WEB BASED SOFTWARE TOOLS FOR 3D BODY DATABASE ACCESS AND SHAPE ANALYSIS

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In the context of the 3D-Centre project, UCL has addressed the problem of fast, secure and efficient storage and retrieval of large numbers of 3D body scans and associated information. Previous work has shown how it is best to organise a secure database for 3D body data and deal with the issues of space demands, secure access and suitable interfaces for dealing with this unconventional type of relational data. These technologies have enabled UCL to pioneer the currently ongoing UK National Sizing Survey, a project that aims to collect scans of approximately 10,000 people in order to build a representative sample of the UK population that will enable the re-assessment of the sizes and shapes of people (and possibly also of the sizing charts used by the apparel manufacturing and retail industry), for the first time, nationally in the UK, since the mid 1950's. Part of the work for this survey has been concerned with the extension of our database technology in order to build internet-based applications whereby the database is held in a centralised location and users access it via a secure web-based interface. The most important factor in the design of the database and interface is that it facilitates integration of market research data with body measurements, statistical information, and 3D data in a system that is simple and easy to use. The design was thus based on consideration of: ease of multiple user access, network bandwidth and security, data integrity, 3D web interfaces and database building in liaison with 3rd-party recruitment and data collection agents.

Outils logiciel basé sur le web pour l'accès aux bases de données de corps 3D et à l'analyse de forme du corps humain.

Dans le contexte du projet "3D-centre", UCL a adressé le problème de stockage et d'accès rapide, sécurisé et efficace, de nombreux corps 3D scannés et des informations qui leur sont associées. Les travaux précédents ont montré comment mieux organiser une base de données sécurisée pour les données de corps 3D, et gérer les problèmes de demande d'espace, d'accès securisé, et d'interface adaptée à la gestion de ces données relationnelles non-conventionelles. Ces technologies ont permi à UCL d'initier l'étude actuelle nationale sur les tailles au Royaume Uni, un projet dont le but est de rassembler des données scannées d'approximativement 10.000 personnes pour construire un échantillion représentatif de la population anglaise, ce qui permettra l'estimation des tailles et des formes des gens (et peut-être aussi des graphes de taille utilisés par les manufactures d'habillement et l'industrie de vente au detail), pour la première fois au niveau national en Angleterre, depuis le milieu des années 1950. Une partie du travail pour cette étude a concerné l'extension de notre technologie des bases de données dans le but de construire des applications internet, moyen par lequel la base de données est maintenue dans un endroit centralisé, et accédée par les utilisateurs au moyen d'une interface web securisée. Le facteur le plus important dans le design de la base de données et de l'interface est qu'il facilite l'integration de données d'étude de marché des mesures corporelles, d'informations statistiques, et de données 3D dans un système simple et facile à utiliser. Le design a ainsi été basé en considérant la facilitation d'accès à plusieurs utilisateurs, la bande passante et la securité du réseau, l'intégrité des données, les interfaces de web 3D, et la construction de la base de données en liaison avec des agents pour le recrutement d'un tiers et des agents de rassemblement de données.

Web-based Software Tools for 3D Body Database Access and Shape Analysis

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Abstract: In the context of the 3D-Centre project, UCL has addressed the problem of fast, secure and efficient storage and retrieval of large numbers of 3D body scans and associated information. Previous work has shown how it is best to organise a secure database for 3D body data and deal with the issues of space demands, secure access and suitable interfaces for dealing with this unconventional type of relational data. These technologies have enabled UCL to pioneer the currently ongoing UK National Sizing Survey, a project that aims to collect scans of approximately 10,000 people in order to build a representative sample of the UK population that will enable the re-assessment of the sizes and shapes of people (and possibly also of the sizing charts used by the apparel manufacturing and retail industry), for the first time, nationally in the UK, since the mid 1950's. Part of the work for this survey has been concerned with the extension of our database technology in order to build internet-based applications whereby the database is held in a centralised location and users access it via a secure web-based interface. The most important factor in the design of the database and interface is that it facilitates integration of market research data with body measurements, statistical information, and 3D data in a system that is simple and easy to use. The design was thus based on consideration of: ease of multiple user access, network bandwidth and security, data integrity, 3D web interfaces and database building in liaison with 3rd-party recruitment and data collection agents.

1. Introduction

Since the beginning of the 3D Centre Project[4], there have been vast improvements in the understanding of the problems and needs related to the implementation of a National Sizing Survey[5]. Additionally, the infrastructure work carried out by UCL[1,6] for that project has generated an appropriate knowledge base that enables us to form a very clear idea of the elements needed for the proposed application and the methods required to implement these elements. This knowledge base, combined with UCL's long-term expertise in human body modelling ensure that the development of a web-based application for access to the database of data collected through such a large-scale survey is a feasible task.

2. Background

The idea behind the UK National Sizing Survey (also known as the SizeUK project) is to gather data on the body size and shape of a representative sample of 5,500 men and 5,500 women from the UK population in order to achieve the following objectives:

- *Identify and classify the shapes and sizes* of the population.
- *Update the sizing charts* used by the UK clothing industry.
- Investigate the prospect of bringing forward a *new garment sizing system*, which not only can cater for the sizes of the population but can also intuitively describe the body *shape* of the customer each garment is made for (in order to achieve better fit).
- *Investigate the correlations* between body shape/size and marketing/socio-economic information on the population.
- Exploit the *full 3D body information* in order to achieve all of the above, rather than simply rely on a collection of 1D anthropometric measurements, as it has always been the case so far.

