A Novel Hybrid Genetic Wolf Optimization for Newborn Baby Face Recognition

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***ABSTRACT** – Biometric secured system to avoid the Missing, swapping and illegal adoption of newborn baby is a global challenge and research done to solve this issue is minimal and least reported in the literature. Biometric face recognition is a novel approach to non-invasive biometric maternity authentication and baby-swapping or missing prevention in maternity wards. The proposed system is expected to solve issues that have occurred in many countries regarding swapping or missing the identities of newborn baby. The main contribution of the proposed approach is a very high level of proof of maternity for each newborn baby, as well as, the prevention of swapping or missing identities of newborn babies in maternity wards, with a system that can be realized via low cost hardware. Hence, a newborn baby personal authentication system is proposed to avoid swapping and missing cases in the hospital. In this paper, proposed a new hybrid algorithm between the genetic algorithm and the grey wolf optimizer algorithm in order to minimize a simplified model of the energy function of the molecule. A hybrid GA with GWO, namely HGWO is proposed, which combines the strengths of both the algorithms effectively with the aim to generate promising candidate solutions in order to achieve global optima efficiently. Genetic Algorithm gives the best feature than the Gray Wolf Optimization. Comparison with several existing algorithms also showcases the effectiveness of the proposed feature extraction fusion. Specifically, we propose a Feature selection method HGWO applied to deep learning model which applies class-based penalties while learning the filters of a Convolutional Neural Network. The proposed Hybrid Genetic Wolf Optimization (HGWO) is applied to the existing algorithm the CNN algorithm achieves a better accuracy of 98.10% for newborn babies face recognition. The experimental results are promising and prove to be an effective system.*

***Keywords:** Newborn, Face, Biometric, Genetic Algorithm (GA), Gray Wolf Optimization (GWO), Hybrid Genetic Wolf Optimization (HGWO) and Convolutional Neural Network (CNN).*

I. INTRODUCTION

Newborn babies who are missing or interchanged with each other at birth are raised by non-biological parents in maternity hospitals. According to statistical report, about 28,000 newborn babies out of 4 million total births are switched every year [1]. Although they stated that many of these cases are solved at some point before families leave the hospital, the objective risks of missing or swapping newborn babies still exist and these issues need to be resolved. The major cause behind newborn baby-swapping or missing is medical staff mistakes. As an example, officials of Smith N. Mercy hospital stated definitively, that human error was the such reason for a mistake [2]. Once an incident is exposed, they registered for the police case against hospitals may occur. Two mothers whose newborn babies were swapped by medical staff at Heartland Regional Medical Center brought a police case against the hospital [3]. The swapping of two Russian newborn babies was exposed after the ex-husband of one of the mothers had refused to pay maintenance on the basis that she looked nothing like him and requested a DNA test [4]. Both families raised a police case against the hospital. Crime provided a more detailed analysis on hospital liability and resulting protection issues [5]. An additional aspect that should also be seriously considered is the maternity patient's levels of tension. They stated that media reports in the USA of baby-swapping caused tension for the number of patients, and, according to an experimental study, 10% of the mothers reported worry about baby-swapping [6]. According to the issues, baby-swapping is a problem that can have the same impact on a health facility as a newborn baby kidnapping [7]. The worries of maternity health providers, including, but not limited to baby-swapping, and the impact on the women they care for are discussed [8].

Situations like these could be avoided or considerably reduced, if reliable and fast methods of recognition for newborns were made available and used inside maternity wards, hospitals, bus stations and airports. Face provides a more direct, friendly and convenient identification way, and is more acceptable compared with individual identification ways of other biometric features. The major reasons for very less research in face recognition for newborns are

- Non-availability of face database of newborns in public domain.
- Preparation of face database of newborns is itself a challenging task because of the privacy issue and most of the time parents are unwilling to allow anyone to take photographs of their baby.
- Newborns are highly non-cooperative users of biometrics as it is very difficult to control pose and expression covariates.
- Face database of newborns can only be prepared with the active participation of medical staff and parents permission, which is not an easy task.
- Popular belief that face of all newborns looks alike, hence it is difficult to differentiate among them by humans.

