Effective Approach of Finding Missing Children using Face Age Progressed Prediction Method

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***Abstract*—** An improved way of finding missing children is presented in the paper. It is very difficult, tedious and least efficient method to find missing children through traditional methodologies. Using the advanced method the factor of facial transfiguration of a child is considered with increases the search efficiency. Large numbers of missing children cases are registered in their young age. These lost or kidnapped or missing children undergo huge facial transformation caused by several external and biological factors. Human face age progressed prediction is the recent upcoming research field which is used to study and decode these facial transfigurations. The facial image is being fragmented into parts to increase the granularity of face prediction with age progression. The growth curve of feature is used to predict the shape, size, and location of each and every feature at a different age. Hence this increases the success rate of finding missing child. Various algorithms and image processing techniques are used to carry out this study. This paper aims at finding missing children with the most effective method.

***Keywords*—** *Face Age Progression Prediction, Feature extraction, Aging database, Mahalonobis distance.*

I. INTRODUCTION

Kidnapping is by far the highest reported crime against children. In India, a child goes missing in every eight minutes, as per survey by the National Crime Records Bureau, India. Maharashtra has highest rate of missing children i.e. over 50,000 having disappeared in the past few years. Madhya Pradesh, Delhi and Andhra Pradesh (Telangana) are distant competitors after Maharashtra with all recording less than 25,000 missing children. The most significant application of face prediction is finding a person who went missing for a long time [1]. The efficiency and effectiveness of search can be increased with the approach used for face prediction. Predicting face progression is an important topic for today's several practical applications especially in security application and finding missing person system. Face Age Progression Prediction (FAPP) is entirely different concept from Age Estimation. FAPP deals with the prediction of face at different stages of age considering several biological factors whereas, in case of Age. It can be once said that Age Estimation is reverse problem of FAPP. FAPP is also becoming a major area of interest for researchers in the field of forensic science to solve and come up solutions for several mysterious cases. Experts say several children from rural India and among urban poor run out of home due to poverty or physical abuse. On the street, without protection, children could be pushed into any racket or abused [2]. As time passes, the facial transfiguring takes place which makes the search of these missing children more difficult. Hence, computational approaches are introduced in the field of finding missing person from domestic as well as national security point of view. The police in some regions have also begun a database for missing children, like zipnet.in [2]. Detailed study of facial growth curves of child's parent, relatives and siblings is done to make search more effective and efficient. There exist several hurdles in the path of searching missing child with the approach of FAPP such as:

1. **Growth rate variation**: Facial growth rate varies from person to person influenced by several factors such as race, health, socio-economic stratum, secretion of hormones, lifestyle, working condition, etc. [3].

2. **Gender:** In certain period of life the hormonal influences play a leading role to attain maturity which directly affects the growth curve of a child entering into adolescence phase. Growth phase in females is usually early than that of males [3].

3. **Aging catalyst:** There exist several factors which act as catalysts for premature aging in humans. Some examples of these are working exposure, mood swings of life, immunity, diet, smoking and liquor addiction, etc. [3].

4. **Database:** Availability of huge database of images of child along with the parents and relatives at different stages of age is very difficult to get. [3].

5. **Non Facial factors:** Face transfiguration also depends on global non-facial factors such as hair color, hair style, boldness of forehead, etc. [4].

6. **Environmental Factors:** Socioeconomic status is one of the major players that can contribute to growth variation. Ideology and beliefs have shown its influence on growth. Environmental pollutant **(**toxicant**)** exposure has been associated with reduced height [5].

7. **Nutrition and Disease throughout the Life Cycle:** this factor is further characterized into two i.e. parental growth and infancy and childhood growth [6].

Proper consideration must be done to overcome the mentioned challenges in carrying out FAPP. Instead of working on whole face the proposed method concentrates mainly on selected few key features which is achieved by image fragmentation. Initially facial features are extracted from

the image provided, Age progression prediction is then carried out for each key feature individually. The key features considered for the proposed method are eyes, nose and mouth.

