

Facial Expression Analysis of Toddlers and Preschool Children using Machine Learning Technique

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Abstract. Facial Expression is one of the most important ways of identifying the mental state of a person. And also expression analysis is the non verbal communication which explains the state of mind. The aim of the paper is to survey and analyze the facial movements of the toddlers or the preschool children which helps in identifying the discomfort occurs in them. The methodology involves expression detection using muscles in the face, eye, eyebrow, and mouth region and cheek alignment by image processing techniques. Its goal is to provide the parents to decode the facial expression with some basic information to help them to serve better and able to recognize the expressive signals of the infants and young children in their care.

Keywords: Expression, Feature Extraction, Expressive Elements, nasolabial furrow

I. Introduction

Reading facial expression is the only way to identify the activeness of the baby. At different stages different emotions are being expressed by the children. Non verbal facial clues which tells the parents about their state of activeness if any contraction occurs so more care has to be taken towards to improve them. Nowadays parents cannot able to engage the children completely to know their active state. Identification of facial expression is the only clue which gets the healthiness of the children.

The study of emotion recognition is complicated by the fact that emotions are faceted and thus varying methods must be employed to investigate the recognition of various affect on emotion labels. Studies with children have differed greatly in methodology and particularly in the types of responses required from subjects. Some investigations subjects have been asked to spontaneously produce a verbal label for a facial expression of emotion. In other studies a choice among emotion words has been required. Still other experiments have bypassed the use of affect vocabulary by asking children to match facial expressions to descriptions of emotion-inducing situations.

Since several researchers have concluded that the ability to recognize affective facial expressions precedes the ability to produce emotion labels. With these emotion labels children are able to communicate with the surroundings.

The paper mainly focuses in identifying the emotions of toddlers and the preschool children in their face through facial detection mechanisms and to identify the discomfort occurs in them.

Summary: The paper is organized in a way in which section 2 describes the state of art that is related to the work specified in this paper, section 3 details on the survey ideas of methodology involved in the pain assessment tools and section 4 provides the idea to enhance the existing system with improved accuracy.

II. State of Art

The state of art of this paper majorly covers the organization of the facial signals and its labels and with the results, the emotion are classified and gives the understanding of the discomfortness occur in the toddlers and the preschool children. The Emotion label gives the suitable inputs to predict the positive and negative feeling for the children. According to the International Association for the Study of Pain, "Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage"[6]. This makes the motivation for choosing the application. It is difficult for health care professionals to foresee which measurement systems apply to accurately measure pain in the pediatric population [1]. Health care professionals often prefer practical methods, which reliably track the child's pain experience and pain control over time whereas researchers tend to focus on tools, which are meticulously proven for reliability with different observers. Stages of showing facial emotions by the toddlers or the preschool children are analyzed on monthly basis [17] based on the development of the children. One year duration of expressions and feelings are surveyed completely in order to get the emotion labels from them.

Month1:

At month 1, infant makes an eye contact, cries for help and responds to parents' smiles and voices.

Month2:

At Month2, infant begins to develop a social smile, enjoys playing with other people and may cry when play stops, prefers looking at people rather than objects, studies faces, gurgles and coos in response to sounds around her and first begins to express anger.

Month3:

At Month3, infant begins to start a "conversation" by smiling at you and gurgling to get your attention. Smiles back when you smile at them. The big smile involves his whole body hands open wide, arms lift up, legs move, can imitate some movements and facial expressions.

Month4:

At Month4, infant begins to be intrigued by children. Will turn toward children's voices in person or on TV, laughs when tickled and when interacting with others and cries if play is disrupted.

Month5:

At Month5, infant becomes increasingly assertive and can differentiate between family members (parents and siblings) and strangers and likes to play during meals.

Month6:

At Month6, infant begins to quickly tire of a toy but will never tire of your attention, temperament becomes increasingly apparent, tends to be easygoing or easily upset, gentle or active, recognizes his own name, coos for pleasure and cries with displeasure and can make noises like grunts and squeals and clicks his tongue.

