Figure 8 represents the mean faces composed of 119 slices of our 115 scanned subjects. The color mapping gives standard deviation on the sample, from green (for a small STD) to red (High STD). This 3D map can now be used to make decisions on how a product interacting with the face is going to be designed and/or how an existing product is going to have to adapt itself (in terms of materials) if it goes through high STD zones.

We can see here that from the chin to cheekbones and going through the cheeks the STD is less than 4mm. This zone of lesser variability would then be the one to use when having a product interact with the face. Zones with a STD higher than 8mm are located around the nose and forehead. Those would be zones we should not consider when design a product.

5. Discussion

We can clearly see two main limits to this method. First of all, our registration process is using 3 angles and a reference point to bring models on an analogous base. We know that changing the reference point, would induce changes in the color mapping. This is easily explained by a null STD at the reference point. Further work is therefore needed on the registration process prior to normalisation and comparison between scans. For our next steps, we will be going toward a multiple point registration rather that just one point, therefore minimizing our mapping error.
Our second limit here is the required anatomical landmark picking. This is also a source of inaccuracy as it necessitates a subjective placement of points by an operator.
In order to avoid those two main limits, further work is necessary to use an automatic registration and spherical normalisation (allowing us not to work with a reference point and landmarks).
Finally, our method will have to be validated in regard to traditional anthropometric methods (2D measurements). This validation will be done on a more representative sample (1500 people). We will compare measurement on our mean face and standard 2D anthropometric measurements (and there standard deviation) such as bizygomatic breadth or Nose breadth.
Complementary to this result, we could compute principal component analysis or multidimensional scaling analysis of every slice for the whole population sample. With such computation Mochimaru [8] was able to categorize its population along two dimensions. Doing so would enable us to compute clusters among our sample.

6. Conclusion

This paper shows a new method to analyses specific body form of a sample population. Centered on face/head analysis, we managed to come up with a simple method, giving engineers and designers a tool to design product interacting with the face. The computed method hasn't been validated yet and current work is being done on an already scanned (Full head scans) sample of 1500 persons in France, Spain and Italia. In the process of improving our method, we have to keep in mind that our solution has to be time and cost effective as it is meant to be used in product design.
3D form analysis is the next step in anthropometry. It takes population morphology analysis to a higher level of precision and allows engineers and designers to come up with products that are always better fitted. The challenge here is to find a way to process a huge amount of data given by 3D scanners into a comprehensive material for everyone that is willing to design human interfaced products.

References

1. Howells,W.W., (1973): "A study by multivariate analysis of patterns of difference among recent human population", Paper of the Peabody Museum of Archaeology and Ethnology, Harvard University, 67, 259 pp
2. Snyder,R.G, Schneider L.W., Owings,C.L. (1978), "Infant child and teenager anthropometry for product safety design", Advances in Consumer Research Volume 05, eds. Kent Hunt, Ann Abor : Association for Consumer Research, Pages: 499-507.
3. Bradtmiller,B., (1993): "An approach to creating three-dimensional head forms for helmet sizing design", Proceedings of the 31st Annual Symposium of Safe Association, 244-249
4. LAI,S-H , CHEN,Y-L, (2003): "Learning a statistical 3D geometric head model", Proceedings of SPIE-IS&T Electronic Imaging, SPIE Vol. 5013.
5. KOUCHI,M.,MOCHIMARU,M., (2004): "Analysis of 3D face forms for proper sizing and CAD of spectacle frames", Ergonomics, 1499-1516,(18)
6. Bo,M., Wong,H-S., (2005): "2D clustering based discriminant analysis for 3D head model classification", Pattern recognition, 491-494
7. Biasotti,S., Giorgi, D., Spagnuolo, M., Falcidieno, B., (2008): "Size functions for comparing 3D models", Pattern recognition, 2844-2873, (41)
8. MOCHIMARU,M., KOUCHI,M., (2008): "Technologies for the design and retail service of well-fitting eyeglass frames: — Toward the mass customization business —", Synthesiology English edition, 1, 38-46