International Journal of Electronics Engineering (ISSN: 0973-7383)
Volume 11 • Issue 1 pp. 14-31 Jan 2019-June 2019 www.csjournals.com

Emotional Intelligence for Cognitive Internet of Things

Mehamed Ahmed Abdurahman[1], Chirag Patel[2]
[1]PhD Research Scholar, Faculty of Engineering and Technology / SCE Department, PIET, Parul University, Limda, WaghodiyaVadodara-391760, Gujarat-India, Affiliated University, Aksum University, Tigray, Ethiopia
[2] Research Guide, Associate professor,Parul Institute of Technology- CE Department, PIT, Parul University, Limda, Waghodiya, Vadodara-391760, Gujarat-Indi

Abstract

Despite the rapid growth of IoT, in the field of modern intelligent service, the current IoT based systems significantly lacks cognitive intelligence this implies cannot fulfill the requirements for industrial services. Due to gradual enrichment in IoT technology for smart environment, Technology disruptions and degradation of performance in the industries.
Deep learning is become one of the most popular technique that takes place in many machine learning related applications and studies. As per the rigorous theoretical and practical analysis, it has been found that an immediate need to address this issue by developing an emotional intelligent approach, Machine learning (deep learning) which will empower IoT into the level of CIoT.
In this study, we aimed to construct a CNN model based emotional intelligence System (EIS), in order to automatically classify expressions presented in Facial Expression Recognition (FER2013) and kaggel image database. Our presented model achieved a success rate of 81.1%.

Keywords: Convolution Neural Networks, Deep Learning, Emotional Intelligence, Facial Expression Recognition, Smart Environment.

1. INTRODUCTION

Since the time human beings start to live in this world, the globe has been gradually changed in several things. For instance, due to the interaction of humans with their environments some impact for this world, such as global warming has arisen. Thus, humans are experienced change of behaviors in response to the change of the environment where they live. Human behavior can be determined from their body expressions, such us their facial and verbal expressions and change behaviors can be observed from different parts of their body. For instance, human faces can constantly convey information and .Human can very easily and fastly interpret the information visually more than any other means such as hearing and touching.

Despite the advancement in IoT technology, for a machine, it is very difficult to do the similar kind of task in such a fast and accurate manner like humans used to do. Humans are able to make high level concepts and cognitive based on low level features, this what makes humans more intelligent and this is what the most difficult task for the machine to imitate. Further, in everyday life activities of humans, a huge volume of data is generated by multiple sources like transactions, social networks, mobile devices, sensor data etc., thus, the variety of different data sources, including data from different parts of humans, gathered via IoT such as cameras, sensors recorders and so on at a very high frequency in unknown and unpredictable ways.

The aptitude of people to recognize our own and other's moods is referred as emotional intelligence or quotient, and used to discriminate among several feelings and name them properly, as well as to use emotional information to controller thoughtful and behavior [1]. Such intelligence consists of the capability to recognize, direct, and have emotions, attached with the capability to regulate such emotions or feelings, bind them for profitable resolutions, and competently grip others emotions. It has been claimed that for measuring facets of success in life, the skills of EI to be a better predictor than IQ [2].

A. Brief description of the research topic

One of guarantees of emotional intelligence its capability to recognize emotion and or moods, and researchers believe that the first step of achieving emotion intelligence of machine is emotion recognition [3]. Human emotions or feelings could be detected from variety of sources, such as gesture movements, facial expression, voice or speech, text, etc.

When we consider Emotional Intelligence (E.I.), we rapidly relate it to the feelings and to the declaration of feelings. The enthusiastic knowledge is a kind of insight that wraps the abilities to comprehend and to impact the feelings. According [4], the enthusiastic insight is the limit of acknowledging and communicating the feeling, absorbing it to the idea, understanding and prevailing upon it and having the capacity to control it in you and in the others". For other authors, the emotional intelligence is associated to the perception and processing of emotions, since according to our life experience, we think and act according to stimulated emotions either by current or by past situations.

IoT is the next development of origination that is made by assistance of internet and smart thins or devices. The objects such as RFID or NFC, that are equipped with appropriate sensors and actuators and communication technologies referred as smart things, which by generating and consuming information try to support people in their life, such as in plummeting expenses and growing the optimization in any application areas. However, a novel mechanism to develop the cognitive to operate the IoT is still lacking. Smart things are not like personal computers; they are user independent to adjust them to innumerable circumstances; they could performance self-sufficiently so they have to organize themselves to their environment and deed properly to the measures that happened all over the place around them. Their prerequisites are appropriate sensors and actuators to make appropriate decisions to have the best reaction to what's going on around them [5].

IoT is a diverse and miscellaneous pervasive network, which has been extensively pragmatic in the field of modern intelligent service and has great potential and scenarios for modern intelligent service applications. In addition, there are abundant solicitations of Machine Learning, right from web page ranking to collective filtering to image or speech recognition. Machine Learning is putting its remarkable footsteps in every field say its medical, oil and gas, education, energy, weather forecasting, stock market etc everywhere is machine learning. With this footsteps, Machine Learning is not only changing the technology, but it's also impacting the life of a normal human. A normal human has now become a tech savvy person, a gadget man because of Machine Learning. However, the current IoT pointedly lacks intelligence which implies could not be adopted on the application requirement of industrial service. In addition, the current IoT is still based on traditional static architectures and models. It lacks enough modern intelligence services like emotion detection and couldn't obey with the growing request performance requirements for industries. By integrating emotional intelligence approaches into IoT, it can be design a new concept of Cognitive Internet of Things.

An IoT with cognitive capability can be referred as cognitive IoT and has accommodating tool which is cohesive to encourage performance and achieve brainpower. CIoT can apperceive existing network settings, evaluate the superficial information, make decisions, and accomplish adaptive activities, which aim to maximize network performance [6]. IoT can be painstaking as a universal network arrangement comprises of plentiful associated things that depend on information exchange, interconnecting, sensory, and information processing technologies [7].

Deep learning is the most noticeable techniques in machine learning, has attained its application in different fields such as image mining, text, speech, pattern recognition and so on with the representative purpose is to discover a mapping from input patterns to an output value. For instance, we have images of objects as input data (represented by pixel intensity values) and correct labels (one for every type of object) as corresponding output values. Thus the ambition of the technique is to learn or adopt this mapping (from the samples to the output value), and to be able to forecast the correct result of a new input sample [8].

From the above facts, it is obvious that machine intelligence needs to include emotional intelligence to develop a machine's ability, IoT based systems, to recognize the human affective state or behavior based on six physiological signals: happy, sad, disgust, depress, stress and anger. Emotional intelligence depict troublesome issues interesting to getting dependable full of feeling information and gather a vast arrangement of information from a subject attempting to inspire and encounter each of eight enthusiastic states of human behavior, day by day, over various weeks [6].

In general, emotional intelligence deals with a new world of ubiquitous computing devices, where physical environments interact intelligently and unobtrusively with people. These environments should be aware of people's needs, customizing requirements and forecasting behaviors [9]. Such environments can be diverse, such as homes, offices, meeting rooms, schools, hospitals, control centers, stores and classrooms. Statistics suggest that emotions play an important role in the learning process, and, thus, their detection can improve our understanding of the role they play [10]. For example, positive emotions can increase students' interest in learning, increase engagement in the classroom and make students happy. Generally, happy students are generally more motivated to accomplish their goals as compared students who have diverse types of emotions like sad, depress, disgust and anger.