This paper presents a maternity verification approach based on newborn baby face recognition biometric characteristic matching. Biometric face recognition is the process of validating the identity of individuals according to their physiological or behavioral character [9], [10]. A fingerprint is the only physiological feature that is completely shaped during the prenatal period [11]. By the conclusion of the 7th month of pregnancy, details point structure on each finger of the fetus is shaped and the ridge shape remains constant during their entire life. Prenatally formed shape of fingerprint ridges and valleys allows biometric template

acquisition of a newborn baby that can later be used for maternity authentication, even if the baby is born premature, e.g. in the 8th month of pregnancy [12]. Unlike fingerprint, the other physiological personalities are uneven at birth. For example, the pigmentation of child's eye is changes until the age of four [13], resulting in an unstable iris acquisition and authentication process for newborn babies. That is why the proposed approach employs the face biometrics. Biometric traits of a baby and the mother are acquired right after the birth on a dual fingerprint scanner; the unique reference is generated and the data is stored in a secure manner on the device. At any time, the identity of the mother and the baby can be confirmed on the same device, e.g., before breast-feeding. Before leaving the maternity hospital a final verification is performed, and the data are securely wiped from the device. The proposed approach employs cancelable biometrics to provide the privacy of stored templates and cryptography to provide security of stored secondary data.

technique which can handle this important issue. In this research paper we have implemented self learning method using SURF descriptor which is considered to be a pose invariant descriptor.

Biometrics secured system for newborn baby is classified into physiological biometrics and behavioral biometrics. Physical Characteristics such as Face, Fingerprint, Iris, Palm print, Retina and behavioral Characteristics such as Signature, Voice, Keystroke, and Gait these are commonly used biometrics [20]. Different technologies are used for face recognition for newborn baby. One approach captures a face image using easy on the pocket camera (visible spectrum). This models key features from the central portion of a facial image extracting features from captured image (s) that do not change with time and avoids exterior features like facial expressions or hair. Major facial recognition benefits include being non-intrusive, hands-free, ensuring continuous authentication and acceptance by users. Face recognition

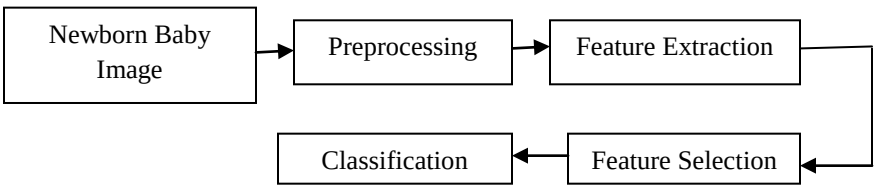

Figure.1 Generalized Block diagram for Newborn Face Recognition

In developing countries the newborn baby swapping, missing and abduction in maternity hospitals is challenging issue and occurs all over the world. Traditional methods to recognize the same newborn baby have their own drawbacks. Providing the solution to the above said challenge, suggests that how a low cost ambient newborn baby biometric secured system based on biometric character of the newborn mothers fingerprint which can easily recognize & identify the swapped baby belonging to own mother. Newborn personal authentication system is proposed for this issue. The biometric traits considered are the footprint of the newborn and the fingerprint of the mother. Globally over 1 billion people lack legal identification and almost half of them are infants and children [14]. To address the need, United Nations Sustainable Development Goal 16.9 calls to provide legal identity for all, including free birth registrations by 2030 [15].Automatic face recognition of newborn baby deserves more attention from the research community, but it is important to frame the research goals in terms of possible applications. While face recognition may not be able to reach accuracy requirements for controlled applications like healthcare, it is still necessary to evaluate the performance and identify the challenges, as it may be a useful analytical tool, in a semi-automatic approach for certain law enforcement applications (e.g. identifying missing newborn baby).

The work done on face recognition for newborn reports the performance of recognition on face, ear, and head print and soft biometric data on newborn database [16–19]. But there is no study on face recognition of newborn across pose or recognition of newborn with single training image. After inspection of newborn data base it was found that proper frontal face photograph of some subjects are not there and in some cases only single training image is present in the database. The newborn baby is naturally non cooperative towards biometric snaps. It is difficult to prepare the face data in reality for training image. This motivates to develop a system is a computer vision that automatically identify a newborn baby face from database images. Newborn baby face recognition problem is challenging as it has to account for all possible appearance variation due to illumination, facial features and occlusions change [21].

As far as feature selection methods are concerned, most of them are based on the optimization of some criterion function using a search method. In this context, we have introduced a new criterion function, based on fuzzy clusters, which is more suitable for non-convex clusters, thus circumventing some problems with the standard approaches such as Mahalanobis distance. Our approach has been assessed through exhaustive experiments using simulated and real data and producing encouraging successful results, as described in the subsequent sections.

