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著者(和文)	MD.ABDUR RAHMAN
Author(English)	ABDUR MD. RAHMAN
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（ 要　旨 ）

Wireless technologies have reached a zenith point in last decade. Applications of different handheld wireless devices are increased in every sector. Thus radio frequency (RF) surveillance is becoming more important to protect the right of primary users as well as various civilian and military applications for regulatory purposes. Nowadays natural and manmade disasters have increased to an alarming state. Recent earthquakes, tsunamis and terrorist attacks took hundreds of thousands human lives. Usually, most of the causalities occur after the disaster, due to the delay and no coordination among different first responders and rescue teams. These problems are observed in Indian Ocean earthquake and Bali Tsunami, Haiti earthquake, London subway bombing, 9/11 terrorist attacks and many more. As almost all the rescue operators use handheld wireless radios, it is possible to develop a cooperative database to share among the stakeholders. In view of that, a database can be created by radio surveillance in the disaster area.

In such disaster scenario precise and efficient estimation of the RF parameters with effective signal processing techniques are necessary to detect the presence of different first responders and rescue teams. Blindness of the receivers about the transmitted signals made the problem more challenging. This dissertation proposes the design and implementation of an RF surveillance system for emergency communications termed as wireless disaster area emergency network (W-DAEN). A real-time database created with the PHY parameters collected by localized clusters can provide the desired interference avoidance and platform for interoperability. Additionally the proposed system can allow more rescue teams on the scene by introducing localized spectrum allocation for mobile rescue teams. Detection of carrier frequency, modulation schemes, symbol rate and other parameters is necessary for identification of the transmitters. In recent time, rescue teams from all over the world come to recover from big scale disasters. That increases the detection and classification space wider and more challenging.

However, for an automatic system, direct application of most of the currently available RF parameters detection techniques is restricted due to the limitations on practicability. During the investigation it has been found that, almost all existing automatic modulation classification (AMC) algorithms are rather restricted in practice. AMC algorithms can be divided in two broad categories: 1) decision theoretic approaches (DTAs) and 2) feature based approaches (FBAs). DTA based algorithms makes the optimal classification decision by utilizing the maximum likelihood (ML) criterion. But these techniques require complex signal processing and hence not suitable for real time implementation. On the contrary, FBA

algorithms make decision based on unique features extracted from the received signals. Although it does not produce optimal performance, these techniques are less complex and quite easy to implement. Still most of available FBA algorithms lack the consideration and discussion of pre-processing like carrier frequency offset (CFO), SNR and symbol rate estimations. In reality CFO rotates the signal constellation for digital modulation schemes, hence make it impossible to detect correctly. Whereas, lower SNR affects the quality of distinguishable unique signature called features of the received signals. In result the probability of misclassification increases for low SNR signals. In addition to that, if the segment under consideration does not contain enough symbols, the extracted feature may become erroneous and result in misclassifications.

Motivated by this, a feature based AMC algorithm for eight basic analog and digital modulation schemes AM, FM, ASK, FSK, BPSK, QPSK, □/4-QPSK, MSK (mostly used by emergency radios) has been developed in this dissertation. Presence of the signal is detected by energy detection while CFO estimation of the intermediate frequency (IF) signal has been performed by using an autocorrelation based technique. SNR and symbol rate estimation is made by empirical mode decomposition (EMD) based algorithms. The received data are divided into several non-overlapping segments, and the classification is done on each segment simultaneously to make the final decision by voting over multiple segments. Proposed algorithm ensures the robustness of the classification system against the variation of SNR and symbol rates by using a machine learning algorithm. SNR has been improved by employing a data driven de-noising technique. Hence the system is able to perform acceptable classification in the lower SNR (0 dB) region. Symbol rate is detected by using an EMD based algorithm. Sample size and symbols per segment has been determined by this information. Threshold for the unique feature are calculated for different SNR steps with varying symbol rate. This multilevel decision tree has improved the classification performance to near optimal solution. Simulations and experiments has shown more that 90% correct classification at 0dB SNR. The performance increases to more that 95% in 6dB and about100% after 9 dB SNR signals. Finally, a test bed has also been developed for the proposed W-DAEN system with the novel AMC algorithm by utilizing the software defined radio (SDR) tools (i.e. GNU radio, USRP) and mostly open-source software (Python, PHP, MySQL etc.).