B. Motivation

In many industrial applications, novel paradigms based on IoT services are evolving. However, today's industrial systems are facing various challenges, due to heterogeneous, mixed and uncertain ubiquitous network, the application prospect of which is extensive in the field of modern intelligent service, and discrepancies between service offering and application requirement. In line to this, the researchers believed that existing technologies and approach specifically, IoT, lack enough cognitive based intelligence and cannot achieve the expected enhancements and smart industry developments.

Human feeling or motions are practiced from different points of thoughtful. In most cases it is related with attitude, personality, behavior, and mood. and the analogous expressions emotions are vital requisites in human communications and they can be consider as tools for signing, guiding, consideration, inspiring and regulatory collaborations, condition impost and so on. The impost and assessment of emotional has newly fascinated the courtesy of several scholars from different areas. The studies on feeling or mood recognition involves of facial expressions, vocal or speech, body gesture and biological signal recognition etc. Now a day, among the factors of mood or emotion recognitions, facial mood or emotion expression or response is the latest and flourishing method preferred by the researchers. Thus, mood or emotion expression detection and recognition from humans is a vital research topic [11].

In pattern recognition, deep learning techniques have carried out very thriving, the digit recognition dataset of MNSIT one of the ample instance [12]. Our model configuration or setting is very analogous to the mission of digit recognition. That is equivalent to the digit labels we had labels of human mood or emotion. But mood or emotion recognition is plentiful difficult because digit images are so humbler than human face images. Furthermore the inconsistency in the images because of diverse personalities or identities impedes the performance. Human accuracy in facial expression emotional states identification or recognitions could not be better than digit recognition and could be also supported by different modes of information like context prior experience voice and speech among others [13].

The stipulations for information interchange, processing, and communications between objects should be well define, and the IoT technical standards and approaches need to be designed so as a high quality services could be provided. Therefore, the researcher motivated to design emotional intelligent system, with the desire to enhance the resource and infrastructures invested for smart environments, the CIoT based smart industries and its corresponding cognitive approaches with a novel deep learning approach, that offer stretchy and vigorous solution, which empowering novel level of flexibility and re-adjustability in the system by self-competences.

Therefore, the key inspiration of our effort is to build an Emotional Intelligence system, which has the potentiality to recognize and regulate the facial expressions or emotions of people in their social interaction. Thus, in the era of factual time judgment making process, this model will facilitate the industry people to track and regulate the real time feeling and behavior of their customer and employees.

C. Need for the research project

The proposed research project aims to embed emotional intelligence with machine intelligence in industrial environments to access the work habit of the employees and customers could make enhanced judgments about work performance of numerous tasks performed by the workers or experts. In addition to this, in this proposal, a novel approach has been introduced to create variety of policies to monitor the behavior of employees in the industrial environments. However, the proposed project also describes difficult issues which are unique for gaining consistent emotional facts and collecting a huge amount of data from a employee trying to provoke and experience each of six emotional states.

Furthermore, described in Fig.s: 1 (a & b), rigorous theoretical and practical analysis has been carried out to analyze and recognize different emotions from facial expression, particularly on the first six Human Emotional States or physiological signals of employees in industrial environments, which show challenging daily variations of employees' faces or emotions. The features of diverse feelings or reactions on the similar time be disposed to group more closely than do the features of the same feelings or reactions on different days. To overcome the daily deviations, a novel emotional intelligent approach, CIoT has been designed. Furthermore, the designed policies are not just restricted to monitor behavior of the workers in the industrial environments; it is easily applicable to stresses employees sitting in a multinational company which can be mentored and counseled by the manager of the company. Such emotional intelligence policies can be imitated to diverse environments like homes, offices, meeting rooms, hospitals, control centers, stores etc.

Fig. 1a: Different emotions are recognized from facial expression.

Fig. 1 b: The Six Human Emotional States

D. Scope and Statement of the problem

Despite its diverse and mixed pervasive network, IoT has been extensively applied in the area of recent intelligent provision and has great potential and prospects for modern intelligent service and applications. However, the current IoT pointedly deficiencies in intelligence which implies there is incapability to meet the application requirement of smart industries. In addition, the current IoT is still based on traditional static architectures and models.
According [11, 55-60], now day's deep learning techniques are used by scientists to resolve extremely real-world difficulties in all traits of business such as:

- Payment system such as Banks or business benefactors uses DL to detect doubtful dealings in actual time.
- Companies with huge data centers and computer networks use deep learning to excavate record files and detect intimidations.
- Machine manufacturers and fleet machinists use DL to excavate data from sensor to foretell some parts and machine failure.
- Deep learning helps organizations with huge and multifaceted supply chains prediction interruptions and thefts in production.

From the above facts, for IoT based systems it is obvious that machine intelligence needs to include emotional intelligence to develop a machine's ability, to recognize the human affective state or behavior based on six physiological signals: happy, sad, disgust, depress, stress and anger. Emotional intelligence depict troublesome issues interesting to getting dependable full of feeling information and gather a vast arrangement of information from a duties or subjects attempting to inspire and encounter each of the enthusiastic states of human behavior, day by day, over various weeks [6, 61].

In general, emotional intelligence deals with a new world of ubiquitous computing devices, where physical environments interact intelligently and unobtrusively with persons. Such surroundings need to be aware of person's needs, adapting desires and predicting feelings or behaviors [9]. Such surroundings could be various, such as class rooms, administrative offices, meeting rooms, homes, hospitals and stores. Statistics suggest that feelings show a crucial part over the learning process, and, thus, their detection can improve our performance of the role they play [10]. For example, positive emotions can increase peoples' interest in their daily activities, increase engagement in their working area and make employees happy. Generally, happy worker is more interested to undertake his/her duties as compared to others who have various types of emotions like sad, depress, disgust and anger.

Research on the prediction of specific emotions from the peoples' face detection, particularly employees' face detection, is in its early days, with very few studies reported in this area [14], and even fewer with focus on industries. As far as embedded emotional intelligence with IoT and deep learning is concerned, the primary focus depends on the prediction with deep learning of emotions relevant for learning or understanding from employees' emotional feedback in an industrial context, which to the best of our knowledge, yet has not been studied. To establish which feelings are more pertinent for learning or understanding, research evidences are used from previous studies. To investigate the prediction of the identified emotions from physiological signals, the experimentations were conducted with several preprocessing and machine learning techniques [15, 62].

To mention few of the benefits of deep learning methods are their capability to identify complex exchanges among structures or features, ability to acquire low-level of them from insignificantly managed raw facts, relaxed to work with extraordinary cardinality class associations and its capability to work with unlabeled data [11, 63].
Having done a profound research on the divergences between provision offering and requirement, the researchers believed that current IoT lacks adequate intelligence which implies cannot achieve the expected increasing performance. IoT has been extensively applied in smart environments including smart buildings, smart cities, smart homes, , smart transportation, smart health, and smart industry [5].

However, in the field of modern intelligent service, the current IoT based systems significantly lacks cognitive intelligence and cannot meet the industrial application requirement. Therefore, general objects in the IoT based systems need to acquire the ability to learn, to think, and to understand the physical and the social domains by themselves [6].

In a nutshell, IoT based systems are lack powerful emotional intelligent systems, as a result, they are suffering with performance evolution mechanism and Management systems.

This paper deals on the deep learning techniques used. It also compared and reviewed the diverse deep learning methods implemented by researchers in the prior years with their benefits, downsides and future works.