This paper proposes a new unconstrained face database of newborns and methodology for recognition of newborns. The objective of this research is to add a new dimension to face recognition of newborns by discussing the challenges, and systematically evaluating the performance of existing and proposed face recognition algorithms on a face database of newborns. Some of the findings presented in this paper like accuracy of algorithm on different facial expressions of newborns have not been observed before in a major empirical study of face recognition for newborn baby. It is our statement that face recognition can be a friendly, hygienic, non-invasive and cost-effective solution for identification of newborns. This research involved a multidisciplinary team composed of computer scientists, medical doctors and nurses. Considering the strengths of GA and GWO, these two algorithms are ideal for hybridization. Therefore, in this study, a hybrid algorithm comprising GA and GWO, termed HGWO is proposed which combines the two algorithms in order to achieve a more suitable trade-off between diversification and intensification, and offer significantly better results than the conventional GA and GWO in terms of solution accuracy and convergence speed.

The most important contributions of this research work are summarizing as follows:

1) A novel hybridization approach based on GA and GWO is proposed.
2) The proposed Hybrid Genetic Wolf Optimization (HGWO) approach is employed to solve feature selection problem and the results are validated on newborn baby face data sets.
3) The performance of the proposed approach is compared with conventional GA, GWO and PSO in previous work.

The general outline of this paper is as follows. Section 2 reviews the limitations of the existing method and motivates new research work in the area of newborn recognition. Section 3 explains the process of newborn face database acquisition and the covariates involved, and Section 4 which elaborates in detail the methodology that is being used. A summary of experimental results appears in Section 5 highlighting experimental protocol and experimental analysis to demonstrate how much influence expression covariates exert over recognition performance. Finally, Sections 6 presents future directions and conclusion.

II. RELATED WORKS

Newborn baby prevention against baby swapping or missing (intentionally / mistakenly) in some of the maternity hospitals, illegal adoption, baby girls killing, child abduction, multiple births in hospitals, birthing centers demand a tightly secure system. Hence, an effective biometric secured system can be implemented to overcome the various problems [22-25]. Biometric secured system authentication is the process where we want to identify or verify the infants to decide the further actions to be taken in case of any identity emergency. How can the parent be sure that their newborn baby will not be mixed up in maternity hospital? The question is unavoidable and none should be answered with greater care, kindness and understanding than this of the incoming maternity patient. The care with which it is answered, and the technique of the identification method explained, hangs the peace of mind of the parents until such time as the infant shows unmistakable evidences of its parentage. The security of maternity ward is of prime concern not only to medical fraternity but also to the parents worldwide. The problem of missing children is a very serious issue throughout the world and seeing the importance of this issue, May 25 is observed as National Missing Children's Day since it was first proclaimed by President Ronald Reagan in 1983. When confronted with baby swapping or abduction, many parents fear that they can do nothing to prevent this tragedy. In developing countries, this problem is more challenging because of overcrowding and scarcity of medical facilities in maternity ward. Every year around 1, 00,000 to 5, 00,000 infants in United States are swapped by mistake, or one out of every eight babies born in American hospitals sent home with the wrong parents [26]. According to study [27], out of 34 infants that are admitted to a neonatal intensive care unit there are 50% chances of incorrect infant's identification only in a single day.

In real applications, the biometrics traits that are commonly used in different authentication systems are the face, fingerprint, hand geometry, palm print, signature, iris, voice etc. [28]. But most of these practical biometric systems are developed for adults only. Therefore, the challenge is to design a biometric system for infants to solve the problem of their missing and swapping, which has been less addressed in the literature as per our knowledge. The face of a newborn baby can appear differently in different lightening conditions. The inter-class difference could be more than that of the intraclass difference in different illumination conditions, which leads to the missclassification of images. Face recognition algorithms which uses the logarithmic transformation such as edge map and image gradient [29] easy to implement but the enhancement in terms of accuracy is very restricted. Several subspace-based methods have also been suggested, for example self-quotient image (SQI) [30] Gradient faces are applied by taking out the illumination insensitive measure from the gradient domain [31]. The performance of Retinex theory based methods is always superior to the other method which uses the illumination invariant features [32–34]. But most of the time large scale features of a face, which might contain some classification information's, are discarded by these methods.

The newborn swapping and abduction in hospital are challenging issue [35]. Traditional method has their drawbacks. Hence a newborn personal authentication system is proposed for this issue based on bimodal biometrics system wherein footprints of newborn and fingerprint of mother is used for recognition. [36] DNA profiling has proven to be powerful technique for human identification, besides its usual application n criminal offense for identifying a crime is also used parentage and kinship determination basically the proposed a software for identification. Though this is very accurate but very time overriding and costlier process. [37] Using face biometrics for helping with the identification of missing baby. The basic technologies involved in such situations are face recognition, identity verification and age progression. The problem addressed by age progression on the sets of images and subsequent hypothesis verification based distribution of extracted features. The overall exercise revealed no of problem. The main problems are quantity and quality of images involved accuracy of the age progression process.