The result of the survey is a database that contains the following information for each of the 11,000 subjects used:

- A *three-dimensional whole body scan* of the subject.
- A collection of *marketing and socio-economic information* that constitutes the profile of the subject's shopping and spending habits when it comes to purchasing clothing.
- A collection of *body measurements*, most of which have been extracted from the scan using automated tape measure simulation software (plus a small amount that have been manually extracted using traditional instruments such as tapes and callipers)

What constitutes a novel approach that differentiates this survey from other ones is the use of 3D scanners for the collection of the body measurements. There are two major advantages of this approach:

- It only takes a *few seconds* for a *non-expert* operator to capture a 3D body scan and extract from it the set of 100 or so body measurements necessary to generate an profile of the body's shape. On the other hand, the same set of measurements would take up to *one hour* for an *expert* measurer to extract. This would mean that a survey of such a large sample would be practically impossible, as it would take a few years to complete, and the cost would be inhibitive too.
- A set of anthropometric measurements is only an *indirect profile* of a person's shape; it can only be used in a *limited number* of ways in order to perform shape analysis; and it really only gives information about the *size* of a person. On the other hand, a 3D scan is a *direct profile* of a person's *size and shape*; it can also be stored for future retrieval and it can be used with an *unlimited* number of available shape analysis algorithms.

The information contained in the database of scans, measurements and marketing data is meant to be available to two groups of users: *Clothing industry researchers* and *academic researchers*. These users can use the database to perform data analysis that could benefit initially the clothing industry, and subsequently other research domains where body shape is important (medical nutrition research, ergonomics, and even the entertainment industry).

All these potential users need an easy, flexible and powerful interface for access to the data. This interface could be a standalone application, working on data stored in individual media copies such as CD-ROM's. However, there are practical disadvantages to this approach. Distributing multiple physical copies of the database is not an advisable practice. Firstly, these data are *commercially sensitive* as they represent high potential profit for their user. It is impossible to control distribution of hard media. Secondly, data are also *ethically sensitive*. Subjects have their body image captured in various stages of undress, there is therefore a legal, moral and ethical obligation to protect them from potential abuse of their images for 'illicit entertainment' purposes. Thirdly, there may be potential upgrades to the software, which would typically include also changes to the data itself, such as the database structure, the addition of new information fields, and the a-posteriori correction of content that may have been incorrectly uploaded. In such cases, costly and tedious re-distribution of the database would be necessary.

All the above factors necessitate the use of a *centralised approach*, where there is a *single copy* of the database available, and users access it securely through an online mechanism – hence the motivation for developing the database interface as a set of *Web-Based Software Tools*.

3. Design Issues

The application should comply with the following requirements:

- *Automation*: Every function available to the user must require a minimal amount of user intervention. In particular, functions related to 3D data processing must ideally be completely automated.
- *Ease of use*: The application must incorporate a simple, clear, helpful graphical user interface, as it is meant to be used by semi-expert or non-expert operators.
- *Flexibility*: The application must use simple and standard data formats for input and output, so that it may easily communicate data between other applications available on the market.
- *Reliability*: The application should be capable of processing almost every data set mentioned in its specification. In case of failure it should retain its run-time integrity and inform the user of the nature of and reason for the failure, suggesting possible actions in order to complete an operation successfully. Part of the development should include thorough reliability testing.

3.1. Performance

The application needs to be capable of serving *multiple users* simultaneously. Each user request typically generates a database query (Figures 2, 3, 4) whereby data (including 3D geometry) must be interrogated, processed, compiled and returned to the user. Returned information may include bandwidth-hungry 3D data, which implies that the entire application needs to be designed so that the available bandwidth and processor power are fully utilised. In particular, three actions need to be taken in order to improve the performance of the running application (ideally to a response-time of a few seconds per query):

- *Simplification* of the 3D body representation, by means of subsampling and rearranging the 3D points in the scan in order to reduce the level of detail to the minimum allowable without compromising the accuracy of the data for analysis purposes.
- One-off, off-line *precalculation* of as many quantities as possible (especially the time-consuming but otherwise invariant shape descriptors and reduced L.o.D. 3D bodies) at the time of data uploading.
- *Database optimisation* at the time of design, by use of canonical forms, relational calculus, primary keys and fast indexing mechanisms that speed up the database searches (even at the cost of slowing down data uploading)[2].

Obviously, along with the above, ample computational resources (hardware) must be used throughout wherever possible: At the server side, high-end machines with multiple processors, SCSI/RAID hard disks, gigabytes of RAM, megabytes of cache memory, large buffer space for a proxy server, and broadband internet access such as ISDN/ADSL; At the client side, accelerated graphics hardware, megabytes of disk space available for web browser cacheing, and the speediest Internet link available (ideally broadband).

3.2. Security

As a result of the security issues stated in section 2, care needs to be taken to protect the database from intruders. The list of necessary measures includes (but is not limited to) the following:

- *Centralised control of user access*. There should be a single administrator responsible for allocating and removing user accounts, as well as monitoring users' conduct in order to make decisions about barring access to users who attempt to override their privileges.
- Utilisation of all standard *network security software* such as firewalls, network intrusion detection systems, disallowing the set-up of trivial

user passwords and, if possible, 128-bit encryption.