Month7:

At Month7, infant begins to understand the meaning of "no" and enjoys social interaction, expresses anger more strongly and tries to mimic adult sounds.

Month8:

At Month8, infant can differentiate between familiar and unfamiliar things, become shy or anxious with strangers, cries in frustration when they can't reach something that they really want to do.

Month9:

At Month9, infant can imitate gestures that other people make, looks at correct picture when an image is named, smiles and kisses own image in the mirror, likes to play near parent (i.e., in kitchen while Mom is cooking) and more sensitive to the presence of other children.

Month10:

At Month10, infant's anxiety may begin, self-esteem begins to develop, responds to positive recognition such as clapping, becomes cautious of heights, and shows moods such as sad, happy, and angry.

Month11:

At Month11, infant tries to gain approval and avoid disapproval and can be uncooperative.

Month12:

At Month12, infant may have temper tantrums, fluctuate between being cooperative and uncooperative, shows a developing sense of humor, and may cling to parents or one parent in particular.

By age 2, toddlers can show a wide range of emotions and are becoming better at regulating and coping with their emotions [19]. In fact, by this age, toddlers can even fake some emotions in order to get what they want. They know that if they fall and show behaviors of being hurt (even if they aren't hurt), they will get attention. Yet they will often still become upset at situations which affect their sense of their normal routine.

Other Developments in Infants

Besides emotional development in infants [19], they also develop other skills during the first three months of life. The Table 1 lists other development in infants which parents can take as a reference.

DEVELOPMENT	HOW IT DEVELOPS
Physical Development	Baby may be overwhelmed by various external stimuli like sounds, shapes and colors. Babies may cry a lot, but avoid shaking them to calm the infants down.
Vision and Hearing	Newborns begin to hear even before they are born. They have underdeveloped eye muscles, so even if they can see at close range, they cannot form visual images with meaningful shapes. By 6 weeks, their eyes can move in unison. Within two months, they are attracted to bright lights, primary colors, stripes, dots and different patterns. The first thing they recognize is the human face. In the first 3 months, they start to recognize particular faces and objects.
Body Using Skills	In the first 8 weeks, babies have no control over their movements. Their physical activities are mostly involuntary or reflex including grasping, sucking, startling and pulling to stand. By 8 weeks, they start to lift their heads and kick their legs while lying on their tummies. On the 3 rd month, they begin watching their hands and feet while they wave in the air. They also try to wave their fists toward you or some desired object.
Speech and Language	Crying is the only means of communication in newborns, so it is important for you to respond to her as soon as possible, which will help her to understand that you are there for them. By 7-8 weeks, they begin to coo and make vowel sounds. They listen to what you say and make noises back while 'talking' to you.

Table 1: Development in infants

ANALYSIS OF EXPRESSING EMOTION THROUGH STATIC POSTURE

The Different expressions of the toddlers or the preschool children are labeled as follows with some technical clues after analyzing with the expression analysis tool. The early studies suggested that the face is the most effective channel for expressing specific emotion [15], the posture provides more information about the Gross Affect, i.e. general information about the emotional state such as the degree of arousal or tenseness, but does not allow determining the specific emotional state. Some studies confirmed that the gross affect can be derived from static posture. For example, (Schouwstra and Hoogstraten 1995) generated 21 figures by varying three head positions and seven spinal positions and reported that a straight posture is judged more positively whereas the figure with pelvis backward, shoulder and head forward (leaning posture) was judged the most negatively[20]. Some emotions can be accurately decoded from a static posture.

Table 2 presents the features of postures that frequently occur depending on the emotional states. It compiles data from various studies[21].