A local approach for face recognition based on combined feature selection methods like Genetic Algorithm (GA), mRmR features selection algorithm, Gramdt Shmidt algorithm and Naive Bayesian classifier was proposed by [37] which was compared with global features based face recognition systems. This study gives a comparative study based on Recognition rates and Execution times. The Naive Bayesian classifier based face recognition system tested on ORL face database showed 78.75% recognition rate and interesting execution times compared to global approaches. An effective Multi-Sub region Correlation Filter Bank (MS-CFB) based feature extraction algorithm for robust face recognition proposed by [38] combined benefits of global and local-based feature extraction algorithms where multiple correlation filters corresponding to different face sub regions are designed jointly to optimize overall correlation outputs. It reduced MS-CFB computational complexity by designing a correlation filter bank in spatial domain and improved generalization capitalizing on unconstrained form during filter bank design process.

In recent years, with the development of machine learning, deep learning as a new research direction caused widespread concern in the field of artificial intelligence[39].Deep learning is a kind of machine learning algorithm which can effectively train deep neural network, which can be used for high-level abstract modeling of data. On December 29, 2012, the front page of the New York

Times reports that "deep learning allows the machine to perform human activities, such as watching, listening and thinking, providing the possibility of pattern recognition and promoting the advancement of artificial intelligence. In 2013 [40], the MIT Technology Review ranked deep learning as one of the top ten technological breakthroughs in the world.

Using deep natural networks to learn effective features has become popular in face recognition. Recently, a few carefully designed deep networks even achieve quiet excellent results. Convolutional neural networks are one of the most commonly studied deep learning architectures. Compared with other regular face recognition methods, training CNN is more troublesome and computational expensive, but nowadays, with the developments of the computers and hardware accelerating techniques, these issues can also be tackled. A number of well-established problems in computer vision have recently benefited from the rise in CNN as feature representations or classifiers. For example, Zhang and Yan devise an effective convolutional neural network to estimate air's quality based on photos by a modified activation function to alleviate the vanishing gradient issue [41]. Girshick et al. [42] applied high-capacity CNN to bottom-up region proposals to localize and segment objects from an image. Hong et al. [43] propose a visual tracking algorithm based on a pre-trained CNN, where the network is trained originally for large-scale image classification and the learned representation is transferred to describe targets.

III. DATASET DESCRIPTION

The newborn baby dataset is collected from various publicly available sources, consists of images of 181 newborn baby faces (Fig.2), corresponding to 16 subjects (no of babies images). Every subject has minimum 4 images corresponding to it. The dataset consists of both, male and female subjects, ranging from the age of a couple of days to 6 months.

The significant covariates of newborn baby face recognition are illumination, image quality, expression, pose, aging, and disguise. In case of newborn baby, the challenges of aging and disguise are not manifested. The newborn baby facial expression influences the apparent geometrical shape and position of the facial feature, the influence on recognition may be more for geometry based methods than for holistic methods. At some point in data acquisition a fundamental problem faced by the researchers is to decide a favorable time for acquisition. If a newborn baby is uncomfortable because of hunger or medical illness then he/she will cry and ceaselessly move his/her head, feet or whole body. Even if they are sleeping, the task of their data acquisition becomes more challenging because of closed eyes. In order to prepare

Figure.2 Sample Newborn babies images with two different babies face.

baby are presumed to wield no voluntary control over their significant behavior (e.g. they do not stick to cultural display rules), because of this they are highly non-cooperative users of biometrics and to capture their frontal face image with neutral face expression is a big challenge. Therefore the images display variation in their pose, illumination and expression and thus it is very challenging to get the same newborn baby facial expression in both stages as it is very difficult to control their expression.

IV. PROPOSED METHODOLOGY

As discussed in the previous section, newborn face recognition has several challenges that arise from their uncooperative nature. Hence, existing handcrafted feature extraction and matching techniques may be unable to perform recognition on par with performance obtained with cooperative adult face images. In such non-ideal conditions, learning based feature extraction and classification techniques (Fig.3) are required that explicitly encode the properties of the feature space to improve the recognition performance.