E. Objectives of the study

The overall objective is to design emotional Intelligence system that supports to enhance IoT based Industry that could help in monitoring, controlling emotion of the employees and improves the performances. In the light of above, the specific objectives of this study can be listed as:
Specific Objectives

1.1. Collecting facial expression image dataset.
1.2. Organizing and Preparing image dataset.
1.3. Designing our model and evaluate the performance.
1.4. Identifying the possible DL methods and compare the performance of each.
1.5. Selecting the appropriate method those are best fit for emotional Intelligence system.

In a nutshell, this paper proposed EIS based model which is capable of detecting and tracking the emotion in humans in the environment.

In order to achieve the above objectives, and understand current Industry environment scenario practically, image datasets of different categories of humans has been taken and analyzed, following methods were applied.
In order to verify the key findings, several sub domains were subsequently visited. Dataset Images of people has been taken, including Managers, employees and customers.
During the collection of image dataset, pre-process images from the internet were also used, for example, images of people in different modes and emotional states from various fields of working environments. Furthermore, for verification purpose employees and customers' image datasets were gathered from in production rooms, product sells rooms, control rooms and data center rooms in real time Industry in Ethiopia.

The findings confirmed that proposed system like any advanced system had not been utilized on general Industry sites or in any manufacturing and industry services. Further, from these findings, it is believed the proposed system has the possible in improving, monitoring and controlling the performance of the industry environments.

2. METHODOLOGY AND PROPOSED MODEL

Facial or emotional expressions are vital clues for non-verbal communications and social interactions among human beings. It is merely conceivable since people are intelligent to identify moods pretty accurately and efficiently. Thus, an automatic facial mood or emotion recognition model is a vital module in the interaction of humans with machines. Rather than the commercial uses of such system it would be advantageous to integrate some clues as of the biotic neural system in our model and use this model to improve supplementary perceptions into the cognitive or intellectual processing capability of human brain.

In this study, a DL based model for enhancing the performance of IoT based systems that detect the human emotional state is proposed. The model allows data harvested by IoT devices to be used for detecting employee emotional states and evaluate the performance accordingly.
The machine is learning the police of industry and correlates the performance with the emotion of employees.

A. Proposed model

Motivated by the above mentioned fact, the proposed work aims to embed emotional intelligence with machine intelligence in industrial environments to access the essential working condition of employees, and behavior of employees of the industry in making better decisions about correlations of emotional states and the performance. In addition to this, in this proposal, a novel approach has been introduced to create variety of policies to track the emotion and monitor the behavior of employees in the industry environments. However, the proposed project also describes difficult issues which are unique for gaining trustworthy emotional data and collecting a huge set of image data from employees trying to elicit and experience each of six emotional states as described in the first section of the introduction part of the proposal.

Furthermore, the rigorous theoretical and practical analysis to be carried out to analyze six physiological signals, see Fig.. 1 b, of employees in industry environments which exhibit a problematic day-to-day variation of employee faces or facial expression that helps to detect and interpret the emotions. There is sufficient indication that our architecture of visual processing is structured in diverse stages. Every stage changes the input in a way that helps the visual task to be carried out. Additional attractive feature of DL models is that there could be sharing of feature and/ or sub-feature. Computationally also, it has been shown that inadequately deeper architectures could be exponentially ineffective. Deep Learning was revolutionized by [12] when they came up with a very efficient method for training multilayer neural networks [13].

B. Deep learning models and techniques

DL is an evolving branch of supervised learning methods or approaches in Machine Learning [8]. For example, in neural network, for a given neuron, the activation or triggering function is applied on the deep layers to extract the abstractions from voluminous data. This is similar to a hierarchical structure where deep learning models are applied [16]. In the research domain, DL is a very promising and evolving area. DL has many highly developed algorithmic models such as, Recursive Auto-Encoders or Restricted Boltzmann Machines, Deep Belief Networks, Convolution Neural Networks and Deep Boltzmann Machines [17][45].

Generally, DL models are applied to the huge volume of unsupervised data generated by IoT devices, to automate the extraction from data. DL has combined with allied domains such as artificial intelligence, which simulate the human brain function to analyze, learn and extract the meaningful insights from the data gathered. The research works addressed towards this challenge, has been a key objective to develop DL algorithmic models [18, 51].

Real time emotion recognition by means of deep learning technique is the hot research area. Thus, researchers using DL techniques could build improved representations and construct advanced models to acquire these features or representations from huge-scale unlabeled data. To mention the most popular techniques of deep learning like CNNs, DBMs, DBNs, RNNs and SAE are useful to hands-on applications like pattern analysis, audio recognition, computer vision, natural language processing, for driver assistance like landmark identification, automatic speech recognition and, image recognition, speech or voice recognition and translation, customer association management, and life sciences where they produce challenging results on various tasks [11, 52-55].

However, how can machine learning or deep learning algorithms be applied to IoT smart data? And what is the taxonomy of machine learning or deep learning algorithms that can be adopted in IoT are still some research works as future directions.

In this study, it is proposed an integration of IoT with IPS and Deep learning based model which helps industry to observe its employees emotion on their day-to-day and to predict the effectiveness and efficiencies upon their performance rather than relying on personal views of their higher authorities of the industries. The main concept is to take judgments regarding the performance of employees using data gathered by industrial IoT devices integrated with the new approach. Here the word ‘decision’ refers to the action taken in response to the performance of employees.

Even though such kind of emotional intelligence based decision in use in industrial environment is dependent, but this work assumes that the decision is to be taken for the selection of penalty and /or reward schemes upon the employee’s enactment or performance. The decision to be taken should be based clue by the proposed model using different deep learning algorithms. The learning skill of this model provides capabilities of cognitive to IoT in the industry. Hence, the decision taken by our approach, integration of IPS and Deep learning models with IoT is referred as ‘cognitive decision’.

The proposed model collects information and his/her emotional states of every person in the industry. DCB is responsible for translation of raw data of the IoT to meaning full information and is the central module of proposed model. Database system is responsible for storing complete data of the industry.

C. Technologies and Architecture

Although several works have been conducted toward smart manufacturing industries, most of them have not come up with the benchmarks to achieve these prerequisites for cognition/smartness. Besides, previous works ordinarily supposed static and prior planning and prediction for industrial processes, and therefore could not accommodate enthusiastically changing environment [24].

Therefore, by effectively integrating the operational process of human cognition into the design of IoT and presenting detailed expositions of cognitive processing procedures that lie at the sentiment of CIoT [15]. Thus, an architectural framework should be build based on Ashton's visionary insights and enhance them by empower general objects to learn, think, and understand physical and social worlds by themselves. Introducing such framework for cognition into the engineering applications of IoT, a wide spectrum of tasks can be performed with minimal human intervention, plays a crucial role to realize the goals of developing a smart Manufacturing [25].

Consequently, to bridge the physical world (with objects, resources, etc.) and the social world (with human demand, social behavior, etc.), and enhance smart resource allocation, automatic network operation, and intelligent service provisioning scholars are continuously imagining to propose on framework of CIoT. For example, within the research field of IoT, efforts have been made on a particular sub-area called cognitive IoT (CIoT) [25], which aims to incorporate cognitive capability into the conventional IoT framework to some extent [19].

The conception of a dynamic cognitive capability called cognitive within dynamic system (CDS) [20, 21], provides guidelines to build cognition into IoT in a systematic way. Adopting human cognition as the frame of reference, CDS has the following five pillars: perception–action cycle, memory, attention, intelligence, and language. Inspired by the effectiveness of human cognition and with a synthetic methodology learning-by-understanding.