Emotion	Frequent posture features
Anger	Head backward, no chest backward, no abdominal twist, arms raised forwards and upwards, shoulders lifted
Joy	Head backward, no chest forward, arms raised above shoulder and straight at the elbow, shoulders lifted
Sadness	Head forward, chest forward, no abdominal twist, arms at the side of the trunk, collapsed posture
Surprise	Head backward, chest backward, abdominal twist, arms raised with straight forearms
Pride	Head backward or lightly tilt, expanded posture, hands on the hips or raised above the head
Fear	Head backward, no abdominal twist, arms are raised forwards, shoulders forwards
Disgust	Shoulders forwards, head downwards
Boredom	Collapsed posture, head backwards not facing the interlocutor

Table 2: Expressive elements of posture

ANALYSIS OF EXPRESSING EMOTION THROUGH MOVEMENT

The study of nonverbal movements, argues that the dynamics of a movement can be sufficient to infer an underlying emotional state [18]. Both objective (using motion-capture data) and subjective studies showed that velocity, acceleration and jerk are movement's variable that is particularly affected by an emotional state. Table 3 reports the observations on which features of arm movement are characteristic of certain emotional states.

Emotion	Frequent features of arm movement
Anger	Lateralized hand/arm movement, arms stretched out to the front, largest amplitude of elbow motion, largest elbow extensor velocity, highest rising arm
Joy	High peak flexor and extensor elbow velocities, arms stretched out to the front
Sadness	Longest movement time, smallest amplitude of elbow motion, least elbow extensor velocity.
Anxiety	Short movement times, constrained torso range of motion.
Interest	Lateralized hand/arm movement, arms stretched out to the front
Fear	Arms stretched sideways

Table 3: Expressive features of Arm Movement

ANALYSIS OF EXPRESSING EMOTION THROUGH SPECIFIC GESTURES

Artificial Intelligence and Image Processing research has in recent years developed a focus on the recognition of emotions as expressed through facial gestures or expressions, conscious and unconscious. Facial feature extraction from images, and preserving or simulating a facial expression in a synthesized face, are key points in developing a system capable for effective human-computer interfacing, since by altering one's features into different facial expressions during conversation humans are able to communicate their emotions across and affect the flow of a spontaneous conversation. A raised eyebrow or a mouth contorted in a smirk or angry snarl can convey a person's emotional state. Humans have the ability to detect and interpret such facial movements and adapt their response in seconds or even milliseconds. Table 4 presents the adaptors observed when experiencing certain emotional states[22].

Emotion	Frequent adaptors
Anxiety	Touching or pulling the hair, plucking eyebrows, wriggling or interlocking the hands, opening and closing the fist, aimless fidgeting, hiding the face
Inhibition	Touching or pulling the hair, stereotyped and unnecessary movements, withdrawal movements, general motor unrest
Depression	Hiding and withdrawal gestures
Pride	Arms crossed in front of chest
Shame	Touching or pulling the hair, plucking eyebrows, wriggling or interlocking the hands

Table 4: Frequent adaptors involved in specific emotional states

III. Pain Assessment Tools

Children's accurate pain measurements are very difficult to achieve. There are three main methods used to measure the intensity of pain: self report, behavioral, and physiological measures.

Self-report measures are optimal and the most valid [4]. The verbal and nonverbal data require a certain level of perception and language development for the child to realize, understand and to provide reliable responses

Behavioral measures consist of analysis of crying, facial expressions, postures of body and its movements. They are which more frequently used with neonates, infants, and younger children where communication is difficult [7]. The Physiological measures include analysis of heart rate, blood pressure, respiration, oxygen saturation, palmer sweating, and neuro endocrine responses [8].

Physiological responses occur during stress.

3.1 Child Facial Coding System (CFCS)

The CFCS Facial actions reads the labels of eye brow lower, squint, eye squeeze, blink, flared nostril, nose wrinkle, naso labial furrow, cheek raiser, open lips, upper lip raise, lip corner puller, vertical mouth stretch, and horizontal mouth stretch.