There are various feature selection techniques from that some of the optimization techniques applied to the newborn baby dataset. According to the biometrics selected and its application the feature extraction technique can be applied to the Newborn babies images [50] and extract the features from the techniques. After extracting features from four techniques, using feature selection method selecting best features from the extracted technique (Fig.3). Apply the CNN algorithm to the selected features using Proposed HGWO and to get the better accuracy performance.

A. Feature Extraction

The purpose of the feature extraction is to extract the feature or information which represents the face and reduce

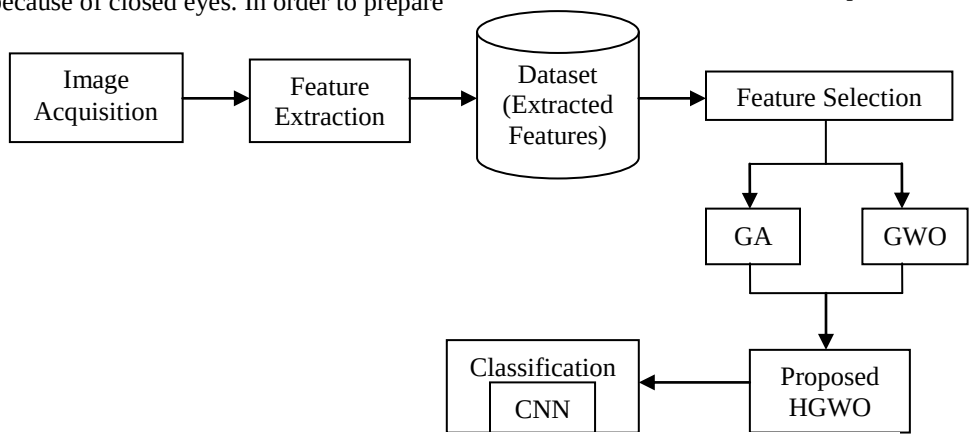

Figure.3 Proposed Architecture for Newborn Face Recognition System.

the computation time and improve the recognition rate. In feature extraction facial features are extracted using Average Filtering method. The first step in image analysis is to extract the features of the image. Feature extraction is a method by which the relevant information related to digital image is extracted. The level to which this extracting is carried depends on the problem being solved. Feature extraction is typically used to collect the features of objects in images. Sometimes we need to read the image correctly and identify the content of the image. In the sense analysis or any visual pattern recognition process, the camera accepts a picture of the scene and passes picture to feature extractor. The objective of a feature extractor is data reduction by measuring certain features or properties which distinguish objects or their parts. Usually, feature extraction is associated with another technique known as feature selection. The objective of feature selection and feature extraction techniques is to reduce this dimensionality. During this process, the salient features are essential for the recognition is retained. As a result, classification methodologies may implement in space with vastly reduced dimension and therefore it requires reasonable time

According to the biometrics selected and its application the feature extraction technique can be applied to the Newborn babies images and extract the features from the techniques. After extracting features from [50] four techniques, combining the best features from two extracted techniques such as LDA and DCP and then apply the CNN classification technique to the combined features set and it gives the best recognition rate than the other biometrics system.

B. Feature Selection

Feature selection can be divided into feature subset selection and feature ranking. Feature subset selection selects a subset of attributes which together increases the performance of the model. Feature ranking calculates the scores of each attribute and then sorts them according to their scores. In this work we mainly focus on two wrapper based feature selection techniques. They are (i) Genetic Algorithm (GA), (ii) Gray Wolf Optimization (GWO). Grey Wolf Optimizer (GWO) is a recently proposed swarm intelligence algorithm inspired by the social hierarchy and hunting behavior of wolves. It has the advantages of less control parameters, high solution accuracy, and fast convergence speed. Compared with other classical metaheuristic algorithms such as genetic algorithm (GA), particle swarm optimization (PSO), and gray wolf optimization (GWO), the GA shows powerful exploration capability and better convergence characteristics. Owing to its simplicity and ease of implementation, GA has gained significant attention and has been applied in solving many practical optimization problems since its invention.

Genetic Algorithm (GA)

Genetic Algorithm is an evolutionary based stochastic optimization algorithm with a global search potential proposed by Holland in 1975[46]. GAs is among the most successful class of algorithms under EAs which are inspired by the evolutionary ideas of natural selection. They follow the principles of Charles Darwin Theory of survival of the fittest. However, because of its outstanding performance in optimization, GA has been regarded as a function optimizer. Algorithm begins by initializing a population of solution (chromosome).It comprises representation of the problem usually in the form of a bit vector. Then for each chromosome evaluate the fitness using an appropriate fitness function suitable for the problem .Based on this ,the best chromosomes are selected into the mating pool, where they undergo cross over and mutation thus giving new set of solutions(offspring). The three principal genetic operators in GA involve selection, crossover, and mutation [45].