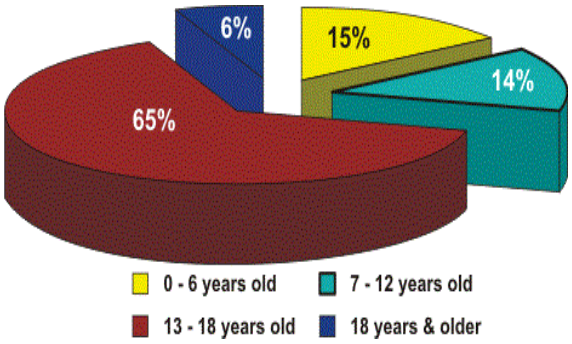

Fig. 1 International statistics of missing children [5]

The international statistics of missing children are explained in Fig. 1. Majority of cases registered for missing children deals with the age group of 13-18 years, the adolescence stage. Major physical and psychological variations take place in this stage for every child. Out of total registered cases 8% still remain unverified and found cases. Table 1 is the data from International Center for Missing and Exploited Children. India has rank 4 as per the statistics of missing children across world. This organization not only finds missing children but also take efforts for their upliftment. Despite of having such statistics our nation has still not progressed in adapting more sophisticated ways for finding missing children nationwide. Several activities are undertaken by the organization to boost the confidence among the exploited children and give them the ray of hope for their life [7].

Country	No. of children missing per year
The United States	467,000
United Kingdom	140,000
Germany	100,000
India	70,000
Canada	40,100
South Korea	31,425
Argentina	29,500
Australia	20,000

Table 1. International data count [7]

Child line is an organization in our country which deals with the child protection and child rights. This organization mainly focuses on the exploitation of children and many vulnerable issues faced by them. One of such issue is missing children (lost/ kidnapped). Today many people are taking initiative to encourage such programs in our country. Several endorsements are been done to make people aware of the issues faced by the nation's young children. As per the data from National Human Rights Commission every year 44.000 children are missing out of which almost 11,000 are untraced [8]. Hence some serious steps are to be taken to reduce the figure. This organization specially focuses on the children who needs extra care and protection such as,

- Children abandoned by parents or guardians.
- Missing children.
- Children who are victims of substance abuse.
- Run away children.
- Children separated from parents due to conflict and disaster.
- Children whose families are in crisis.
- Victims of child trafficking, etc.

Ministry for Women and Child Development has launched a website named khoyapaya.gov.in. [9] This website mainly serves the families who have lost their children. Unlike many NGOs the family must register the case of their missing child and database is maintained for all these case. On the other side of line the website also maintains the database in which similar child is sighted and further the families are notified. This work is done on real time basis i.e. real time communication among organization, police and families takes place. Very soon this website got tremendous positive response nationwide. Hence government decides to launch an application for android phone users to increase the efficiency of the search. In its first week of operation 99 profiles of children believed missing has been uploaded on the KhoyaPaya website.

TrackChild is software which is updated by two thirds of the country's police stations and 5,000 children's homes but the only limitation in this software is public cannot upload information to it. Over 150,000 children have been tracked and found through TrackChild since its launch in 2008 [9].

National Center for Missing Children is another organization working for finding missing children across the nation. Strategy used by this organization is, the nation is divided into five zonal areas (north, east, west, south, central). Every Zonal office has got a headquarters which controls the search across its area. This organization mainly works on two sections: 1. Found children 2. Separated in childhood [10].

1. Found children: It deals with the tracing of parents of children found from various sources such as orphanages, etc. [10]
2. Separated in childhood: It deals with the information about children who were found missing from their childhood and have grown up now. [10]

II. RESEARCH HISTORY

Human facial growth across ages is mainly attributed to the growth of craniofacial and skin related transformations which introduces the facial transfiguration. Although there are many facial changes occurring with time, the craniofacial changes take place in proportion with respect to time.

