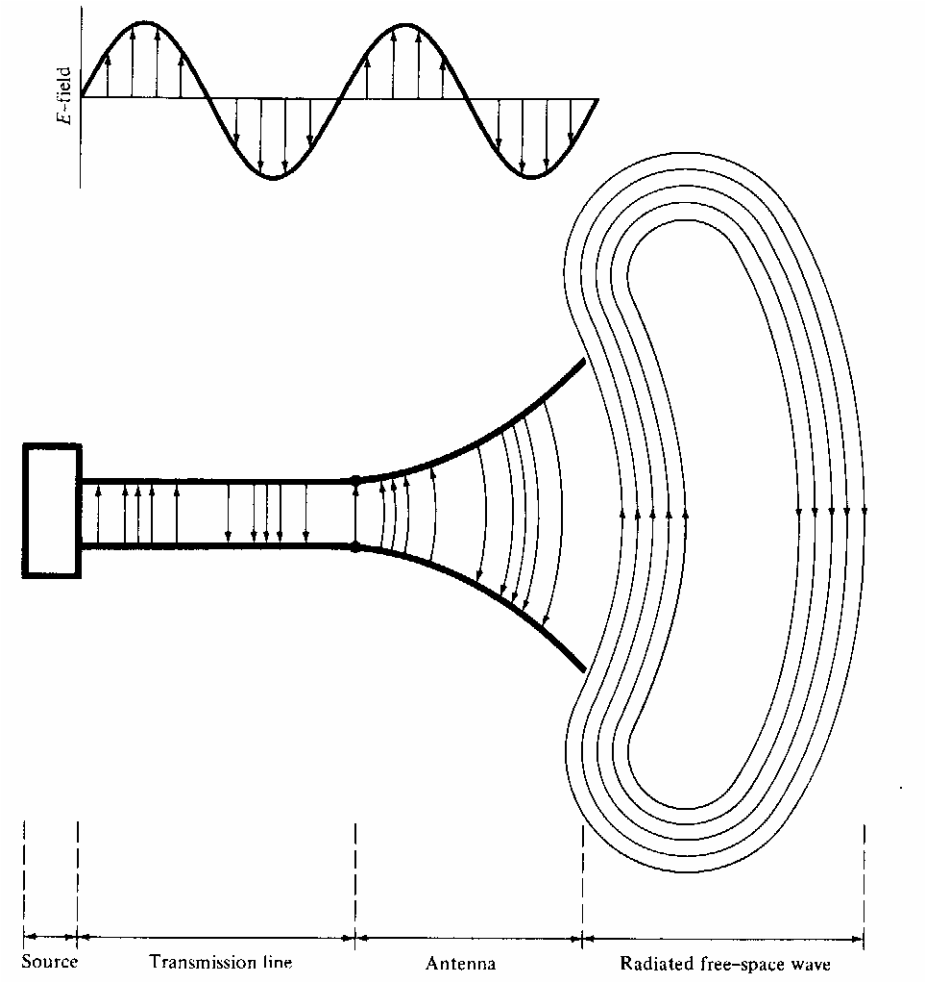
ANTENNAS

- Introduction
- Types
- Radiation mechanism
- Current distribution
- Historical advancement

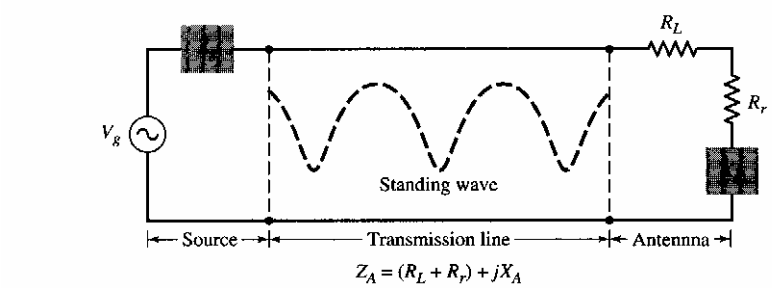
Definitions:

- A metallic device for radiating or receiving a radio wave.
- Means for radiating or receiving radio waves.
- A transitional structure between free space and a guiding device.

The antenna as a transitional device is demonstrated in the following figure.



The transmission line Thevenin's equivalent circuit of the antenna system, in the transmitting mode, is also shown below.