In reply to the prerequisite of incapacitating heterogynous technology several work proposed cognitive tools establish an competent method for tackling the issues due to heterogynous technology and attaining context awareness, consistency and energy adeptness, a lot of framework was proposed. For instance, a new management mechanism for big data, that enables the processing of data and the extraction of valuable knowledge from it, can be offered by employing cloud computing with the CIoT, was presented in [22]. In all these papers, the authors found the solutions and equilibrium status of the systems under consideration.

In [25], an operational framework of CIoT paradigm, that could be applied to various applications scenarios such as smart home, smart office (easy meeting), smart city (smart transportation) or smart business (supply chain management) and having five fundamental cognitive tasks, sequentially: 1) perception-action cycle;2)massive data nalytics;3) knowledge discovery and semantic derivation;4) Iintelligent decision-making; 5) and provisioning on demand service, has been proposed . A generic framework based on management cognitive for IoT was also proposed in [23].

An architecture to process images and videos to detect, track, and understand people's face, body, and activities was developed and distributed the technologies by the People Image Analysis (PIA) Consortium. The ranges of technologies onto which the Consortium emphases on includes face recognition, detection and tracking of humans, facial expression analysis, gait analysis, and activity recognition. The intention with this Consortium was to develop a complete set of image processing technologies, models, or approaches that outperform in the real-world surroundings [26]. The designed architecture is shown in the Fig. below which is appropriate for the image analysis, which is suitable with our model to detect the emotion of people.

International Journal of Electronics Engineering (ISSN: 0973-7383)
Volume 11 • Issue 1 pp. 14-31 Jan 2019-June 2019 www.csjournals.com

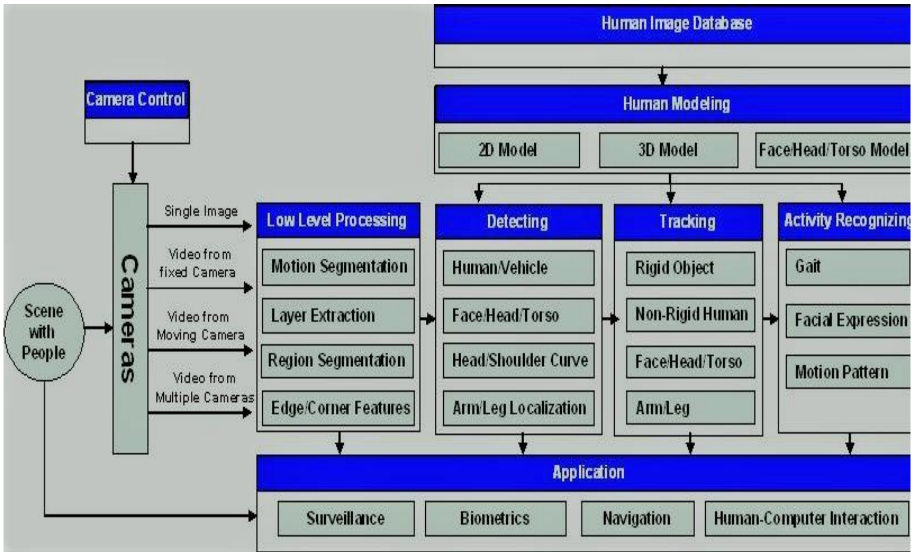

Fig. 2:Technologies and Architecture for Image Analysis [26]

D. Development tool identification

To achieve with our objective, the required tools and materials which are relevant for our study were selected and the methods and/or the methodologies to be used for and analysis has been decided.

- ✓As development tool, Python 3.6 using Anaconda IDE which has potential packages and libraries.
- ✓For constructing of our model, we were designing the model using CNN supported by Keras backend with TensorFlow.
- ✓Dataset preparation, Organizing and extracting the dataset, the facial expression image from the Cohn-Kanade database, were used with permission.

3. EXPERIMENTATION AND FINDINGS

A. Background

Facial or emotion expression and related changes in facial patterns give us clue regarding the mood state and help to regulate and track the social interaction with the other person. Moreover, these facial expressions support in thoughtful mood or feeling of people in a enhanced way. Thus, they play a crucial role in non-verbal message and interfaces of human's in their daily activities [27, 45].

Classification of facial expressions could be used as an effective tool in behavioral studies, in medical rehabilitation, in entertainments, in educations systems and so on. Facial expression investigation deals with recognizing and analyzing diverse facial motions and feature changes [28, 46]. For measuring the facial or emotional behavior, a coding system known as facial action coding system (FACS) was developed by [29, 47] and codes diverse facial actions into Action Units (AU) upon the fundamental muscular activity which harvests temporary changes in the facial expression. Thus, an expression can be further recognized by properly detecting the action unit or permutation of them in association to a specific expression.

Neural networks for classification of facial expressions have used by several researchers [30-38, 45]. Their enactment is subject to numerous aspects like the initial weights, training data, activation function, and structure of the network (number of neurons in the hidden layer) etc. In addition, the concept of Committee neural networks in which a huge amount of networks trained was developed by [39-43, 48-50]. These authors observed that a committee neural network system provides an improved performance when compared to a single network. The question remains if a committee or committees of neural networks trained on back-propagation can provide a sound accuracy with a close to 90 percent in classification of diverse expressions. The motive of our work was to address this question by evolving and assessing a committee neural network classification system to classify moods using static facial images.

B. Experimentations

To be able to recognize emotions on images and implement the system, we will use python platfor with its popular library OpenCV. For emotion recognition, OpenCV has a few classes known as facerecognizer that we can used also and different techniques could possibly be used, of which haarcascades xml files was the mostly used once [27].

Once you have the datasets from Kaggle with permission, extract it and look at the readme. It is organized into directories and sub-directories, which are consisting datasets of images, text and readme files of the datasets, with emotions preset as neutral, anger, contempt, disgust, fear, happy, sadness, surprise respectively, that resemble to the compassionate of emotion as shown in [28]. Accordingly, our work was organized as following:
First the dataset should be organized. In the directory we're working, we made two sub-directories named as emotion and images. Then the dataset should be extracted and stored in all directories consisting of the text in the sub-directory called emotion. Further, the sub-directories containing the image datasets in a directory called images and to retain our arranged emotion images we created a directory named arranged-list, having sub-directories for the emotion labels.

C. Image and Feature Extraction Processes

In order our classifier could work well, all the image datasets have only a face on them without clutter and be the same size. Actually, OpenCV offers four pre-trained HAAR cascaded classifiers, thus we noticed as various faces as possible and used most of these onto classification, and terminate the face exploration after we had got one. Therefore, we have been using HAAR filter from OpenCV library to automate face finding on each face image converting to grayscale, croping it and saving it to the image dataset. Furthermore, we should to extract have the pre-trained HAAR cascaded classifiers files in same sub-directory on which we put our python scripts. We created another sub-directory namely dataset, within it we created subdirectories for every emotion or mood in our practical works. The image dataset we could use would be reserved in these subdirectories. After that, it could be detected, cropped and saved the image or face for the same. To have all the work well performed, we wrote a small python snippet.

Humans may have one emotion expressions that can be counted more than once like the neutral, so we should cleaned the neutral sub-directory, because more than one neutral image of the similar people. Thus it could lead us to have biased of classifier on the unfairly accuracy, that is it could identify the similar person on another image or be triggered by other features rather than the mood showed.