- *Protection of visual data* by ensuring that they are made unrecognisable (in the UK, this is actually a legal requirement under the Data Protection Act[7]). In the case of 3D scans, it is recommended that the face is blurred, distorted, smoothed out or (best approach) altogether removed from the 3D data.
- *Protection of the subject's personal details* that could be used for identification and/or unsolicited communication (also a legal requirement in the UK[7]). The approach followed in the SizeUK project was that details such as name, address, telephone numbers and e-mail addresses are NOT included in the database at all. Instead, each subject is assigned a unique 5-digit ID number upon or soon after recruitment. In that way, even a successful intruder cannot obtain identity and contact information.

3.3. Working with 3D data

Owing to the nature of 3D data (typically represented by large files), in combination to the number of records involved (order of 10^4), it is apparent that the demand for space is well above average[1,6]. The database system used needs to be capable of handling *gigabytes* of storage, without compromising on the speed of retrieval. It is generally desirable to incorporate the body data into the database rather than storing them into an external file system. This allows the implementation of easier methods of retrieval and processing, and at the same time increases security as in introduces an additional layer of protection against potential intrusions.

One of the major requirements of the Software Tools package is the ability to generate 3D averages of the bodies of all subjects returned by a query. In order to be able to generate these average bodies (and also, in the future, create the 3D Point Distribution Model (PDM) of the human torso), it is necessary to normalise each of the torsos in the query set such do that they are composed of an equal number of anatomically equivalent surface points. We call this representation "*Canonical representation*", but it can also be found in the body modelling literature as "*regular*"[9,10] or "*normalised*"[11] representation. In order to achieve this, each of the body scans, which was represented by an unorganised set of points, was first arranged into an ordered set of horizontal slices (pl. see Figure 1). Anthropometric survey data was then used to segment each of the scans at the armpit, crotch and neck levels, to remove the arms the legs and the head, leaving just the torso. Interpolation techniques were used to convert the torsos into a canonical representation with an equal number of horizontal slices and an equal number of points per slice. The decision as to how many points to use was made so as to ensure that the required level of surface detail was preserved.

Future implementations of the SizeUK Software Tools may include more of the body, i.e. arms and legs[8,9]. However, a canonical representation for an object with complex branched topology is not easy and straightforward to design nor to implement, and it has been left out at present.

The resulting canonical representation of torsos can be easily rendered as quadmesh surfaces. Since ease-of-use is a crucial requirement for the type of software described here, it is important to design the web interface of the application in a seamless way that offers interactive functionality at the same level as offered by modern 3D data manipulation and CAD application. For the SizeUK software we implement an approach based on VRML data displayed in a number of client browser windows. The client areas are controlled by Java modules that allow a level of user interaction. Figure 6 shows a screenshot from the display of a human torso, where the user is able to define and view cross-sections of the 3D shape in three different orthogonal directions.

It is worth noting that both the canonical form and the tri-directional slices are precalculated at the time of data uploading. This is a trade-off, since the user cannot choose the sampling frequency. This is predetermined by a number of empirical and statistical factors so that slices are dense enough for data analysis purposes. Instead, however, this means that the slice points can be stored in index tables in the database, which allows fast retrieval rather than time-consuming calculation, resulting to overall better response times

Moreover, the resulting VRML files may be downloaded by the user for further processing using a generic CAD or 3D-manipulation software package. A potential application may involve conversion to DXF and feeding into CAD/CAM software for the manufacturing of workroom stands.

3.4. Data Collection

To ensure that the Tools work reliably, the development team needs to be provided with as much information about the scanning hardware used and about the data file formats involved as possible. Preferably, this information could be provided to the development team well in advance. VRML is the preferred format for data interchange, since it is a widely accepted standard and also relatively easy to work with. It was initially stated that it would be a great advantage if the vertices in the VRML file came organised as horizontal slices, as this would make the development of the tools much easier and would also improve their performance significantly, as it would allow the use of more efficient data structures. However, this has not been possible for a number of reasons, so the unorganised dense point cloud was supplied instead, and the development team produced the canonical form generator.

Another very important issue regarding data collection is the establishment of a reliable and efficient *communication mechanism* between the various teams working within the project (Recruitment Agents[5], Hardware Providers, Data Collectors, Software Developers, Data Hosts and Data Analysts, as described in more detail in Section 4). There are some attributes that constitute the absolute minimum set of information necessary in order to develop reliable and robust software. This information is:

- The *units* of measurement used for representing the co-ordinates of the vertices within a scan file.
- The location of the *origin* of the co-ordinate system used relative to the scan.
- The arrangement of the *axes* of the co-ordinate system.
- The arrangement of the groups of vertices (if any).
- The *completeness* of the scan (i.e. each scan added to the Data Hosts' database will be assumed to cover the whole body surface).
- The *cleanliness* of the data (each scan file should either have all outlying data removed using the manufacturer's software).

3.5. Data Loading

Because of the size of the database, the actual uploading of data is an important issue that must not be overlooked. Although the loading is generally *not* a part of the Software Tools development, it is a lengthy process that is crucial to accomplish correctly on the first attempt, otherwise it may lead to significant delays and repeated attempts that prolong the development and jeopardise the integrity of the content. For the purposes of SizeUK, a 'Loader' program was developed for copying scans, measurements and marketing data onto the database.

