CHAPTER -1-
INTRODUCTION

Fire safety is important throughout the lifetime of a plant, from design to construction and commissioning throughout plant operation and in decommissioning. Requirements for fire safety in the operation of Nuclear Power Plants (NPPs) are established in an IAEA Safety Requirements publication [1]. The integrity of the cables located in a cable spreading room in NPPs is very important in the Fire Protection system, since the CDF (core damage frequency) and CCDP (conditional core damage probability) may be changed according to the results of a cable integrity assessment that depends on the upper layer gas temperature and flame height[2].

The work focuses on the fire modeling tools and using one of them for simulating fire in the cable spreading room in NPPs [3], since they could simulate the fire growth, determine the survive ability of components, structures and cables as well as predict ability within the fire areas of concern, and finally make the fire protection simulation results more realistic. Fire modeling can determine the temperatures that the safe shutdown equipment and cables in the fire area are exposed to as a result of a postulated fire in the fire area [4].

There are many fire modeling tools that could be applied in NPPs and each has its own distinct advantages, disadvantages, and limitations. Zone and field models [5] are most ordinarily used as fire modeling tools. Zone models vary in their capabilities and limitations, but typically have common features and capabilities in many regards. Zone models are applicable on on-rectangular compartments as well as relatively simple fire compartments. They have their own advantages that it takes less time to simulate a fire than the field models and it is easily applicable on relatively small rectangular areas like cable spreading or pump rooms. In general, zone models are commonly applied to the analysis of nuclear power plant fire scenarios in fire PSA[6]. In this thesis, CFAST [7] as zone model is used, since, it was developed to support the general fire protection community. It has many advantages such as, it is intended to predict the temperatures, gas concentrations and smoke layer heights in a one or multi-compartment structure during a postulated fire. The zone model approach that is implemented by the software tracks the energy and mass transfer in the building that is the result of a defined fire. The software is used to estimate the timing of specific events in the building fire performance: detector activation time, sprinkler activation, and flashover.

The main target of this work is to detect fire in Cable Spreading Room (CSR) of NPPs. The fire modeling CFAST is used to simulate fire in the room. The results from the simulation show that the response of the smoke detector in the room is very high, which very dangers for the cables and the systems in the room. Mechanical ventilation [8] is used for reduced the smoke and the temperature of the room after the smoke detector detected fire. It is a suggested step for fire protection in NPPs. In this study, the descending of smoke layer, temperature of the room and output fire gases under different fire sizes, extraction air flow rates of make-up air supply will be discussed. The results estimated based on a self-suggested for running CFAST two-layer zone model with differnt air flow rates for Mechanical ventilation [8].

Conventional point smoke and fire detectors are widely used in buildings. They typically detect the presence of certain particles generated by smoke and fire by ionization or photometry. Alarm is not issued unless particles reach the sensors to activate them. Therefore, they cannot be used for fast fire detection as it required in NPPs building. Video based fire detection systems can be useful to detect fire in them. The strength of using video in fire detection makes it possible to serve large and open spaces. In addition, closed circuit television (CCTV) surveillance systems are currently installed in various NPPs places monitoring indoors and outdoors. Such systems may gain an early fire detection capability with the use of fire detection software processing the outputs of CCTV cameras in real time.

Image and video content understanding and analysis methods have been studied by many researchers including [9,10]. Content-based understanding methods have to be designed according to the specific application. Fire detection in video is such an application that needs specific methods. There are several video based fire and flame detection algorithms in the literature [11]. These methods make use of various visual signatures including color, motion and geometry of fire regions. Healey et al.[10] use only color clues for fire detection. Phillips et al.[9] use pixel colors and their temporal variations. Chen et al.[11] utilize a change detection scheme to detect flicker in fire regions. In Fast COM Technology [12] Fast Fourier Transforms (FFT) of temporal object boundary pixels are computed to detect peaks in Fourier domain. Liu and Ahuja [12] also represent the shapes of fire regions in Fourier domain. An important weakness of Fourier domain methods is that flame flicker is not purely sinusoidal but random. Therefore, it is hard to detect peaks in FFT plots. In addition, Fourier Transform does not carry any time information. In order to make FFT also carry time information, they have to be computed in windows of data. Hence, temporal window size is very important for detection. If the window size is too long, then one may not observe peakiness in the FFT data. If it is too short, then one may completely miss cycles and therefore no peaks can be observed in the Fourier domain. The new hybrid fire detection algorithm includes recognition of evolving region shapes. There has been an enormous amount of literature related to static shape analysis. A survey can be found in [11]. The work implemented in this study is more relevant to work on modeling and recognition of deformable shapes/objects [12,13]. These methods implicitly assume all shapes have to be observed before learning the subspace or the manifold. Thus, they are very likely to fail to recognize objects with stochastic appearances, such as fire. The shapes of fires with different burning materials could be of a large degree of variability. These methods also do not have good representation in shapes, evolution and their learning.

Artificial Neural Networks (ANNs) [14] have advantage to other artificial learning methods, since they are able to deal with several data types. The back-propagation (BP) algorithm is one of the most common supervised training methods. The main attribute, which distinguishes BP from traditional econometric methods, is its ability to generate non-linear relationships between a vector of input variables and a dependent. Back-propagation also has the ability to model any complex system. Although BP training has proven to be efficient in many applications, its convergence tends to be slow, and yields to sub optimal solutions since it converges to local minima. Attempts to speed up training and reduce convergence to local minima have been made in many contexts of gradient descent. The major algorithms are based on adapting the weights, learning rate, step size and bias to dynamically adapt BP algorithm during its training cycle. There are a number of review papers in this area (for example, [14]), as well as methodology studies [15,16].

A new hybrid fast video real time fire detection algorithm is proposed by optimizing two back propagation algorithms to detect fire in the CSR as early as possible. Each algorithm is evaluated and benchmarked against other algorithms. Comparison between the results of modeling and detection are also presented. The propsed hybrid algorithm uses the available CCD systems [9]. Robustness and reliability are achieved using the proposed algorithm. . The work is based on the characterization and detection of smoke observable from low quality fixed video surveillance, set at a distance from the potential fire location. The method is independent to atmospheric conditions at the time of filming—temperature, wind speed, wind direction and the time of the day.

The detection of more than one minimizer can be achieved by modifying the objective function, so as to contain information concerning the position of the previously detected minimizers, in its new form. In the context of Goldstein and Price, they proposed an efficient algorithm for the minimization of algebraic functions, which exploits higher order derivatives of the involved polynomials [17]. The technique was later generalized for nonpolynomial problems using a transformation, which involves the Hessian of the objective function. However, the numerical, computation of the Hessian is not always feasible and in any case, it is computationally expensive. Thus, in its general