Genetic Algorithm can be briefed as below:

Step1: Choose initial population

Step2: Evaluate each individual's fitness

Step3: Determine population's average fitness

Step4: Repeat

- select best-ranking individuals to reproduce
- mate pairs at random
- apply crossover operator
- apply mutation operator
- evaluate each individual's fitness
- determine population's average fitness

Step5: Until terminating condition (e.g. until at least one individual has the desired fitness or enough generations have passed)

Gray Wolf Optimization (GWO)

Gray wolf optimization (GWO) is a recently developed evolutionary algorithm, which says that the gray wolves have a successful reproduction more than hunting in the pack. Two gray wolves (male and female) that are in a higher position manage the other wolves in the pack. Gray wolf optimizer is one of the latest bio-inspired techniques, which simulates the hunting process of a pack of gray wolves in nature. The gray wolves are often live in a pack [47]. The size of a pack is usually 5 to 12. The wolves follow very stringent rules in social dominant hierarchy. There wolves in the pack are categorized as alpha wolf , beta wolf and delta wolf where alpha wolf makes all decisions, beta wolf helps alpha wolf to make decision and delta wolf moves to the more dominant wolf.

Gray Wolf Optimization can be briefed as below:

Step1: Initialize the grey wolf population

Step2: Calculate the fitness of each search agent

Step3: α = First best search agent

Step4: β = Second best search agent

Step5: δ = Third best search agent

Step6: Max number of iterations

- For each search agent
  - Update the position of the current search agent by ω.
- End for
- Update grey wolf population
- Calculate the fitness of all search agents
- Update search agent

Step7: Return.

According to the optimizer, the role of each wolf is given below:

- The α are leading the pack, the α wolves are responsible for making decisions. The α decisions are dictated to the pack
- The β are subordinate wolves that help the α in decision making or other behavior. The β can be either male or female, and he/she is almost certainly the best candidate to be the α.

- The ω wolves play the role of scapegoat. They have to give to all the other superior wolves. They are the last wolves allowed to eat.
- The δ wolves have to submit α and β, but they dominate the ω. Scouts, elders, sentinels, hunters, and caretakers are fall in this category. Scouts are watching the limitations of the region and alert the pack in case of any danger. Sentinels are protecting and also assure the safety of the pack. Elders are the most knowledgeable wolves which are α or β.
- Hunters help the α and β by hunting prey and supplying food for the pack.
- Finally, the care takers are responsible for caring for the weak, ill, and injured wolves in the pack. The wolf attracts towards the first three best solutions.

Proposed Hybrid Genetic Wolf Optimization (HGWO)

In this work, to propose a hybrid algorithm by combining the genetic algorithm and grey wolf optimizer algorithm. The numerical results and the combination between the two algorithms improve the performance of the proposed algorithm. HGWO is based on procedures, which make it powerful and able to solve the minimization of potential energy function. The problem of finding the minimization of the potential energy function is an NP hard problem, which is difficult to solve since the number of the local minima increases exponentially with the molecular size.
The design of proposed work is given below:
Step1: Generate the initial population.
Step2: Initialize α, β and δ Position and Score.
Step3: Initialize the random position of search agents.
Step4: Estimate the fitness value of each hunt agent.

- α=the best hunt agent
- β=the second best hunt agent
- δ=the third best hunt agent

Step5: To obtain search agents for each agent choose a random number.
Step6: Update the Position of search agents (wolf).
Step7: Then (grey wolf pack size) Renew the location of the current hunt agent.
Step8: Estimate the fitness value of all hunt agents.
Step9: Update the value of α, β, δ.

- Apply a tournament selection operator
- Apply a uniform crossover operator to generate a new population of parent
- Apply a mutation operator

Step10: Update the position of prey.
Step11: Return the position of α as the fittest optimum.
Step12: Finally, consider the best found solution.

To identify the important feature subset in the given dataset, a hybrid binary gray wolf optimization algorithm with genetic algorithm is proposed. The proposed HGWO operators play an important role in improvising the solutions as far the algorithm is concerned. In the HGWO, the pool of solutions is in binary form at any given time then the position of wolf is updated and crossover is done and best solution wolf act as a leader for the pack of wolves.