Psychophysics and human perception were the approach used earlier for studying facial aging [4]. Each type of growth affects the facial appearance. These techniques fail in terms of efficiency i.e. successful search rate for this technique was low. Hence, there arises a need of computational approach towards face aging prediction. There are several visual characteristics which are helpful for studying the facial growth of the person, this can be achieved by introducing computational approach. Computational approaches focuses more onto 1. Age estimation from given faces images 2. Appearance prediction across different age groups. Earlier the study of face aging was categorized into two: 1. Child Growth 2. Adult Aging.

1. Child Growth:

Different researchers used different approaches to go ahead with growth prediction, few researchers adopted statistical parameters, few went for developing different aging functions and others went with the texture parameters. This shows the growth of research in the field of face prediction study [4].

2. Adult Aging:

Computational approach is being encouraged in this study. Appearance and shape of facial features are been studied which helps for facial modeling. Several computer graphics also play a leading role for synthesizing of the predicted image [4].

III. PROPOSED METHOD

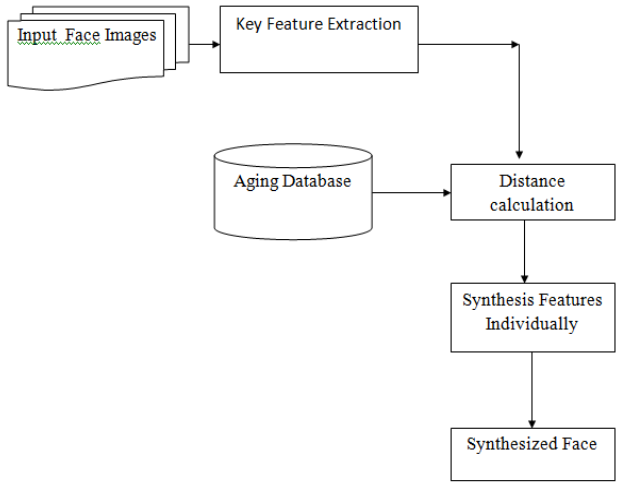

Fig. 2 Proposed method flow

Flowchart shown in Fig. 2 explains the proposed approach for FAPP. From the given face image the key facial features are extracted (eyes, mouth, nose). Different computation techniques are applied to detect these facial features. These detected features are then further undergone through other computations for prediction. These computations majorly deal with the distance calculation between facial features. Distance calculation is used to reduce visual distortion in data hiding application of binary images. These binary images are the feature contour maps which are extracted from aging database which is referred for study. Various free databases are used to compile the aging database. Facial features are predicted individually based on calculation and aging database.

For predicting age progressed facial image of the child, a large database is required. This database mainly comprises of images of parents, relatives, sibling and several similar images [3]. The growth curves of related images is studied and is applied on the key features to synthesize the final age progressed image. To make this procedure simple the images of database is been categorized into different groups, 1. Early Growth Group (1-6 years); 2. Late Growth Group (6-16 years). During the study it is assumed that the missing child was in the age group of 1-16 years [3].

The facial features adopted for this work includes four meshes representing the face shape, mouth, nose, and eyes, respectively. These meshes are basically the vectors representing contour details of the key facial features. Let $G_{a,i} = \{g_{f,a,i}, g_{e,a,i}, g_{n,a,i}, g_{m,a,i}\}$ denote the facial feature of child i at age group $a \in A$, where subscripts f, e, n, and m indicate face, eye, nose, and mouth, respectively. For simplicity, let $C = \{f, e, n, m\}$ and let the missing child be indexed by zero. Also, let us assume $h_{c,a,I}$ and $w_{c,a,i}$ denote the height and width of facial component c ($c \in C$), respectively.