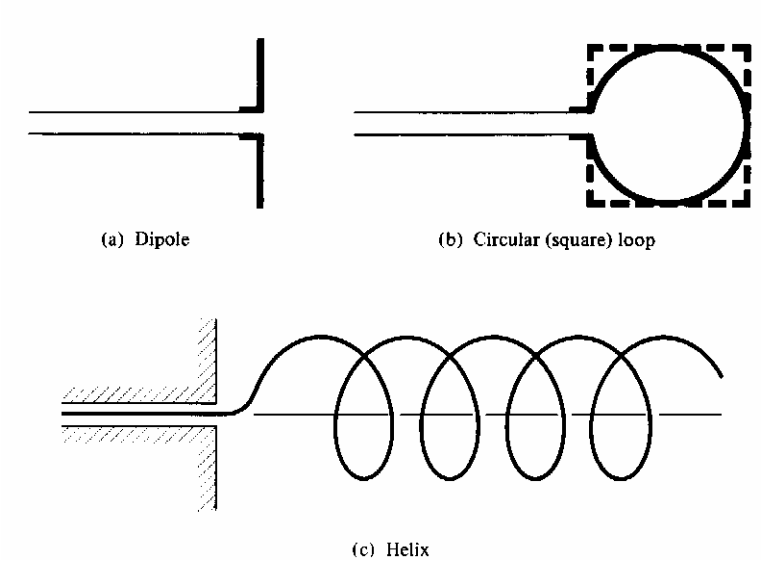


An antenna in an advance wireless communication system is required to optimize the radiation energy in some directions and suppress it in other directions.

Types of Antennas

Several classes of antennas have been developed over the years to be used at the different frequency ranges, and in different areas of applications. The different types of antennas are:

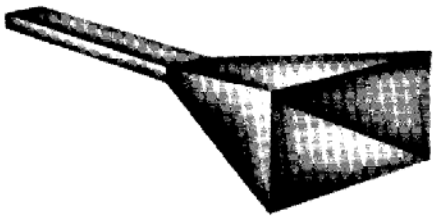
1. Wire Antennas



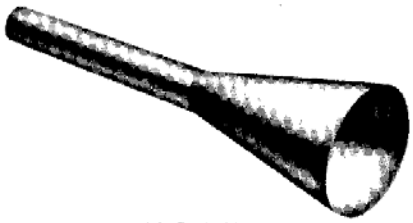
These are typical examples of wire antennas, which can be found in many applications such as on cars, buildings, ships,..etc.

2. Aperture Antennas

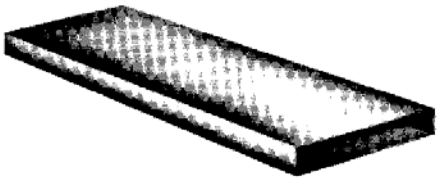
Aperture antennas became very popular due to the increase in frequency range of operation in the microwave range. Typical aperture antennas are the horn, the slot , and the open-ended waveguide.