C. Classification Algorithm

Training basically involves feeding training samples as input through a CNN method. Testing image is used as a sample image which has to recognize from the trained images. In this section, we conduct comprehensive experiments on large-scale newborn baby face databases to verify the performance of our algorithm and system. To challenge our algorithm, we choose only a small set of illuminations for the training set, yet we include all illuminations in the testing set. In the following section, we will test our algorithm on a newborn baby face dataset that is collected by our own system. The goal for that experiment will be to show that with a sufficient set of training illuminations for each subject, our algorithm indeed works stably and robustly with practical illumination, misalignment, pose, and occlusion, as already indicated by our experiment in newborn baby datasets. This database contains images of 181 subjects across simultaneous variation in pose, expression, and illumination. The dataset is challenging due to the large number of subjects, and due to natural variation in subject appearance over time.

Convolutional Neural Network:

This is the most commonly utilized deep learning for large scale picture characterization. This model consists of an input and an output layer along with many hidden layers. The hidden layer of CNN model mainly consists of convolutional layer, pooling layer, and fully connected layer.

Convolution is a specialized kind of linear operation and it indicates that the network employs a mathematical operation called convolution. Convolutional networks are simply neural networks that use convolution in place of general matrix multiplication in at least one of their layers. Convolutional neural network consists of an input and an output layer, as well as multiple hidden layers. The hidden layers of a CNN [49] typically consist of a series of convolutional layers that convolve with a multiplication or other dot product. The activation function is commonly a RELU layer, and is subsequently followed by additional convolutions such as pooling layers, fully connected layers and normalization layers, referred to as hidden layers because their inputs and outputs are masked by the activation function and final convolution. The final convolution, in turn, often involves backpropagation in order to more accurately weight the end product.
A convolutional neural network is comprised of the following types of layers:

- Input Layer**:** This input layer holds the raw input of image with width, height and depth.
- Convolutional Layer: A convolutional layer is a small window that extends throughout the depth of the image, and slides over the complete image to learn the features. Multiple filters can be used in a single layer. These can be thought of feature maps.
- Activation Function Layer**:** This activation layer will apply element wise activation function to the output of convolution layer. Some common activation functions are RELU: max (0, x), Sigmoid $\frac{1}{(1+n\hat{}-x)}$, Tanh, Leaky RELU, etc. The volume remains unaffected hence output volume will have dimension.
- Pooling Layer: This pooling layer is occasionally inserted in the covnets and its main function is to reduce the size of volume which makes the computation fast reduces memory and also prevents from overfitting. A pooling layer is used to reduce the spatial size of the representation. It is usually inserted between two successful convolutional

layers. Max-pooling and average-pooling are common operations for the pooling layer.

- Fully Connected Layer: Neurons in a fully connected layer are connected to all neurons of the previous layer, as in a regular neural network.

V. RESULTS AND DISCUSSION

In order to classify the usefulness and validity of our database, we have selected newborn baby face biometric data to demonstrate the accuracy of identification of newborn baby. The performance of the proposed feature selection is applied to the CNN is compared with existing handcrafted and learning-based techniques. The existing feature extraction algorithms are computed on Newborn Face Database. It is observed that newborn baby have rich skin texture, distinct facial features and so on. Further, it is difficult to restrict pose and expression variations of babies. The hypothesis is that for babies, information content present in the image changes with expression variations. In order to achieve our goal of applying face recognition to newborn babies, we evaluate well-known, deep learning algorithm such Convolutional Neural Network (CNN).

Table.1. Comparison of Accuracy, Sensitivity, Specificity, PPV, NPV with feature selection using CNN with 5-fold cross validation

Performance Metrics	GA	GWO	Proposed HGWO
Accuracy	97.56	97.01	98.10
Sensitivity	100	100	100
Specificity	90.99	89.58	93.45
PPV	70.17	69.25	80.23
NPV	100	100	100

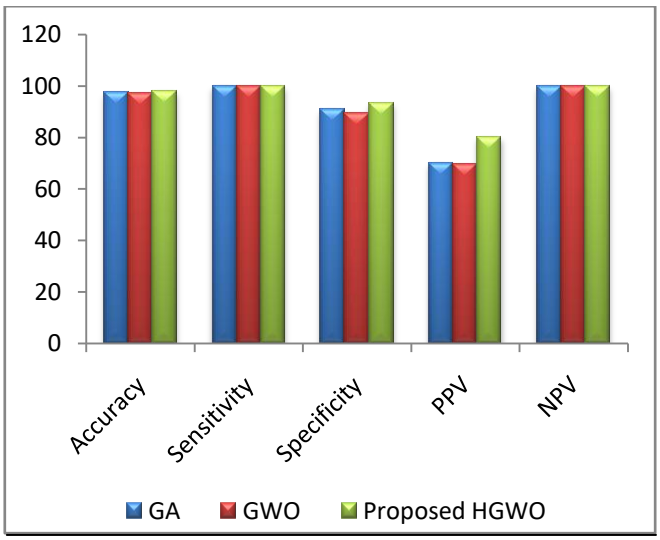

Fig.4. Comparison analysis of performance metrics (Accuracy, Sensitivity, Specificity, PPV, NPV) for feature selection