In fact, the 'Loader' is much more than a simple copying utility. It is a sophisticated piece of software that performs the numerous tasks that involve addition or modification of database content, such as:

- Data *integrity checking and validation*.
- Generation of *canonical body representations* and slice information.
- *Interpretation and validation* of the input spreadsheets that contain the measurements and market research information
- Creation and *management of user accounts*.

It is essential to test and rehearse the Loader thoroughly before using it for uploading any real data, in order to ensure that nothing is omitted or wrongly encoded into the complex database structure. Besides, since loading also includes intensive calculations and processing, testing is lengthy when a non-trivial number of records is involved. Moreover, the Loader is a good means for testing the *scalability* of the database schema. Most tables are indexed in order to facilitate speedy interrogation and searching, but the trade-off is slower updating and adding of records, as the entire table needs to be re-structured every time a record is added. Once the size of a table exceeds a few hundred records, the Loader becomes noticeably slower. Since all data tables need to be filled with approximately 11,000 records (or multiples thereof, depending on the structure of some tables), it is essential that the increase in loading/processing time per new subject is no more than linear, otherwise a scalability problem may occur, and it will typically be resolved by re-designing the database, or the Loader itself, or both.

Another important issue is the design of the *database schema*. All types of information that need to be contained in the database must be known to the Software Development Team prior to the building of the database and the development of the Loader, otherwise the Loader is impossible to develop. It is even more important for the schema to be finalised before the development of the Loader commences. It is possible to design the database so that some particular fields of information can be added a posteriori (the SizeUK database, for instance, is designed so that it can accommodate future addition to the body measurements spec, so that nothing needs to be re-written if new measurements need to be added in the future). However, this is not possible for every kind of information.

There must therefore be a communication mechanism between Software Developers, Data Collectors and Data Analysts in order to ensure that:

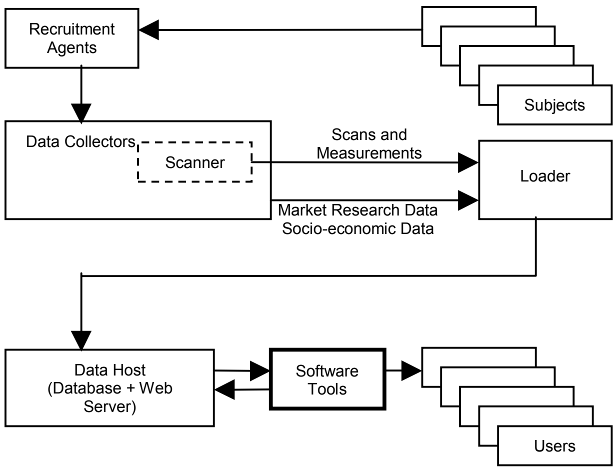
- Collectors and Analysts *agree on the types of information* that needs to be collected, and supply this information consistently to the Developers.
- All three parties agree about which one party is responsible for holding the *latest version of the schema* at all times. This party must also undertake responsibility for informing the other two parties of any changes (in order to prevent the situation where the Developers are building the Tools/Database/Loader based on an outdated version of the schema)
- All three parties agree and undertake to use the *same naming and labelling information for each field of information*. Especially the data collectors must undertake the responsibility to conform by the naming conventions when supplying data for uploading, otherwise the Loader's parsing mechanism will *fail* and the data will not be loaded.

In addition, the three parties along with the Subject Recruitment agent must agree to any applicable rules for structuring the individual subject ID's. Once data collection has commenced, *all parties must use exactly the same ID's*, otherwise it is impossible to associate scans with measurements and marketing information (which, in their "Loader-ready" form they usually come from different sources), and this is a high risk factor, as it may render the entire database unusable and useless.

Finally, it is clear that the associate responsible for assigning subject ID's must undertake the responsibility to ensure that *no duplicate ID's* are generated, as this constitutes an equally high risk factor.

4. Hosting and system structure

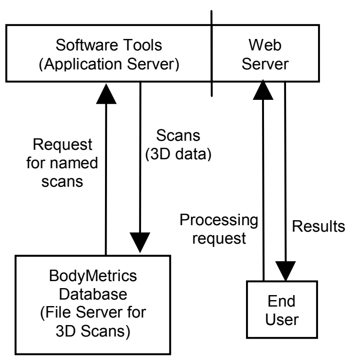
The diagram below illustrates the structure of the SizeUK operation, and the position of the Software Tools within it.



As it can be easily seen, development of the Software Tools for database access is a relatively high-risk operation, since it is dependent on information that is passed down a chain of multiple parties. The co-operation and communication among those parties themselves, as well as between the software development team and each one of the individual parties is crucial in order to design a working model and get the implementation right at the early stages of development.

The development team will need to be given information by the Data Hosting Agents in order to achieve seamless and reliable interfacing between the Tools and the database that holds the data to be processed by the Tools. To achieve acquisition of all necessary information, the Data Hosting Agent must agree to liase with the development team, with both parties signing (where appropriate) the necessary Non-Disclosure Agreements and other related documents.