3.2 COMFORT Scale

In COMFORT Scale the labels of Calmness/agitation, respiratory response, physical movement, blood pressure, heart rate, muscle tone, and facial tension are read.

3.3 Faces Pain Scale

In Face Pain Scale the Pain intensity Faces correspond to pain intensity labels are captured.

3.4 The Observational Scale of behavioral Distress (OSBD).

In OSBD the Eleven behaviors related to pain and/or anxiety labels are captured.

3.5 Poker Chip Tool

In Poker Chip Tool the labels of pain intensity Poker chips represent “pieces of pain”.

3.6 Oucher Scale

In Oucher Scale the labels of pain intensity faces correspond to pain intensity are captured.

3.7 Visual Analogue Scale (VAS)

In VAS, the labels of Pain intensity in terms of numeric and color are captured

3.8 Pediatric Pain Questionnaire

In Pediatric Pain Questionnaire the labels of information seeking, problem solving, seeking social support, positive self-statements, behavioral distraction, cognitive distraction, externalizing, internalizing etc are captured.

3.9 Premature Infant Pain Profile (PIPP)

In PIPP, the gestational age, behavioral state before painful stimulus, change in heart rate during stimulus, change in oxygen saturation, brow bulge, eye squeeze nasolabial furrow are captured.

3.10 Neonatal Facial Coding System (NFCS)

In NFCS, the labels of Brow bulge, eye squeeze, nasolabial furrow, open lips, stretched mouth (horizontal or vertical), lip purse, tout tongue, and chin quiver are captured.

3.11 Neonatal Infant Pain scale (NIPS)

In NIPS, the labels of Face, cry, breathing pattern, arms, legs, and state of arousal are captured.

3.12 Crying Requires Increased vital signs Expression Sleeplessness (CRIES)

In CRIES, the labels of Crying, increased oxygen requirements, expression, vital signs, sleeping are captured.

3.13 Maximally discriminate facial movement coding system (MAX)

In MAX ,the labels of Brow, eye, and mouth movement re captured.

3.14 Children’s Hospital of Eastern Ontario Pain Scale (CHEOPS)

In CHEOPS, the labels of Cry, facial, child verbal, torso, touch, legs are captured.

3.15 Observational Pain Scale

In Observational Pain Scale, the labels of Facial expression, cry, breathing, torso, arms and fingers, legs and toes, and states of arousal are captured.

IV. Inference of survey results

Based on the survey results with emotion labels and the pain assessment tools the emotions of verbal or non verbal communications can be clearly encoded and decoded. Figure 1 shows an animated picture of the emotion labels.



Figure 1: Emotional Expression of children.

To capture the perfect emotion of facial expression the adult person's expressions are captured to define the perfect label.