A. FEATURE EXTRATION

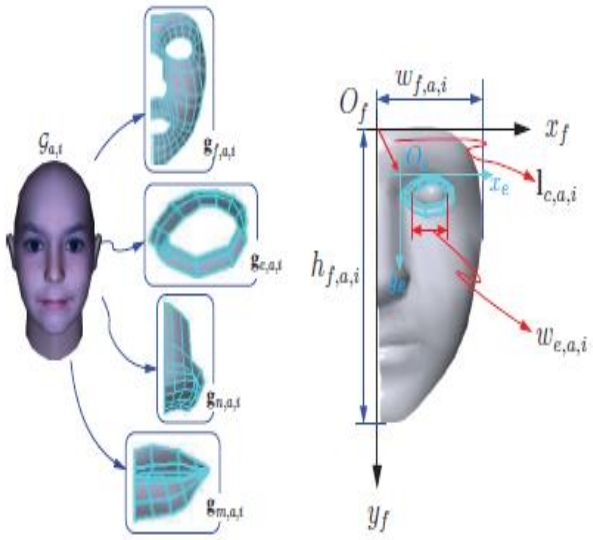

Fig. 3 Feature extraction coordinates [3]

Computer Vision system Toolbox provides MATLAB algorithms for feature extraction, object detection, object tracking, object recognition, and geometric camera calibration and 3D vision. It also supports rapid prototyping along with the fixed-point arithmetic support and C-code generation. Hence this toolbox extends the boundaries of MATLAB and OpenCV.

B. DISTANCE BETWEEN FACIAL FEATURE

To determine the similarity between two facial features or to predict the growth curve of the face, distance calculation plays a key role. Several distance calculation methods are used in image processing such as,

- Euclidean Distance
- Chamfer Distance
- Geodesic Distance
- Mahalonobis Distance
- Manhattan Distance
- City Block Distance
- Chess Board Distance

In the proposed method, mahalonobis distance computational approach is being implemented. The Mahalanobis distance measures the distance between a point and a distribution. Mahalanobis can also be defined as a measure of dissimilarity between two random vectors *x* and *y* of the same distribution with the covariance matrix *S*:

$$d(x,y) = \sqrt{(x-y)^T S^{-1}(x-y)}$$

Mahalanobis's definition was stimulated by the problem of identifying the similarities of skulls.

C. PREDICTION ALGORITHM

A standard linear regression model with standard estimation techniques makes the prediction of the relationship between the response variables feasible. The vectors obtained from the features extracted acts as response variables. The relation among these variables is computed to find the growth curve of the facial feature of the missing child. Using this growth curves, the future image of facial features is predicted. Linear regression is the technique widely used for the pattern recognition[12].

Logistic regression is a technique in which unknown values of discrete variable are predicted based on known values of one or more continuous and/or discrete variables.

D. DATABASE

Database is the basic requirement for finding missing children. Size of database increases the search rate of the missing child proportionally. In general the database provided for finding missing children consist of very few images. These images limit the search efficiency hence the requirement of computation algorithm efficiency increases. To make the age-progressed feature sequence study easy the database is split into five age groups namely A = {A1,A2,A3,A4,A5}, where A1, A2, A3, A4, and A5 represent age groups of 0-3, 3-6, 6-11, 11-16, and 16-18 years old, respectively. It is assumed that the input images provided from the database of the missing child is in age groups A'⊂ A, where A' represents the age of the missing child. As per the international statistics the major abduction or missing of children takes place in the age group of 13- 16 years old band [3]. Hence obtaining huge database requirement is major issue of concern to come up with the most efficient and correct results.

IV RELATED WORK

In this Section, we describe various algorithms applied in the area of face age progressed prediction undertaken by various authors.

Exemplar-based Age Progression Prediction has been proposed by Cheng-Ta Shen, Wan-Hua Lu, Sheng-Wen Shih, and Hong-Yuan Mark Liao [3]. In this method, key features of face are extracted and computation of age progression has been imposed on those features. This computation is done on the base of aging database which is been provided. Growth curves of two similar looking children has been studied and the features of missing child are predicted. These predicted features are then merged to complete the facial front view using *thin plate spline (TPS)* method [3]. A curvature weighted plus bending-energy distance is used for determining the similarity of two facial components. This computation is also done to reduce the distortion in data hiding applications especially in binary images. TPS method is also used for data interpolation & smoothening. In case of face transfiguration image alignment and shape matching is must and this is handled by TPS method.