Finally as it were mentioned the related work in [27], there are two kinds of parameters were extracted from the facial images persons such as, parameters of real valued and binary. Based on the measurement of the distance and the pixels number the real valued have to be defined. The binary measures refer to the presence as 1 or absence of feature as zero value. Thus, we had gotten 8 and 7 measures of real and binary respectively.

In order to decide the efficiency of classifying a confident emotion a certain parameters, were analyzed and those which did not deliver effective clue on the facial expression or emotion represented in the image were rejected and not castoff in the ultimate work. The ultimate choice of the parameters were motivated by the facial action coding system and used in this work and discussed in the following section as in [27].

Table 1: The parameters of real valued [27].

R#.	REAL VALUED PARAMETERS	THE DISTANCE BETWEEN THE
1	***Eyebrow raise distance***	Junction point of the upper and the lower eyelid and the lower central tip of the eyebrow
2	***Upper eyelid to eyebrow distance***	Upper eyelid and eyebrow surface

3	***Inter-eyebrow distance***	Lower central tips of both the eyebrows.
4	***Upper eyelid – lower eyelid distance***	Upper eyelid and lower eyelid
5	***Top lip thickness***	Measure of the thickness of the top lip.
6	***Lower lip thickness***	Measure of the thickness of the lower lip.
7	***Mouth width***	Tips of the lip corner
8	***Mouth opening***	Lower surface of top lip and upper surface of lower lip

The above real valued parameters on table 1are shown in Fig. 3 below [27].

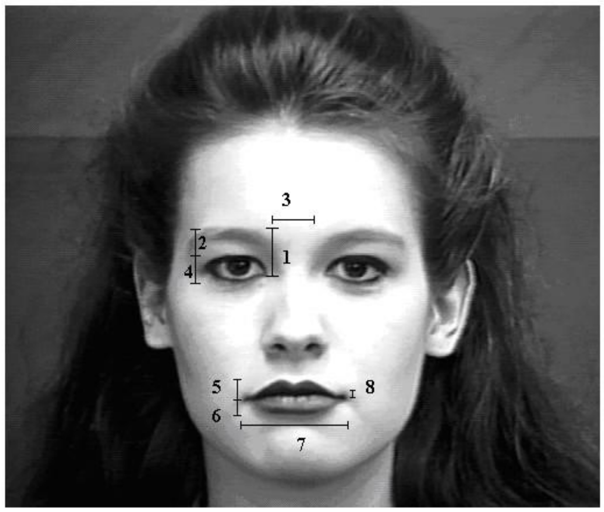

Fig. 3: Real-valued measures from a sample neutral expression image. (Facial expression image from the Cohn-Kanade database [27, 28]. Used with permission)

Table 2: Parameters of the binary [27].

R #.	Binary parameters	Presence or absence of
1	***Upper teeth visible***	Visibility of upper teeth
2	***Lower teeth visible***	Visibility of lower teeth
3	***Forehead lines***	Wrinkles in the upper part of the forehead
4	***Eyebrow lines***	Wrinkles in the region above the eyebrows
5	***Nose lines***	Wrinkles in the region between the eyebrows extending over the nose
6	***Chin lines***	Wrinkles or lines on the chin region just below the lower lip
7	***Nasolabial lines***	Thick lines on both sides of the nose extending down to the upper lip

The above binary parameters on table 2 are shown in Fig. 4.

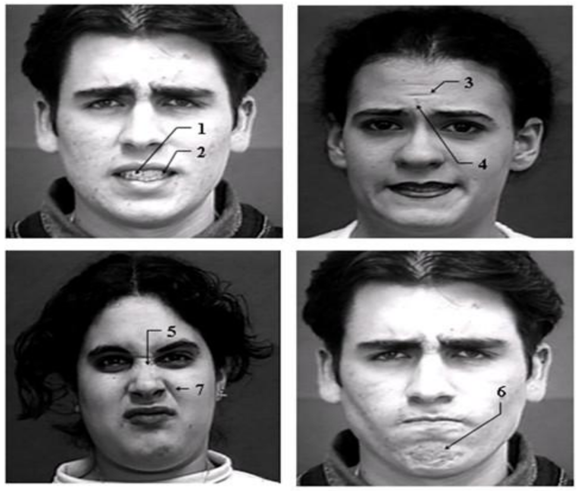

Fig. 4: Binary measures from sample expression images (Facial expression image from the Cohn-Kanade database [27,28]. Used with permission).

The distance between the numbers of pixels measured were specified as features expression and taken as the real valued parameters. In case of parameters concerning features which proportionally existed on the sides of the human face, middling of the dimensions were found and the measures were acquired for expressions with the neutral image. The parameters were then controlled in the following method:

$$\text{Normlizred Value} = \frac{\text{MeasuredValue} - \text{NeutralValue}}{\text{NeutralValue}} \quad \textbf{Eq. 1}$$

The extraction of most parameters carried out by automatic methods. The goal of our work was to assess the effectiveness of CNN. Thus, the determination was prepared to improve the automated methods.

In our study paper we investigated various techniques of edge detection. We found canny edge detector out performs better than the others. This is because, unlike the rest detectors on several facets, it performs better for noisy image, gives sharp edges , low probability of detecting false edges etc [12,44]. Therefore, to decide either a pattern of wrinkles occurred or nor that additional decided the binary feature was true=1 or false=0, a modest canny edge detector that is an OpenCV over python based was used.
Finally, the 8 real valued together with the 7 binary parameters were inputted to NN and The complete datasets were was distributed into three parts: for training data set, for initial testing, and for final evaluation.
Training of networks

To train our model, convolutional neural networks were trained to classify different expressions or emotions. The training the complete network was done using various number of hidden layers having alternating initial weights, number of neurons and transfer functions.

In this study, our NN had input neurons or nodes with equivalent parameters. Similarly, it had seven output nodes which resultant to one of the 7 FEs. A transfer function called the 'tansig' function was used, since the standardized input data was in the range of negative one to positive one. The result of the NN has to be in the range of zero to one. Thus, the "logsig" function was used as the transfer function for the output layer neurons. The results of the nodes were altered to a binary numbers of zero or one. For instance, the results like 0.55 or more were enforced to 1 and the results like 0.55 or less than were enforced to 0. Thus, the results with a value of 1 revealed that specific expressions were existing and the results with a value of 0 revealed that specific expressions were absent. We had examined various thresholds in the range of 0.5 to 0.95 and we got that the threshold of 0.55 had given improved results.

The networks were trained using Python with the modified version of back propagation method Levenberg-Marquardt known as trainlm technique. Our error box was set as 1/1010 epochs used for training varied with the minimum of 100 and the maximum of 1000.