(a) Pyramidal horn

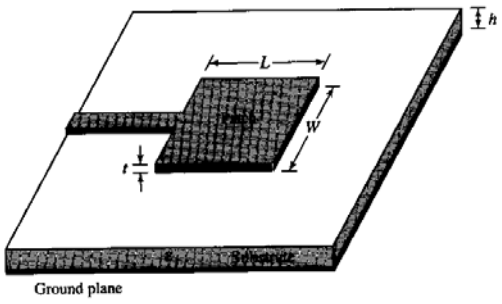


(b) Conical horn

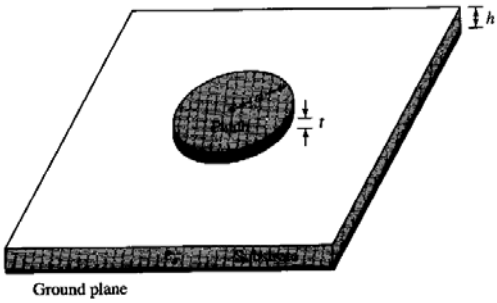


(c) Rectangular waveguide

3. Microstrip Antennas



(a) Rectangular

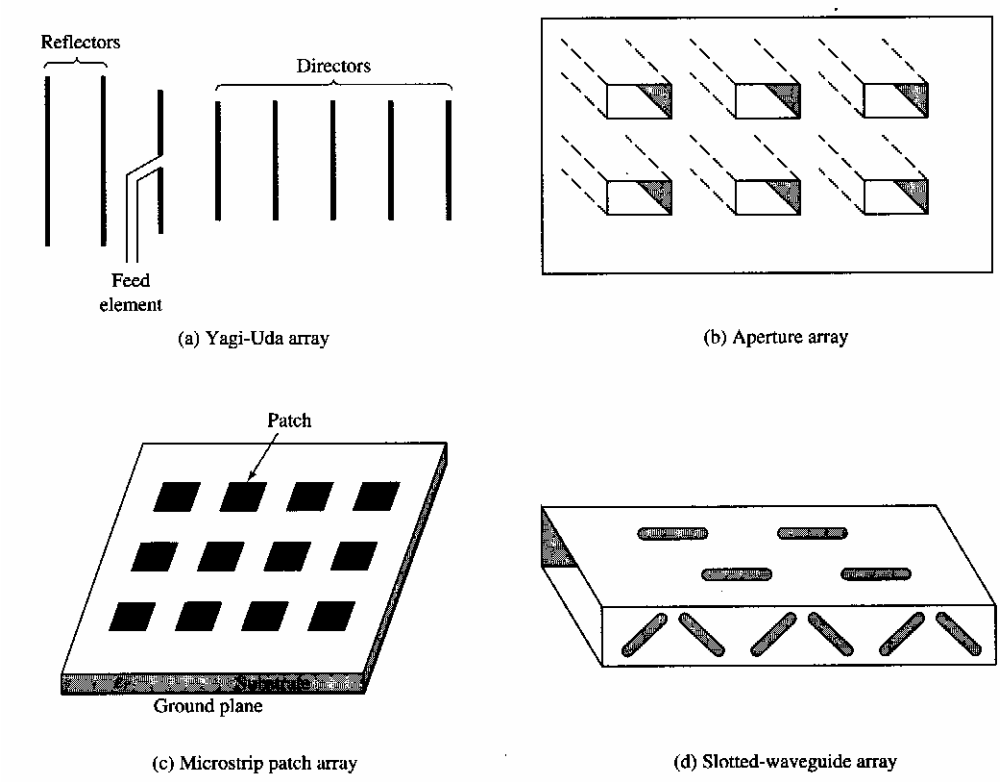


(b) Circular

Microstrip antennas became very popular in the last three decades. This is due to the advance of space explorations. They

have the advantages of being conformal, low profile, easy and cheap to manufacture.

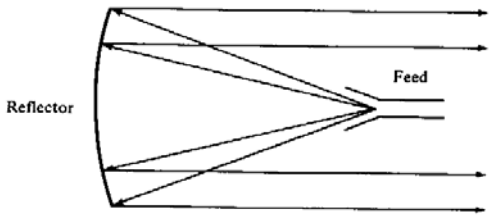
4. Array Antennas



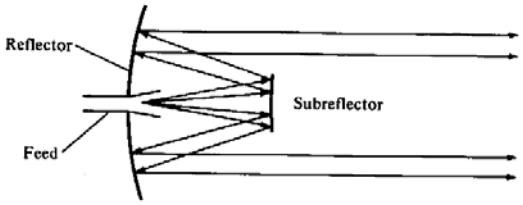
Many applications require radiation characteristics that may not be available by a single element. In this case, it is possible to use a collection of antenna elements in the form of an antenna array, to achieve the required radiation characteristics. The antenna elements may be similar or dissimilar. Example of antenna arrays are shown above.

5. Reflector Antennas

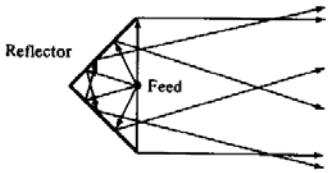
The need to communicate over great distances, such as the case of space exploration and satellite communication, resulted in the development of reflector antennas. The most common reflector antenna is the parabolic reflector shown.



(a) Parabolic reflector with front feed



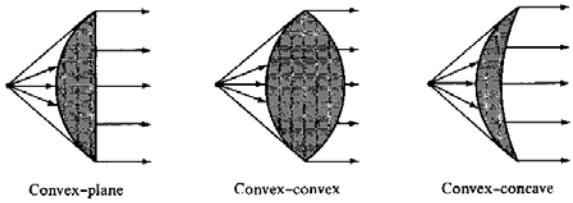
(b) Parabolic reflector with Cassegrain feed



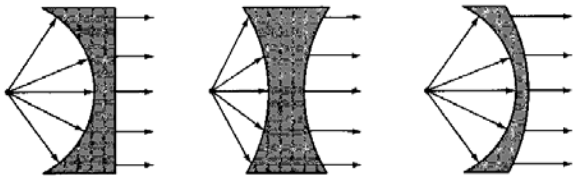
(c) Corner reflector

6. Lens Antennas

Lens antennas are used to collimate incident divergent energy to prevent it from spreading in undesired directions. Lens antennas help transforming of divergent energy to plane waves. They can be used in the same applications as reflector antennas at high frequencies. Their sizes become very large at lower frequencies.