The interfacing structure has been proposed to be as in the diagram below:



The web server software used will be hosted on the machine provided by the Data Hosting Agents. The web server will also support CGI scripts[3], so that all front-end code can be written in that form. In that case, no separate application server software will need to be installed at the user's end of the connection.

5. Data output and analysis

This section describes the methods through which the user can access the results of database queries for further exploitation.

5.1. Data Output

As already described in 3.3, VRML is used for the transmission and display of 3D data to the user. Users have the option to download the VRML for further analysis using their own 3D data manipulation tools. Legal limitations[7] may necessitate an executive decision to disable that option for some or all of the users. The decision made for the purposes of SizeUK was to allow the users to download the impersonal, statistically created average 3D bodies, but prohibit the downloading of individual 3D images of real people from the database, as this may still constitute personal data even if the head/face areas are not included.

Output of *non-3D information* (e.g. all other data such as measurements, landmarks, market information, socio-economic grouping, shape descriptors) is made by exporting to generic formats such as comma-delimited text and XML[12] (since all of the above constitute query results that come in a tabulated form by default). The user can then download the exported files the for use with standard data analysis packages such as Excel, SPSS, etc

5.2. Basic Data Analysis

In addition to exporting data directly from the database as a result of effecting a query, the software performs some basic analysis for each set of query results. This is done by carrying out some aggregate statistics on the returned data and calculation of quantities that are likely to be necessary for most kinds of subsequent data analysis. These calculations include but are not limited to the following (Figures 5, 6, 7, 8 and 9):

- *Basic Statistical Quantities:* Calculation of the average and median size over a number of subjects.
- *Percentiles:* Calculation of the percentage of subjects that fall within a user-specified size range.
- *Measurement Span:* Aggregation of the maximum and minimum measurement values for a user-specified subset of standard measurements across a set of subjects.
- *Confidence Levels:* Calculation of the confidence level of the probability of a person belonging to a particular size group.
- *Measurement Relationships:* Aggregation of the values for pairs of measurements across a dataset

in a form that allows them to be plotted against each other (by means of exporting the data to an appropriate application such as Microsoft Excel).

- *Size Charts:* Aggregation of measurement values for a user-specified subset of standard measurements across the data for a set of subjects in a form that allows them to be plotted as size charts (or by means of exporting the data to an appropriate application such as Microsoft Excel – Figures 7, 8, 9).
- *Cross-section analysis:* For each 'slice' of the 3D torso described in 3.3, calculation of the contour length, convex hull length, moments and principal axes (shape descriptors – Figure 6).

6. User Access Control

In order to prevent unauthorised access to the data, it is important to decide on an efficient policy for setting up user accounts. After the initial rollout, the number of users may increase to an extent that it becomes impossible for the Database Hosts to manage. Furthermore, the administrators of the database and software tools need a mechanism that allows them to check whether an applicant should be entitled to an account.

Since the likely 'customers' of the service are organisations (commercial or academic) rather than private individuals, it is possible to offload some of the administration effort by making the organisations partially responsible for the creation and management of accounts for individual employees.

This is possible by introducing two levels of authorisation: on the first level, the client organisation nominates an authorised individual who signs a legally binding paper form. On the second level, all requests for accounts for individuals within an organisation are made through that authorised respondent. At this stage, the following options can be given to the organisation:

The first option is a *single account* for all the employees within an organisation. The authorised respondent is responsible for disclosing the access details to individual employees. This is not the most secure option, as the number of individuals who know the username and password and can access the data may spiral out of control. However, it minimises the management effort, as long as none of the employees who know the organisation password depart (in which case the authorised respondent should change the password and inform all employees who need access)

The second option is *multiple accounts* for individuals or groups within the organisation, with *account management by the Data Hosts*. This the most tedious, yet the most secure option. The Data Hosts receive requests from an authorised respondent and they can check all applicable credentials before creating a new account. They can also immediately remove or disable the account of a user who is suspected of attempting to abuse the data.

The third option is *multiple accounts* per organisation, with *account management by the organisation's authorised respondent*. In that case the Data Hosts provide the respondent with administrative rights to the database, and supply either additional web functionality (higher risk) or a standalone access applet (lower risk). The respondents can then manage accounts in the Hosts' absence. This is fairly secure as long as the respondent is trustworthy and the organisation agrees to undertake responsibility for breaching security.

In all cases, an additional security measure is enforceable: Accounts can be set up so that each user may only access the data from *a particular IP address or a small range of IP addresses*. This means that each individual may only log on to the database and use the access tools from the premises of the organisation they work for.

7. Conclusions

The SizeUK project has been a pioneer operation that has addressed the issues related to the use of 3D technologies for the rapid and large-scale acquisition of body and market data for the clothing industry. We expect that the experience acquired throughout the National Sizing Survey will contribute to the standardisation of methodology for anthropometric surveying. Similar exercises are being planned in other countries, and there may even be an EU-wide sizing survey in the mid- to long-term future[13]. We hope that these future operations will benefit from our current experience.

8. Acknowledgements

The authors wish to thank: The DTI-supported Foresight-LINK Award 3DCentre/SizeUK project, through which the work presented here was carried out; [TC]² for supplying the scanners for the SizeUK survey; Mr Avy Tahan, the London College of Fashion, and BodyMetrics Ltd for their collaboration and assistance in the development of the presented work.