4. FINDINGS AND DISCUSSION

Having implemented our model, in order to recognize facial expressions or emotions, we had collected and prepared custom images of people from industrial work environments. For the preparation of the images to predict the emotions, we wrote a small python script as follows
:

```
img = image.load_img("users/moha/sample-image.jpg", grayscale=True, target_size=(48, 48))

x = image.img_to_array(img)
x = np.expand_dims(x, axis = 0)

x /= 255
 sample = model.predict(x)
emotion_analysis(sample[0])

x = np.array(x, 'float32')
x = x.reshape([48, 48]);

plt.gray()
plt.imshow(x)
plt.show()
```

The human emotions of our work were labeled as , 'angry', ‘contempt’, 'disgust', 'fear', 'happy', 'sad', 'surprise', 'neutral' and stored as numerical as labeled from 0 to 6. Therefore, the scores these different emotion was produced using Keras with the backend of the tensorflow, as of an output array and also we could visualized each prediction using charts such as bar chart. Thus, for visualizations of the predictions of the emotions on the bar char was tested using the python script below:

```
def emotion_analysis(emotions):
objects = ('angry', 'disgust', 'fear', 'happy', 'sad', 'surprise', 'neutral')
y_pos = np.arange(len(objects))

plt.bar(y_pos, emotions, align='center', alpha=0.5)
plt.xticks(y_pos, objects)
plt.ylabel('percentage')
plt.title('emotion')

plt.show()
```

In the nutshell, from the collected and customized images, the following images of sample employee were taken for the testing purpose of the system. Accordingly, the randomly selected emotions like Happy, Sad, angry and neutral were tested and the results with their score displayed on the bar chart presented below.

1. **Happy mood**

From our test, it was found that the model can successfully recognize the emotions of employee from their facial expressions. For instance, it’s obvious that when an employ is rewarded of his or her best performance in his or her activities and achievements in the industrial environments, he or she became happy. Therefore, as it can be seen from the Fig. below, It seems that the model we’ve constructed can successfully recognize the emotion of the employee in happy mood.

Fig. 5: Happy mood

2. Sad mood

Once again, we had tested the scene of another person in any working environment. The person was badly disappointed at the punishment on his poor performance or lack of work ethics. Therefore, as it can be seen from the Fig. below, it was found that the model we've constructed can successfully recognize the emotion of the employee in sad mood, too.

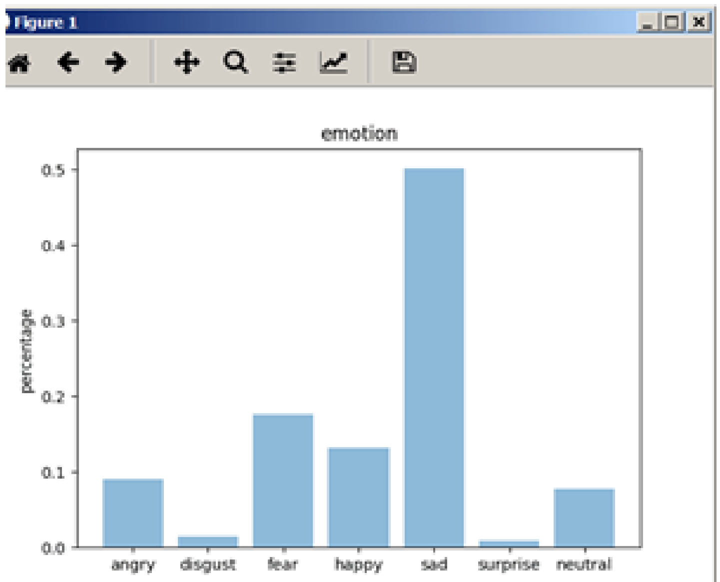

Fig. 6: Sad mood

3. Angry mood

Next, the facial expression of angry person was tested with the image taken from an employee comes to my mind as when a person gets angry in the middle of his work while he or she was touched by anyone else after his or her punished by the concerned bodies of the industrial work environment, as shown on the Fig. below, he or she gets angry. For this reason, we had tested the emotion and the results were found very successful detected as an angry emotion.

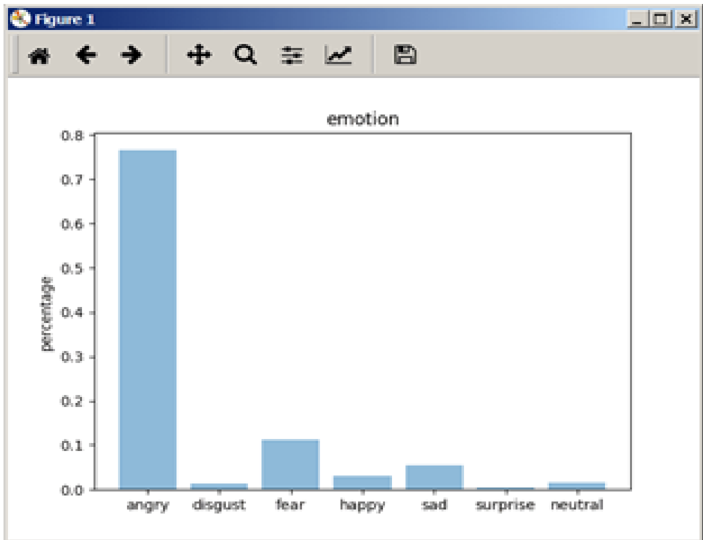

Fig. 7: Angry mood

Lastly, the facial expression of neutral person was tested with the image taken from a customer comes with a neutral face at the first interaction of the industry people and with the concerned bodies of the industrial work environment, as shown on the Fig. below. For this reason, we had tested the emotion and the results were originated very prosperous detected as a neutral emotion.

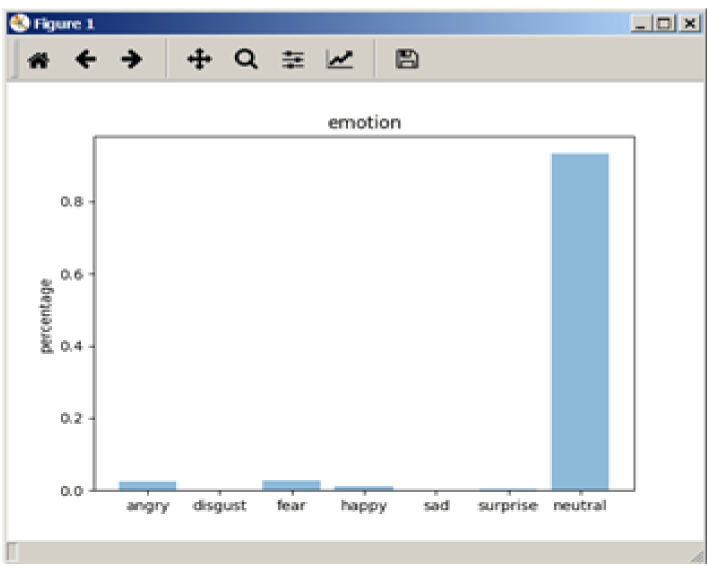

Fig. 8: Neutral mood

Finally, our CNN model had been constructed to recognize facial expressions or emotions of human beings from live video. Thus, we found hoping results of our model produces 81.1 % accuracy on the tested sets of images. Since, the frontrunner of kaggle and the related problems had got an accuracy of 34% and 61.7 % [27, 28], our model could be taken as acceptable and progressive. Moreover, believing that instead of taking the entire image of the employees, processing only the detected faces would increase accuracy. Thus, we had done a little trick on the images, that is in prior of running the images on the network, we the faces has been cropped. Furthermore, our model also had been constructed to recognize emotions of human beings from live video. The detailed of the results found will presented and discussed on the results and discussion part of this work and the code of the project will be putted with detail explanation on the appendix for further related work.

4. CONCLUSION

In the era of actual time judgment making process, the continuing improvement in IoT technology leads to building the basic block of smart environments. However, in the field of modern intelligent service, despite the fast development of IoT, the current IoT based systems significantly lacks cognitive intelligence this implies cannot fulfill the requirements for industrial services.

