1.1.1. Historical Perspective

- 2000 years ago: First usage of metal detectors to protect Chinese emperor, [Garrett, 2002].
- 1868 : First usage of simple metal detector by Saxby [Saxby, 1868]
- 1879 : Induction balance experiment (discovery) by D. Hughes [Hughes, 1879][1].
- 1881 : Graham Bell's proposal for detection of a bullet in President Garfield's body.
- 1882 : Experiments for detection of vein in the earth by G. Bell.
- 1887 : Experiments for detection of metallic masses in the human body by Dr. J. Girdner.
- 1890 : Attempt for measuring the earth conductivity[2] using telegrapher receiver.
- 1900 : Works for using the metal detector into the water by Captain McEvoy.
- ..... : Invention of an electric ore finder by George Hopkins.
- 1915 : Experiments for a bomb detection device with Maxwell-bridge circuit by M. C. Gutton [Gutton, 1915].
- 1922 : Termed "*Induction Balance for Detecting Metallic Bodies*" by U.S. Bureau of Standards.
- 1924 : Called *a radio detector* with beat frequency circuit was patented by Daniel Chilson.
- 1927 : First successful hunt with a radio detector (4 year governmental license for Panama)
- 1927 : The first metal detecting book[3] by R. J. Santschi.
- 1929 : Metalloscope (later on, M-Scope) patented by Gerhard Fisher.
- 1930 : A new N.A.C.A. detector for unexploded bombs by Theodore Theodorsen.
- 1935 : Invisible (magnetic) gun detector for prisoner and a detector buried boxes behind walls on a campus
- 1939 : Treasure finder using the Chilson bridge circuit of beat frequency by Harry Fore.
- WWII : High demand for mine detectors
- 1941 : A new model advantages in manufacturing by Polish forces.
- 1942 : Introduction of a frequency-modulated detectors.
- 1943 : Improvements on the beat-frequency metal locator circuit by William Blankmeyer.
- 1943 : Development of Wheatstone bridge circuit.
- 1946 : An electro-coupled zero-beat metal detector.
- 1960 : Metal detectors with transistors
- 1972 : Usage in airports
- 1987 : First microprocessor metal detector patent by Garrett Electronics.
- 1987 : First automatic ground tracking (balancing) gold detector (GT16000) by MineLab.

Historical development of the metal detectors is accelerated during the World Wars I and II. The sophisticated, handheld, low-power metal detectors were produced with integrated circuit revolution in the 1970s. The discrimination concept has also utilized after 1980s by using signal-processing techniques [Roberts, 1999].

The metal detection by the metal detectors are somehow possible, however discrimination (characterization) is problematic. Therefore, aim of the modern detectors should have identification and discrimination capability (operating content) and being operator independent (reliability).

The main desire of the metal detectors is high detection rate and low probability (low false alarm rate) of missing buried object. However, the critical drawback of classical metal detectors is high false alarm rate (up to 1000 per object, 999 from 1000) means low probability of detection due to

- Inhomogeneous conductive, dispersive and magnetic ($\mu_r > 1$) uncooperative soils,
- Harmless (innocuous) metal objects (clutter, junk),
- Low metal content of objects such as mines,
- Some rocks or voids in the soil.

Therefore, discrimination and identification abilities of the detector are decreased. A sure classification for depth, size, shape and material is not fully possible.

Some deficiencies (difficulties) of classical (single frequency) system:

- Tonal change based detection can cause false interpretation by operator (especially for multi-targets),
- 3D picture of the object cannot be obtained at single operational frequency,
- Depth scanning limitation due to single operational frequency (skin depth),
- Sensitive to all metallic clutters causes discrimination problems (Faking response from different objects),

[1] He was also known as an inventor of carbon microphones.
[2] This is generally taken as $\sigma = 25$ mS/m.
[3] Modern Divining Rods: The Construction and Operation of Electrical Treasure Finders, 1927, 1928, 1931, 1939.

- Limited discrimination ability due to sensitivity to ground mineralization,
- Limited bandwidth,
- Co-located,
- Unwanted effect of height variations and not equal range steps of the search head.
- System does not have an automatic recognition algorithm.