From Table 1 the improvement in classification performance using the proposed HGWO optimized feature subset is applied to CNN gives the best recognition accuracy 98.10% is obtained and in addition that other performance metrics also evaluated they are Accuracy, sensitivity, specificity, Positive Predictive Value(PPV), Negative Predictive Value (NPV). The performance metrics of CNN are presented in Fig. for a better illustration.

Table.2. Comparison of F-Measure, ROC, G-Mean, MCC with feature selection using CNN with 5-fold cross validation

Performance Metrics	GA	GWO	Proposed HGWO
F-Measure	94.23	93	95.47
ROC	95.63	94.57	96.08
G-Mean	94.58	93.74	96.74
MCC	81.65	80.03	86.98

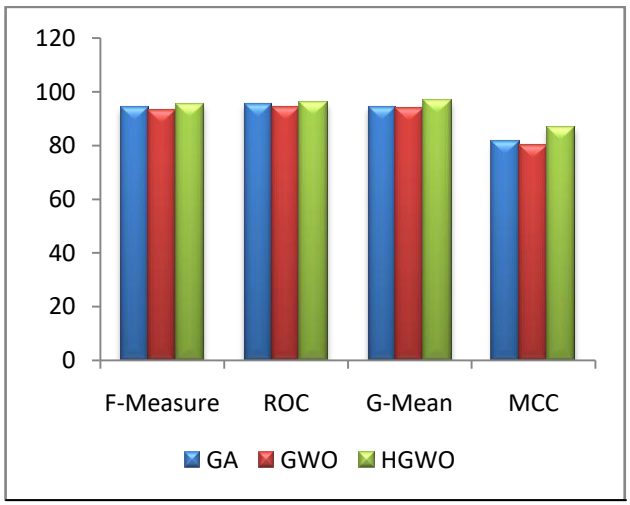

Fig.5. Comparison analysis of performance metrics (F-Measure, ROC, G-Mean, MCC) for feature selection

From Table 2, the value of performance measures determined from the proposed HGWO feature selection algorithm is applied to CNN gives the best recognition accuracy 98.10% is obtained and in addition that other performance metrics also evaluated they are F-Measure, Receiver Operating Characteristic Curve (ROC), G-Mean and Matthews Correlation Coefficient (MCC). Finally, we concluded that the CNN with proposed HGWO feature selection algorithm gives the best result it selects the best features for the newborn babies face database and CNN is the best classifier algorithm.

VI. CONCLUSION

Although the various biometric secure system for anti baby-switching or missing procedures are implemented in hospitals worldwide, no 100% proof maternity authentication method is reported in the literature or, to the best of our knowledge, used in any maternity wards. The major contribution of the approach presented in this paper based on a newborn baby face dataset is the elimination of worry caused by baby-switching or missing and the provision of a proof to each mother that she will leave the maternity hospital with her own baby.

In this paper, Convolution Neural Network (CNN) architectures are applied for newborn baby face biometric system with different approaches the CNN algorithm gives the better result than compare to the other existing algorithm present in the previous work. The performance is evaluated for the CNN applied for extracting learned features from LDA-DCP with Feature Selection (GA and GWO) and evaluated the performance metrics. The performance for Proposed LDA-DCP Fusion (Previous Work) feature set with feature selection is applied to the CNN for the classification task. The investigation study was conducted on newborn baby

face datasets. The results showed the accuracy with of 98.10% is obtained using CNN classifier with proposed Hybrid Genetic Wolf Optimization (HGWO) feature selection. The results showed that our model achieved a higher accuracy than most of the state-of-the-art models. To do so, more databases need to be included for training our CNN models, as well as to test different convolutional neural network models for better functioning. The newborn baby face recognition can be performed using different techniques effectively. This research improves performance for matching face images of newborns. Adapting a cascade of classifiers to be performed in a similar domain classification for which only a few positive samples are available. In the future, utilizing the hybrid algorithm as a filter and wrapper feature selection approach seeking to evaluate the generality of the selected features will be a valuable contribution intends to further improve recognition and classification accuracy.

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