The researches argued the IoT devices might be supportive in gathering and disseminating the data to the machine and actively track the employees in their activities. For instance, cameras take the pictures of the employees and other people from their environments, and it could be used as input to the emotional intelligence sub-system to regulate the emotion/ feelings of the workers in their social interactions. Obviously, the processes of mood or emotion identification and /or recognition is an intricate task that is if only using images are provided, similarly if for human's emotion recognition problematic because the accurate detection of emotion or feelings from facial expressions habitually be contingent on the situation within which the emotion initiates and is articulated.

In this work, we had investigated the recent progress of IoT in smart environment and deep learning in object detection, object tracking, face recognition, image classification and emotion recognition. The deep models have significantly improved the performance in these areas, often approaching human capabilities. The reasons for this success are two-folded. Firstly, big training data are becoming increasingly available (e.g. data streams from a multitude of smart devices of IoT) for building up large deep networks. Secondly, recent innovative GPU hardware had essentially minimized the interval of time required by deep networks for training.

Emotion recognition or emotion intelligent systems have attracted much research interest within the field of artificial intelligence, particularly deep learning. Obviously, there are various conventional emotion recognition systems which apply the standard traditional ML to extracted features of image, and these methods oversimplify unwell to heretofore unobserved data. Motivated on the aforementioned ideas, our work has been built upon recent research to classify images of human faces into discrete emotion categories using convolutional neural networks (CNNs). We had investigated CNN with diverse architectures and techniques such as max-pooling, ReLU and fine-tuning, ultimately achieved an accuracy of 81.1% in a seven class classification task.

Finally, the researchers believed that deep learning; particularly CNNs will have a more prospective future in a wide range of applications such as medical industries, entertainment industries, and educational systems etc.

REFERENCES

[1]. http://www.zdnet.com/article/emotional-intelligence-is-the-future-of-artificial-intelligence-fjord/ — Fjord

[2]. Picard R W, Vyzas E, Healey J. Toward machine emotional intelligence: Analysis of affective physiological state[J]. IEEE transactions on pattern analysis and machine intelligence, 2001, 23(10): 1175-1191.

[3]. B. Reeves and C. Nass,The Media Equation.Cambridge Univ.Press, Center for the Study of Language and Information, 1996.

[4]. Mayer, John D.,Salovey, Peter,Caruso, David R.:" Emotional intelligence: New ability or eclectic traits?": American Psychological Association, Vol 63 Issue 6, PP 503-517, 2008.

[5]. Allen-Bradley, Rockwell Automation, Rockwell Software and TechConnect is a trademark of Rockwell Automation, Inc. EtherNet/IP is a trademark of ODVA Inc. Publication CIE-WP007A-EN-P - July 2016 www.rockwellautomation.com/connectedenterprise

[6]. Ovidiu V.: Internet of Things - From Research and Innovation to Market Deployment: River Publishers Series in Communication, ISBN:978-87-92982-96-4, 2014 www.riverpublishers.com

[7]. Kirmani, N. et al.: "Performance Modeling of Automated Manufacturing Systems," Technometrics, vol. 35, no. 4, p. 456, Nov. 1993.

[8]. Renuka Devi.D ,, Diana Judith.I," Deep Learning Methods for Big Data Analytics", INTERNATIONAL JOURNAL OF RESEARCH IN ELECTRONICS AND COMPUTER ENGINEERING (IJRECE), A UNIT OF I2OR, VOL. 6 ISSUE 4, ISSN: 2348-2281 PP 24-26, 2018.

[9]. Xu et al.: Internet of Things In Industries: A Survey: IEEE Transactions on Industrial Informatics, ISSN 1551-3203 ,Vol. 10, No. 4, PP 2233-2243, 2014.

[10]. Ejaz A.: "Internet-of-Things-Based Smart Environments: State of the Art, Taxonomy, and Open Research Challenges": IEEE Wireless Communications and Networking Technologies for Internet of Things. IEEE Wireless Communications. PP 10-16, 2016.
[11]. Latha, Charlyn & Mohana Priya, M. :"A Review on Deep Learning Algorithms for Speech and Facial Emotion Recognition. International Journal of Control Theory and Applications. Vol 9. Pp 183-204, (2016).
[12]. Geoffrey E. Hinton, Yee-Whye Teh and Simon Osindero, A Fast Learning Algorithm for Deep Belief Nets. Neural Computation, pages 1527-1554, Volume 18, 2008.
[13]. Awasthi, A. Facial Emotion Recognition using Deep Learning. Project Report submitted to Indian Institute of Technology Kanpur. 2016 Available at: http://home.iitk.ac.in/~aawasthi/cs676/project/report.pdf.
[14]. Ahmed K. N. : Potential of Cognitive Computing and Cognitive Systems: Center for Advanced Engineering Environments, Old Dominion University, Norfolk, United States, October 29, 2014 http://dx.doi.org/10.1515/eng-2015-0008
[15]. Qu, S. et. al. Comuptional Reasoning and Learning for Smart Manufacturing Under Realistic Conditions. In Proceedings of the Behavior, Economic and Social Computing (BESC) Conferencece, PP 1-8, 2014
[16]. A. Sheth, "Internet of things to smart iot through semantic, cognitive, and perceptual computing, IEEE Intelligent Systems, Volume 31, Issue 2, PP 108-112, 2016.
[17]. S. Bin, L. Yuan, W. Xiaoyi," Research on data mining models for the internet of things", in: International Conference on Image Analysis and Signal Processing, IEEE, pp. 127-132, 2010.
[18]. H. Gonzalez, J. Han, X. Li, D. Klabjan," Warehousing and analyzing massive rfid data sets", in: 22nd International Conference on Data Engineering (ICDE'06), IEEE, pp. 83-83, 2006.
[19]. Foteinos V. et al., "Cognitive Management for the Internet of Things: A Framework for Enabling Autonomous Applications," IEEEnVehic. Tech. Mag., vol. 8, no. 4, pp. 90-99, Dec. 2013.
[20]. Haykin S.: "Cognitive Dynamic Systems": Perception-Action Cycle, Radar, and Radio, Cambridge Univ. Press, 2012.
[21]. Haykin S., "Cognitive Dynamic Systems: Radar, Control, and Radio," Proc. IEEE, vol. 100, no. 7, pp. 2095- 2103, July 2012.
[22]. Ramon Caceres and Adrian Friday, "Ubicomp Systems at 20: Progress, Opportunities, and Challenges", in Pervasive Computing, IEEE, vol.11, no.1, pp.14-21, 2012.
[23]. Baldini G. et al. "A Cognitive Framework for Realizing and Exploiting the Internet of Things Concept". In 27th WWRF Meeting, Dusseldorf, October 2011.
[24]. Harding J. et. al.: "Data Mining in Manufacturing: A Review", J. Manuf. Sci. Eng., vol. 128, no. 4, p. 969, 2006.
[25]. Wu Q. et al., "Cognitive Internet of Things: A New Paradigm Beyond Connection," IEEE Internet Things" , vol. 1, no. 2, pp. 129-143 , Apr. 2014.
[26]. Takeo Kanade and Martial Hebert (kkitani at cs.cmu.edu), http://www.consortium.ri.cmu.edu/index.php]
[27]. Kulkarni, Saket S. et al.: "Facial expression (mood) recognition from facial images using committee neural networks." Biomedical engineering online 8, no. 1 (2009): 16.
[28]. Kanade T, Cohn J, Tian Y.: "Comprehensive Database for Facial Expression Analysis." 4th IEEE International Conference on Automatic Face and Gesture Recognition, France. 2000.
[29]. Ekman P, Friesen WV. : "The Facial Action Coding System A Technique for the Measurement of Facial Movement." San Francisco: Consulting Psychologists Press; 1978. http://face-and-emotion.com/dataface/facs/manual/TitlePage.html
[30]. Kobayashi H, Hara F.: " Facial Interaction between Animated 3D Face Robot and Human Beings."Proceedings of International Conference on Systems, Man, Cybernetics. Vol. 3, pp.732–737. ,1997
[31]. Padgett C, Cottrell GW.: " Representing Face Images for Emotion Classification." Proceedings of Conference on Advances in Neural Information Processing Systems. pp. 894–900, 1996.
[32]. Zhang Z.el at.: "Comparison between Geometry-Based and Gabor Wavelets-Based Facial Expression Recognition Using Multi-Layer Perceptron." Proceedings of IEEE International Conference on Automatic Face and Gesture Recognition. Pp. 454–459, 1998.
[33]. Zhao J, Kearney G.: "Classifying Facial Emotions by Backpropagation Neural Networks with Fuzzy Inputs." Proceedings of Conference on Neural Information Processing. Vol. 1, pp. 454–457, 1996.
[34]. Zhang Z.: "Feature-Based Facial Expression Recognition Experiments With a Multi-Layer Perceptron." International Journal of Pattern Recognition & Artificial Intelligence.vol. 13, pp.893–912, 1999.
[35]. Ekman P.: "Unmasking the Face." New Jersey Prentice Hall; 1975.
[36]. Fasel B, Luettin J.: "Automatic Facial Analysis A Survey. Pattern Recognition. "Vol. 36, pp.259–275, 2003.
[37]. Pantic M, Rothkrantz L.: "Automatic Analysis of Facial Expressions: The State of the Art." IEEE Transaction on Pattern Analysis and Machine Intelligence. Vol. 22, pp. 1424–1445, 2000.
[38]. Sebe N.: "Authentic Facial Expression Analysis. Image and Vision Computing." Vol. 25, pp. 1856–1863, 2007.
[39]. Reddy NP, Buch O.: "Committee Neural Networks for Speaker Verification." Computer Methods and Programs in Biomedicine. Vol. 72, pp. 109–115, 2003.
[40]. Das A, Reddy NP, Narayanan J.: "Hybrid Fuzzy Logic Committee Neural Networks for Recognition of Swallow Acceleration Signals." Computer Methods and Programs in Biomedicine. Vol. 64, pp. 87–99, 2001.

