Introduction
INTRODUCTION

FORENSIC SCIENCE AND PERSONAL IDENTIFICATION

Forensic Science is the application of the concepts of sciences to legal system and it provides various activities and specialties. It includes various branches such as skull identification, body fluid identification, grouping of body fluid, DNA profiling, firearm identification, identification of poisons, document examination, tool mark identification, identification of counterfeit currency, voice identification, identification of digital evidence and so on. The first system for personal identification was developed by Alphons Bertillon based upon body measurements (anthropometry).

The decomposed and disfigured dead bodies recovered from the scene of crime are to be identified to fix the deceased. Identification of unidentified skeletal remains is one of the main duties of Forensic Sciences Laboratories. The Skull-Photograph (ante-mortem face photograph) Superimposition (SPS) and DNA profiling are the two techniques employed in Forensic Sciences Laboratories to identify the skeletal remains. SPS technique was employed for first time in forensic setup by Glaister in 1935 (Glaister and Brash, 1937), but the DNA testing was started for identification only in 1986 (Butler, 2005). Since there is similarity in facial features of the victims to twins, siblings and close relatives, the SPS technique using ante-mortem face photograph provides only probable opinion on identification. Since the findings of DNA profiling on identification is conclusive, it is considered as primary identifier. The SPS technique is considered only second to DNA profiling due to its inability to produce definite identification. Although conclusive identity could be achieved
using ante-mortem dental radiograph or ante-mortem radiograph of head for superimposition, the availability of such documented records is scarce.

**RELIABILITY AND CAUTIONS IN SKULL-PHOTOGRAPH SUPERIMPOSITION (SPS) TECHNIQUE**

Brues (1957-1958) categorically stated that it would be proved awkwardly wrong when a person declared as dead by the Scientists presents alive. Extensive researches have been done on the reliability of SPS technique by many researchers. Earlier, the reliability of the opinions arrived from SPS technique appears to have been over-estimated (Sen, 1962; Helmer and Gruner, 1977; The Judgement of the case related to Shankar Vs State of Tamil Nadu; Trial No.3/1991 dated 17.7.92 High Court of Madras). Inspite of the methodical approach involved in SPS technique, more cautions have been insisted by the researchers like Stewart (1979), Koelmeyar (1982), Dorion (1983), Schimmer et al. (1993), Seta and Yoshino (1993) and Yoshino et al. (1995) regarding ‘false match or ‘mismatch’ that a skull may fit with a photograph of a person known to be alive. It was substantiated by the experimental evidence of Austin- Smith and Maples (1994) which proved the probability of mismatch estimated to be at 9% during superimposition of skull with a single frontal view photograph. Several authors (Chandrasekharan, 1971; Iscan and Loth, 1997; Steyn et al., 2000; Glassman, 2001; Gosh and Sinha, 2001; Jayaprakash, 2001; Naidoo and Steyn, 2001; Iscan et al., 2005; Ricci et al., 2006; Eliasova and Krsek, 2007; Stephan and Cicolini, 2008; Dirkmaat et al., 2008; Fenton et al., 2008; Ibanez et al., 2009; Raijion et al., 2009; Birngruber et al., 2010; Davis et al., 2010; Berar et al., 2011; Deng et al., 2011; Ibanez et al., 2012) suggested different methodologies to carry out craniofacial superimposition with its limitations.
Gordon and Steyn (2012) stated that a 100% positive identification rate has never been established with the possibility of false positives and false negatives being an ever present reality. They insisted for constant testing to ensure that the best available techniques and equipment are being used. They found 85% accuracy in skull-photo superimposition using morphological assessment and 80% accuracy in landmark based assessment in South African samples. Huete et al. (2015) presented a literature and international surveys on the past, present, and future of craniofacial superimposition. Hashim et al. (2015) prescribed superimposition technique for determining a frontal sinus pattern match. Jayaprakash et al. (2015) explained the relevance of whitnall’s tubercle and auditory meatus in diagnosing exclusions during skull-photograph superimposition.

**SKULL-FACE RELATIONSHIP**

The skull-face relationship was named as cranio-facial morphanalysis by Jayaprakash et al. (2001) who stated that it depends upon the assessment of morphological correlates between a skull and the corresponding face photograph. A correlation between the skull and the face (skull-face relationship) was studied by Broadbent and Mathews (1957), Krogman (1962), Moss (1965), Gerasimov (1971), Farkas and Lindsay (1973), Wolff (1976), Angel (1978), Gatliiff and Snow (1979), Stewart (1979), Rhine and Campbell (1980), Hodson et al. (1985), Caldwell (1986), Krogman and Iscan (1986), Macho (1986), George (1987), Fedosyutkin and Nainys (1993), Rosenstein et al. (2000), Jayaprakash et al. (2001), Taylor (2001), Stephan (2002), Wilkinson and Mautner (2003), Ghosh and Sinha (2005), Rynn (2006), Stephan and Simpson (2008), Balueva et al. (2009), Stephan (2010) and Deng et al. (2011), and the above authors established the applications of skull-face relationship. The above researchers also provided
criteria to increase the reliability and reduce the errors in forensic identification of skull. Jayaprakash et al. (2001) also added ten more new correlates between skull and face to their credit. His method is used as a conjoint application with SPS technique to eliminate the mismatch and increase the confidence of analyzing expert.