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13. e-T Cluster project: Developing Common Standards for the Integration of 3D Body Measurement, Advanced CAD, and Personalised avatars in the European Fashion Industry. Website: http://www.atc.gr/eT-Cluster/

(Pictures and screenshots from next page onwards)

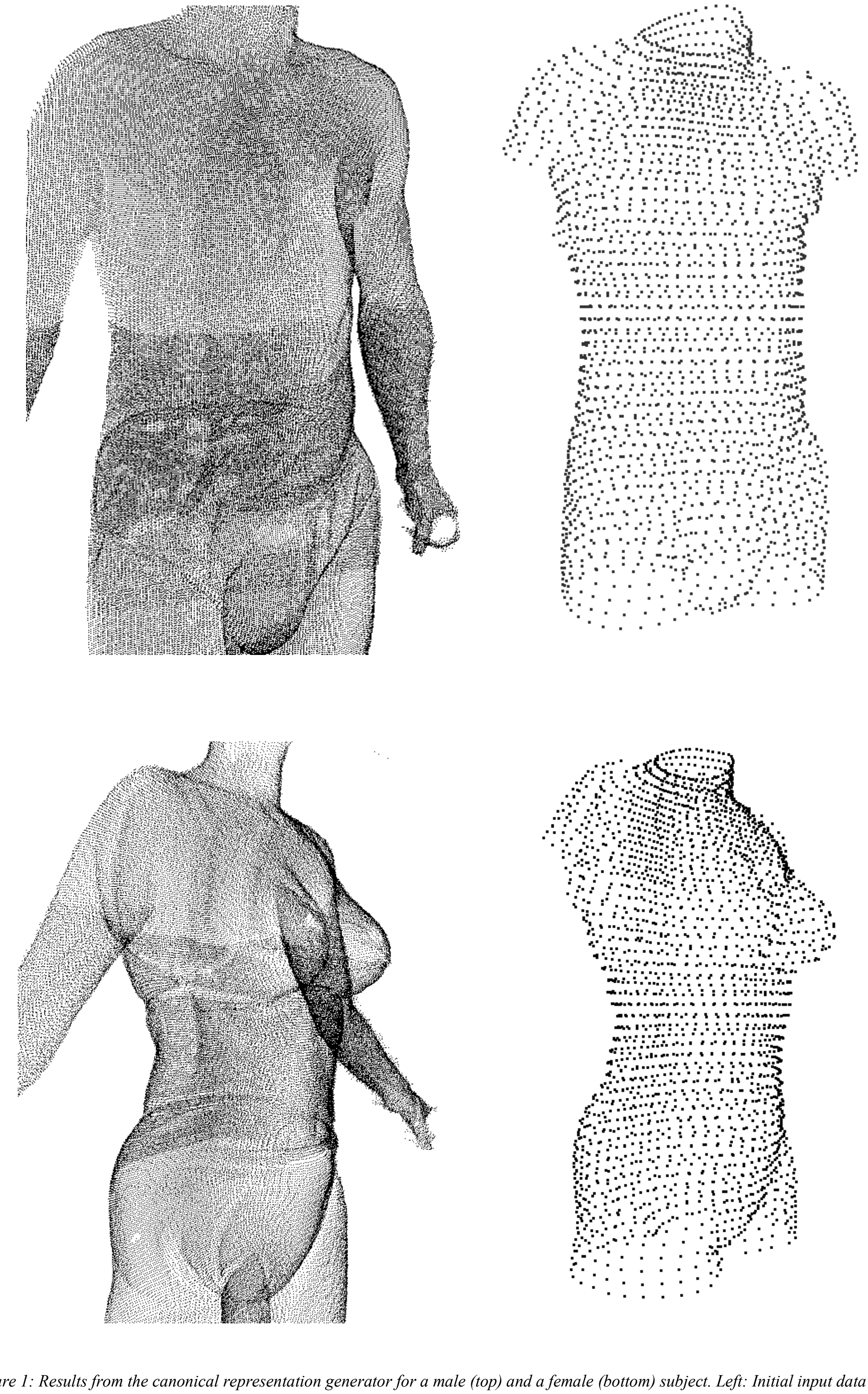

Figure 1: Results from the canonical representation generator for a male (top) and a female (bottom) subject. Left: Initial input data (3D point cloud); Right: 'sliced' canonical representation.