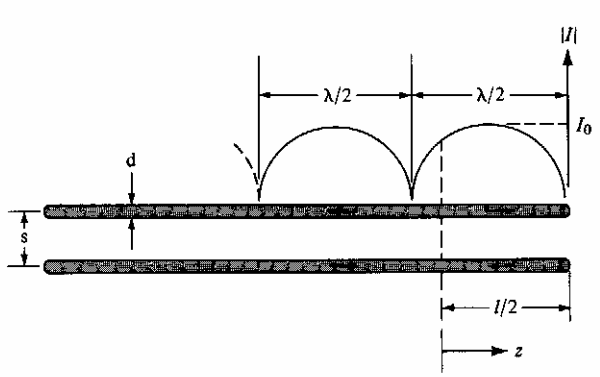
(a) Lens antennas with index of refraction $n > 1$



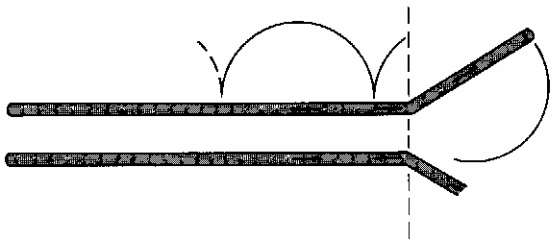
(b) Lens antennas with index of refraction $n < 1$

Current Distribution on a Thin Wire Antenna

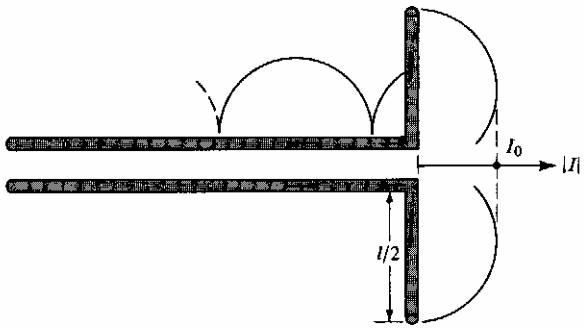
Current distribution on a lossless two-wire transmission line, flared transmission line, and linear dipole is shown in the following figure



(a) Two–wire transmission line

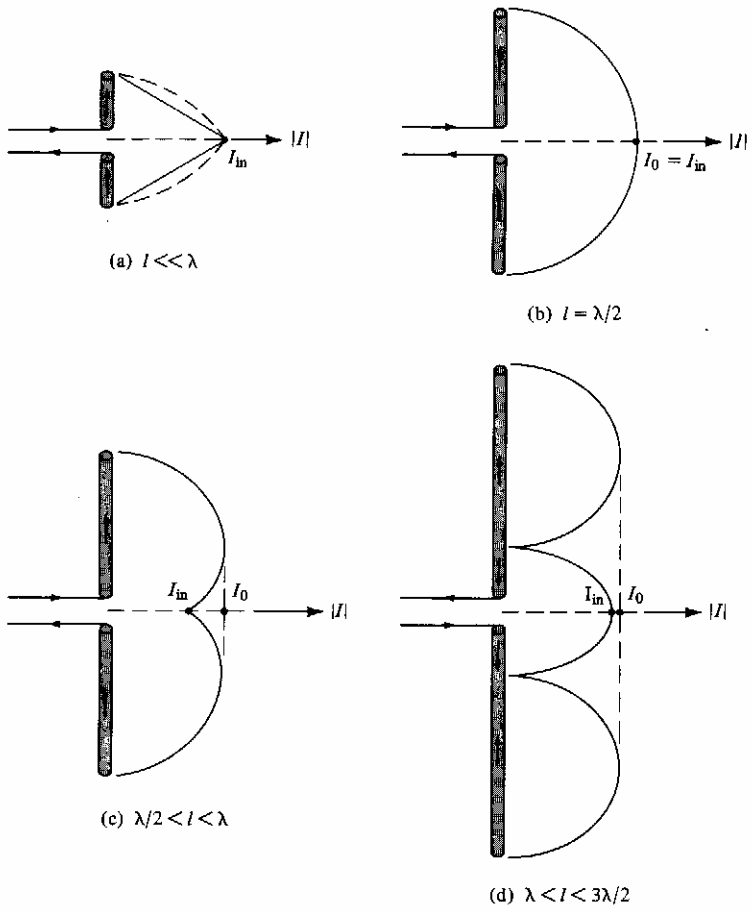


(b) Flared transmission line



(c) Linear dipole

The current patterns on a centre fed dipoles of length $l \square \lambda$, $l = \lambda/2, \lambda/2 < l < \lambda, and\ \lambda < l < 3\lambda/2$, are shown in the following figure.


|I|
I_{in}
(a) $l \ll \lambda$
|I|
$I_0 = I_{in}$
(b) $l = \lambda/2$
I_{in}
I_0
|I|
(c) $\lambda/2 < l < \lambda$
I_{in}
I_0
|I|
(d) $\lambda < l < 3\lambda/2$