LIMITATIONS IN SKULL-FACE RELATIONSHIP

Iscan (1993a) has cautioned about the more common characteristic facial features in specific racial or ethnic group. The application of skull-face relationship reduces the errors in identification using the SPS technique. Since closely related individuals may resemble in their facial features, the findings from this technique cannot be given in definite term. But the findings have to be in qualified term that “the skull could very well have belonged” to the suspected dead individual as opined by Jayaprakash (2001).

RECENT STUDIES IN CRANIO-FACIAL SUPERIMPOSITION (CFS)

Since there is no systematic methodology in cranio-facial superimposition, Ibanez et al. (2009) designed a complete, automatic soft computing based procedure to aid forensic anthropologists in identification task by photographic supra projection. But they also stated that this fully automatic method is still to be refined by forensic experts to obtain good quality superimposition. Deng et al. (2011) estimated the facial appearance for human skeletal remains using the relationship between the soft tissue and the underlying bone structure and concluded that the facial feature shapes, such as eyes and nose, also deserve further research to improve the accuracy of facial reconstruction. The quality of the photograph is more important in skull-photo
superimposition, because all parts of the face are not always clearly visible and the camera angles and distance are the main criteria (Gordon and Steyn, 2012). Ibanez et al. (2012) proposed an advanced scatter search design for skull-face overlay in cranio-facial superimposition and further, they recommended it for future development. Even recent studies are unable to give conclusive result on skull identification using superimposition of skull and photograph. Ibanez et al. (2015) studied the performance of different craniofacial superimposition approaches and presented the ratings of different methodologies.

NECESSITY OF STRENGTHENING THE CAPACITY OF SPS TECHNIQUE

Forensic Sciences Department, Chennai, India, has well equipped Forensic Anthropology Unit, which receives around 200 skulls and photographs every year for personal identification. A total of 1399 cases have been referred for skull-photograph superimposition in the period between 2005 and 2010. A survey of records reveals that only 318 cases were received for a period about 15 years (from January 1973 to July, 1987) as pointed out by Chandrasekharan (1989). This survey proved the increased preference of SPS technique over the years. Before the establishment of DNA profiling technique, the findings of SPS technique was accepted in the court of law as a definite identification method (Shankar Vs State of Tamil Nadu, Judgement in Referred Trial No.3/1991 dated 17.07.1992 High Court of Madras). Of late, opinions of SPS technique are being questioned by the Court of Law as its findings are considered to be subjective and the Court of Law insists identification using primary identification technique i.e., the DNA profiling. As a result, difficulty is faced by the experts from Forensic Anthropology to defend their opinions from critical cross examination
in the court of law. Hence, a questioned is raised on the role of SPS technique in Forensic Sciences Laboratories.

Though the identification through DNA profiling is considered as conclusive, the identification of the deceased through DNA profiling is not feasible in all the cases because of various reasons. In instances like the absence of blood relatives such as parents and children of the deceased for comparison, the identification through DNA profiling is not possible in India. Some other reasons could also be attributed for its failure such as the high rate of decomposition, burning of the dead bodies at high temperature, bones buried in the soil for a longer period, and the preservation of the skull and bones in formalin (Pushparani et al., 2012 b). Hence the investigating agency has to resort to SPS technique for identification purpose. At this juncture, it is inevitable to assess the reliability and bring out its significance in skull identification.

Many researchers accepted that the asymmetries are the specific characters for skull and face identification. Facial asymmetries are indeed efficient in identifying people. The asymmetry of face is an individual characteristic, differing in perceptible ways even between identical twins (Mealey et al., 1999). Asymmetry in the bone is associated with the asymmetry of the muscle that anchors on the corresponding bone (Rogers, 1958, Jayaprakash, 2001). In this present study, the correspondence in asymmetry between the skull and face are quantified by a new methodology using the software Adobe Photoshop and AutoCAD. The uniqueness of the asymmetries in skull identification has been also tested in this study using a photograph with unrelated skulls and vice-versa by visual assessment. This study establishes the
use of symmetries and takes SPS technique towards eliminating the subjectivity in skull identification.

The thesis is divided into three Chapters.

I. Detailed report on the reliability of SPS technique based on the data collected from Forensic Anthropology and DNA Profiling Unit is discussed in Chapter I.

II. Significance of SPS technique in Justice Administration is dealt with its forensic importance in Chapter II.

III. The role of facial asymmetries for skull identification is explained and a new methodology is established as an additional tool for skull identification in Chapter III.
Review of Literature