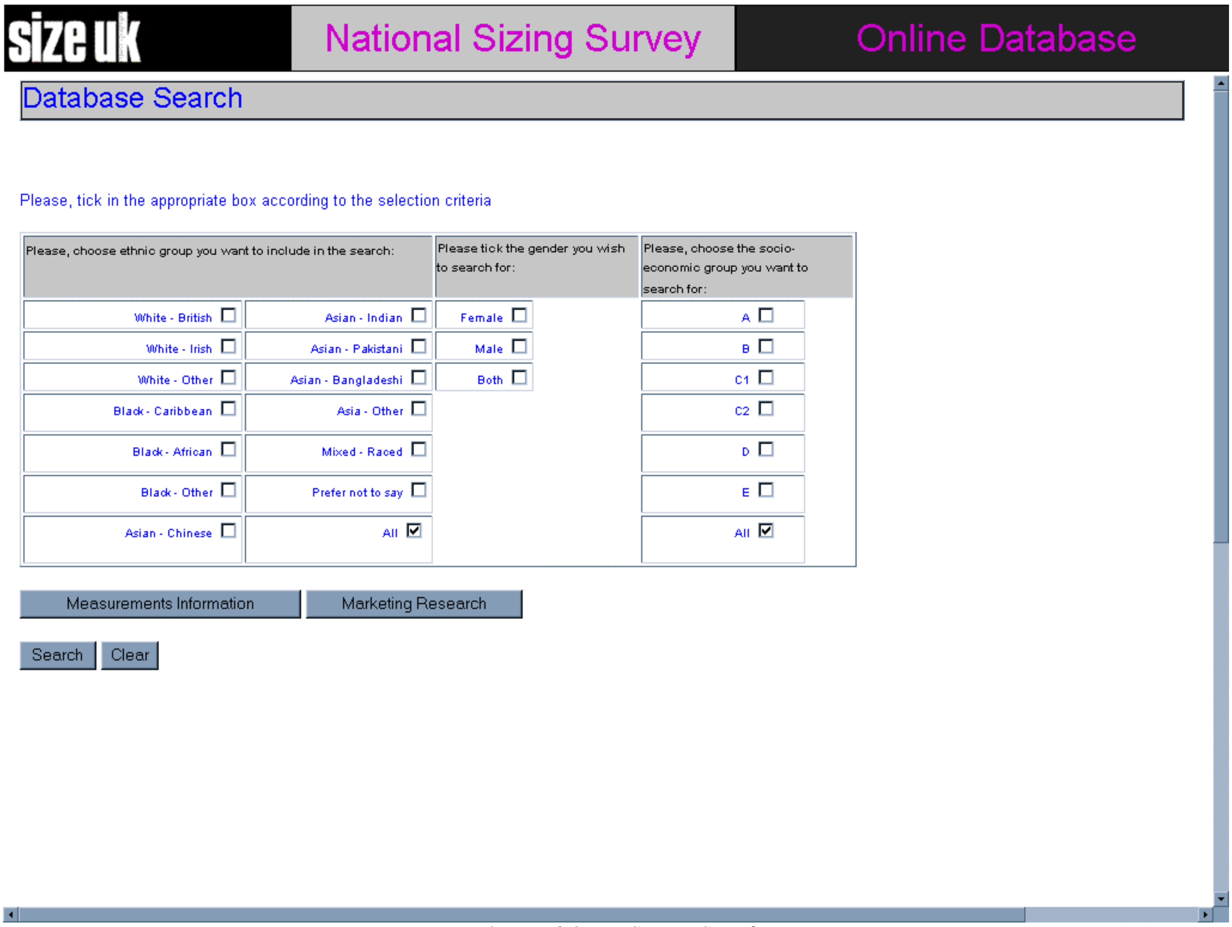

Figure 2: Initial Query Criteria Specification

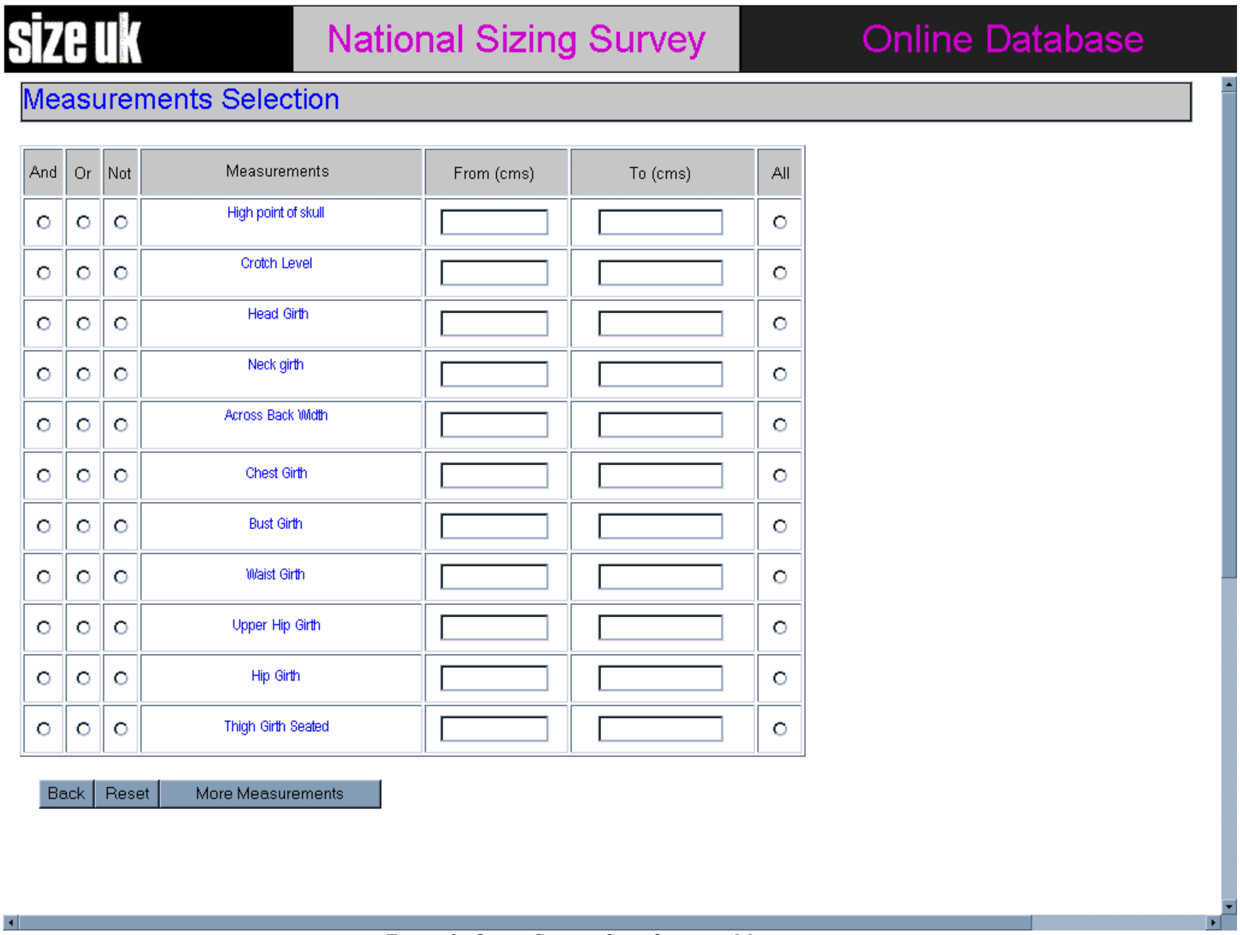

