directional change in the energy in the terahertz frequency range.

5. The apparatus of claim 1, wherein the terahertz emitter comprises one of a single emitter and a plurality of emitters.

6. The apparatus of claim 1, wherein the computing device is configured to determine a state of the surface proximal the surface feature.

7. The apparatus of claim 1, wherein at least one of the terahertz emitter and the detector is coupled to an end effector of a robotic arm.

8. The apparatus of claim 1, where at least one of the terahertz emitter and the detector is coupled to a hand-operated system.

9. The apparatus of claim 1, wherein the computing device is further configured to detect a secondary surface feature of the surface feature.

10. The apparatus of claim 9, wherein:

the surface feature is a fastener; and

the secondary surface feature comprises one of a washer, a nut, and a collar.

11. The apparatus of claim 10, further comprising: a tool coupled to the end effector to interface with the surface feature and perform an operation on the secondary surface feature.

12. The apparatus of claim 11, wherein: the secondary surface feature is the nut; and the operation performed on the secondary surface feature comprises one of tightening, repositioning, and removing the secondary surface feature.

13. The apparatus of claim 1, further comprising: a tool coupled to the end effector to interface with the surface feature and perform an operation on the surface feature, wherein the operation performed on the surface feature comprises one of tightening, repositioning, and removing the surface feature.

14. A system for surface inspection, the system comprising:

a robotic arm;

an end effector coupled to a process end of the robotic arm;

an apparatus for surface inspection coupled to the end effector, wherein the apparatus comprises:

a terahertz emitter oriented to emit energy in a terahertz frequency range toward a surface and configured to rotate and move in a plurality of search patterns while emitting the energy in the terahertz frequency range, the surface having a surface layer disposed on the surface to be in a proximity of a surface feature; and

a detector positioned to receive the energy in the terahertz frequency range from the terahertz emitter that is reflected by the surface; and

a computing device in signal communication with the detector, wherein the computing device is configured to detect a geometry of the surface feature using a signal from the detector,

wherein:

the signal from the detector for detecting the geometry of the surface feature is based on the plurality of search patterns, and

the geometry of the surface feature comprises one of an edge and a center of the surface feature.

15. The system of claim 14, wherein the computing device is configured to align the apparatus for surface inspection with the surface feature.

16. The system of claim 14, wherein the surface layer comprises at least one of a sealant, a paint, and an adhesive.

17. The system of claim 14, wherein the robotic arm is attached to an independently positionable mobile device.

18. A method for surface inspection, the method comprising:

positioning an apparatus for surface inspection relative to a surface having a surface layer disposed on the surface;

emitting energy in a terahertz frequency range from the apparatus to impinge on the surface through the surface layer while rotating the apparatus and moving the apparatus in a plurality of search patterns;

detecting the energy in the terahertz frequency range reflected from the surface; and

detecting a geometry of a surface feature of the surface through the surface layer based on an analysis of the energy in the terahertz frequency range reflected from the surface,

wherein:

detecting the geometry of the surface feature is based on the plurality of search patterns, and

the geometry of the surface feature comprises one of an edge and a center of the surface feature.

19. The method of claim 18, further comprising: repositioning the apparatus for surface inspection to align with the surface feature; and detecting a state of the surface proximal the surface feature.

20. The method of claim 18, wherein the surface feature comprises a fastener.

21. The method of claim 20, further comprising: positioning a tool at the surface feature; and performing an operation on the fastener with the tool, wherein the operation performed on the fastener comprises one of tightening, repositioning, and removing the fastener.