[41]. Gopinath P, Reddy NP.: "Toward Intelligent Web Monitoring Performance of Single Vs Committee Neural Networks. "2000 IEEE EMBS Conference on Information Technology Application in Biomedicine Proceedings. pp. 179–182, 2000. http://ieeexplore.ieee.org/xpl/RecentCon.jsp?punumber=7174

[42]. Srirao NA, Reddy NP, Kosuri R.: "Neural Network Committees for Finger Joint Angle Estimation from Surface EMG Signals." Biomedical Engineering Online. Vol. 8, pp. 2, 2009.

[43]. Reddy NP. et al.: "Redundant Neural Networks for Medical Diagnosis of Dysphagia." Intelligent Systems through Artificial Neural Networks. Vol. 5, pp.699–704, 1995.

[44]. Suwicha Jirayucharoensak et al.: "EEG-based emotion recognition using deep learning network with principal component based covariate shift adaptation." The Scientific World Journal pp. 1-10, 2014.

[45]. Patel, Chirag I., Sanjay Garg, Tanish Zaveri, Asim Banerjee, and Ripal Patel. "Human action recognition using fusion of features for unconstrained video sequences." Computers & Electrical Engineering 70 (2018): 284-301.

[46]. Patel, Chirag I., Ripal Patel, and Palak Patel. "Handwritten character recognition using neural network." International Journal of Scientific & Engineering Research 2, no. 5 (2011): 1-6.

[47]. Patel, Chirag I., and Sanjay Garg. "Robust face detection using fusion of haar and daubechies orthogonal wavelet template." International Journal of Computer Applications (0975–8887) 46, no. 6 (2012): 38.

[48]. Patel, C. I., and Ripal Patel. "Gaussian mixture model based moving object detection from video sequence." In Proceedings of the International Conference & Workshop on Emerging Trends in Technology, pp. 698-702. ACM, 2011.

[49]. Patel, Chirag I., Sanjay Garg, Tanish Zaveri, and Asim Banerjee. "Top-down and bottom-up cues based moving object detection for varied background video sequences." Advances in Multimedia 2014 (2014): 13.

[50]. Ukani, Vijay, Sanjay Garg, Chirag Patel, and Hetali Tank. "Efficient Vehicle Detection and Classification for Traffic Surveillance System." In International Conference on Advances in Computing and Data Sciences, pp. 495-503. Springer, Singapore, 2016.

[51]. Patel, Ripal, Shubha Pandey, Chirag I. Patel, and Robinson Paul. "Effective Flicker Detection Technique Using Artificial Neural Network For Video."

[52]. Patel, Chirag I., and Ripal Patel. "Counting Cars in Traffic Using Cascade Haar with KLP." International Journal of Computer and Electrical Engineering 5, no. 4 (2013): 435.

[53]. Patel, Chirag I., and Ripal Patel. "Illumination invariant moving object detection." International Journal of Computer and Electrical Engineering 5, no. 1 (2013): 73.

[54]. Jivani, Nimesh, Jignesh Padasumbiya, A. Thakkar, and C. I. Patel. "November). A new hybrid method for face recognition." Proceedings of (NUiCONE) (2013): 1-5.

[55]. Patel, Chirag I., and Ripal Patel. "Robust face recognition using distance matrice." International Journal of Computer and Electrical Engineering 5, no. 4 (2013): 401.

[56]. Patel, Ripal, Chirag I. Patel, and Ankit Thakkar. "Aggregate features approach for texture analysis." In Engineering (NUiCONE), 2012 Nirma University International Conference on, pp. 1-5. IEEE, 2012.

[57]. Patel, Chirag I., and Ripal Patel. "Contour based object tracking." International Journal of Computer and Electrical Engineering 4, no. 4 (2012): 525.

[58]. Patel, Chirag I., Ripal Patel, and Palak Patel. "Goal detection from unsupervised video surveillance." In Advances in Computing and Information Technology, pp. 76-88. Springer, Berlin, Heidelberg, 2011.

[59]. Patel, Chirag I., and Ripal Patel. "Object counting in video sequences." International Journal of Computer and Electrical Engineering 4, no. 4 (2012): 522.

[60]. Patel, Chirag, Ripal Patel, and Alefiya Nalawala. "Finding Object categories in Image collections." In Proceedings of the International Conference on Signal, Systems and Automation ICSSA 2011 (JAN).

[61]. Bhatt, Dulari, Chirag Patel, and Priyanka Sharma. "Intelligent Farm Surveillance System for Bird Detection." (2011).

[62]. Patel, Chirag I., and Sanjay Garg. "Comparative analysis of traditional methods for moving object detection in video sequence." Int. J. Comput. Sci. Commun 6, no. 2 (2015): 309-315.

[63]. Patel, Chirag I., Ripal Patel, and Ankit Thakkar. "Object Detection and Segmentation using Local and Global Property." International Journal of Computer Science 2, no. 02 (2012): 02-10.