Exemplar-based algorithm and non- negative matrix factorization approach has been proposed by Hsuan T. Chang and Hsiao W. Peng [11]. In this method, six features are extracted as regions of interact (ROIs). This includes eyes, eyebrows, mouth, nose of facial image to predict age progressed image. Database of family and non-family members is required to make the prediction and computation. The Exemplar-based method is used between target and reference images on the base of six ROIs considered. To make results more accurate and efficient genetics is brought into the picture i.e. family images are brought into the picture. The NMF technique is introduced to identify the hidden characteristic of ROI image of family members and to predict the human face sequence in his growth based on the computation [11].

A Compositional and Dynamic Model for Face Aging has been proposed by Jinli Suo, Song-Chun Zhu, Shiguang Shan [12]. In this method, statistical model of human face has been studied. A hierarchical AND-OR graph representation is adopted for accounting age perception. Model represents the face in each and every age group through a three level AND-OR Graph, consisting AND nodes, OR nodes and Leaf nodes. The computation takes place at three levels- 1. Level one describes hair and face appearance, 2. Level two describes refined facial components and 3. Level three describes wrinkles and skin marks. Results are dependent on two factors: a large training set and compositional model [13].

Following table.2 explains different methodology used towards face age progressed prediction by different authors.

References	Methodology used
Suo et al. [14]	Computational model based on And Or Graph.
Ramanathan, Chellappa [3]	Formulation of physically based parametric muscle model.
Chang et al. [11]	Exemplar based algorithm considering environment of human growth.
Suo et al. [13]	Built a high resolution grammatical face model describing aging effects.
Patterson et al. [15]	Study of morphological changes in faces on biometric systems.
Haibin et al. [16]	Proposed face descriptor which deals with study facial aging effects.
Ramanathan, Chellappa [17]	An anthropometry based facial growth model was proposed
Ramanathan, Chellappa [18]	Characterization of age-based appearance variations using subspace methods.
Lanitis et al. [19]	Characterized facial aging effects considering regression functions
Burt, Perrett [20]	Differences between age-based face composites are categorized

Table 2. Different computational approaches

V APPLICATIONS

1. The main application of Face Age Progression Prediction is the theme of the paper i.e. finding missing children.
2. Other than that it also helps to know one's facial retirement.
3. The approach is also useful in security applications to predict the face of terrorist after few years. Hence is also used by several national security agencies for tracing a terrorist.
4. Helps today's young couples to know how their kid will look like in future.
5. Another application field is forensic science; here this approach helps to get information about unidentified murdered body of a person.

VI CONCLUSION

The necessity of study of face age progressed prediction is increased for finding missing children and also in the security application. The major difficulty is to overcome the hurdles mentioned to predict a face of missing child. Huge database of family and non-family member is required to study the growth curves of similar facial features and face prediction. Neural networks can also be used to predict the values of variables on the basis of artificial intelligence.

Facial growth statistics: The facial measurements extracted from different facial features of different ages provide various evidences on facial growth of child. Computational models should be built using ground-truth data on facial aging for the different rates of growth observed across ages.

Physical built variation: We actually don't know in which environment the child is surviving. Hence there will be variation in the weight of child. So, account for this factor is must to reach the result successfully. In future, to increase the search rate of missing children 3-D Measurement can be brought into picture. Several factors are not considered yet for the study such as facial hair growth, hair loss, wrinkles, etc. adding these features to study will increase the accuracy of predicted image [21].

Despite all kids been warned about stranger danger, children do co-operate and leave the playground with strangers in the space of 90 seconds, highlighting to children that bad people can come across as friendly and approachable and they must be beware of that. Hence parents must make kids understand the danger of stranger and should be aware of their child's environment.

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