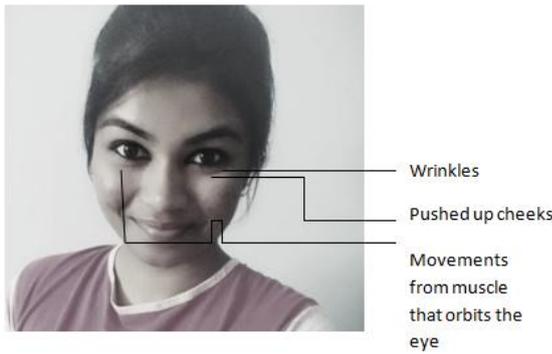


Figure 2: Lables of Happiness

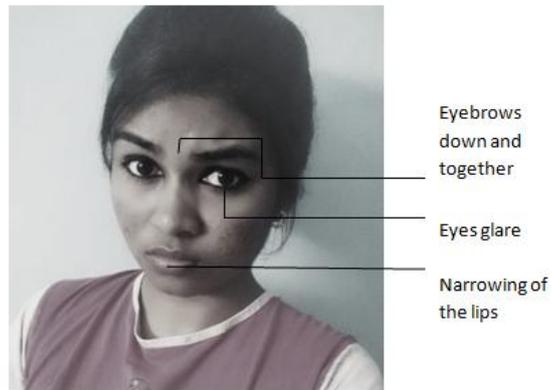


Figure 3: Labels of Anger

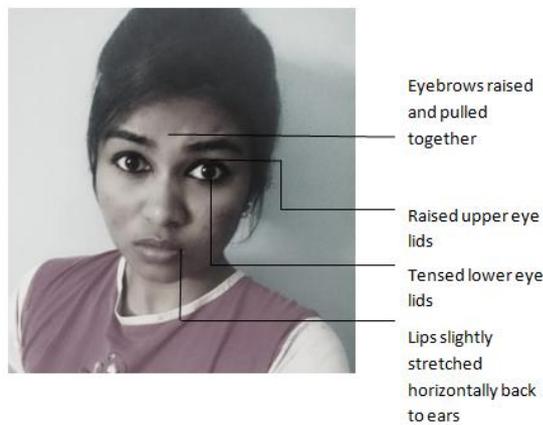


Figure 4: Labels of fear

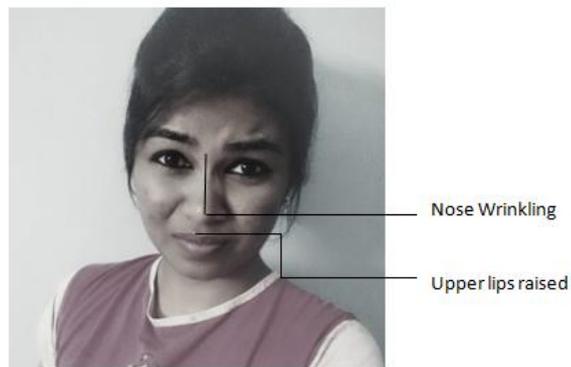


Figure 5: Labels of Disgust

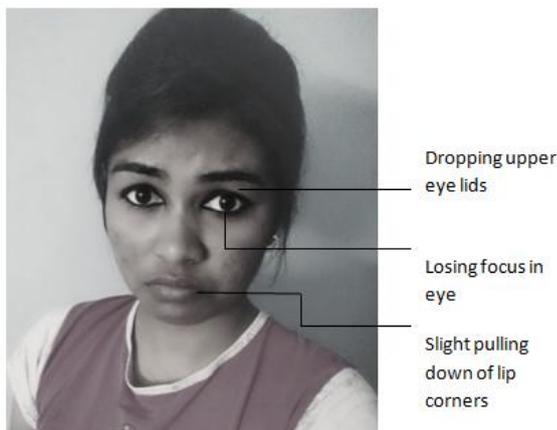


Figure 6: Lables of Sadness

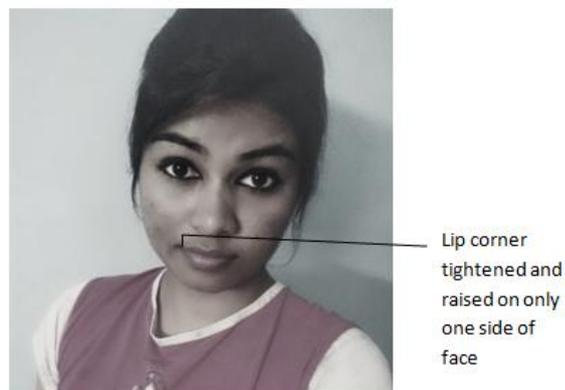


Figure 7: Lables of contempt

IV. Conclusion

This survey thus makes an analysis about the facial expression in toddlers and preschool children which decodes the verbal and non verbal communication into labels, which helps in identifying the discomfortness, occurs in them. The inference of this survey gives a best analysis of the assessment tools. The expression emotion through specific gestures gives the best result to classify the emotions in the children. The labels can be created perfectly with this technique.

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