Figure 3: Query Criteria Specification - Measurements

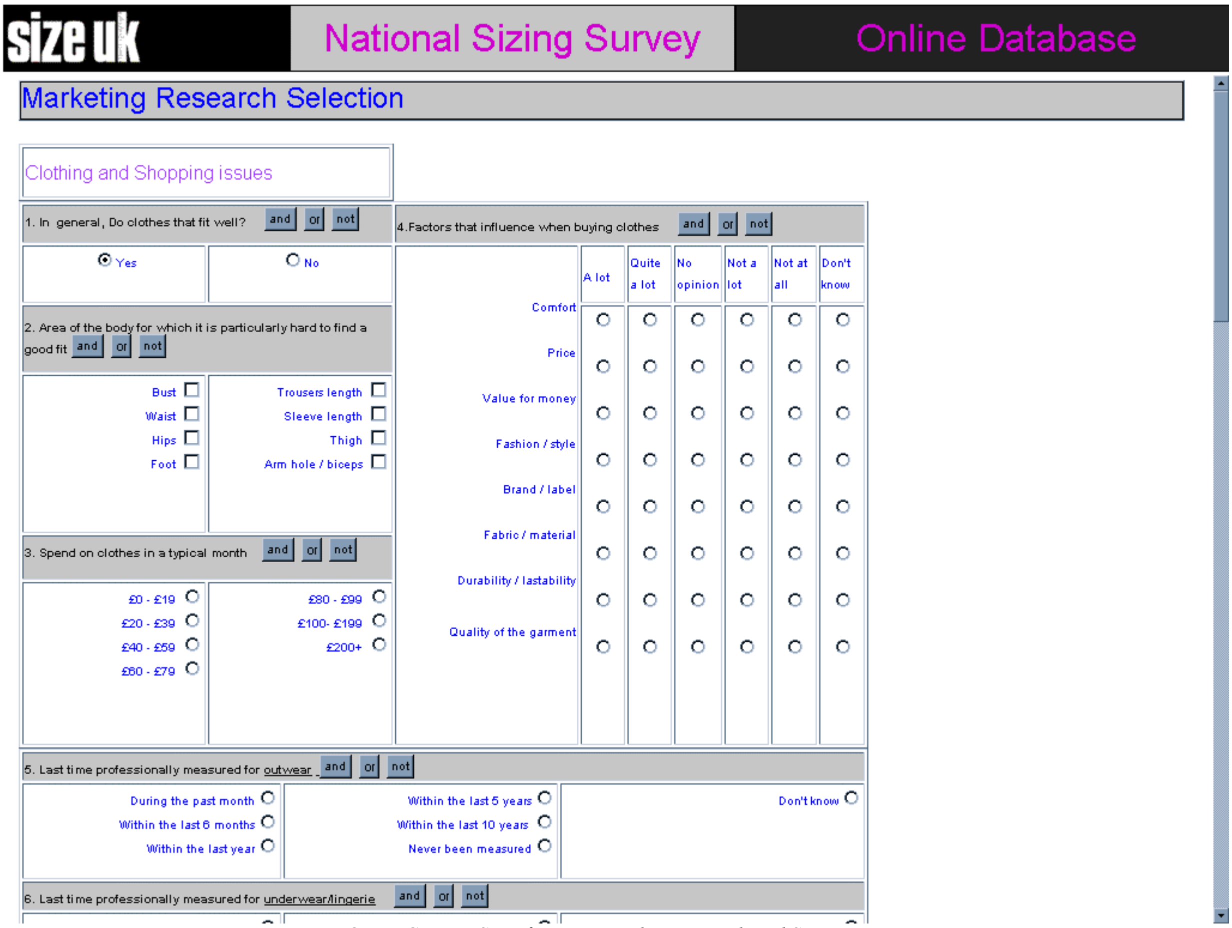

Figure 4: Query Criteria Specification: Market Research and Socio-economic Data

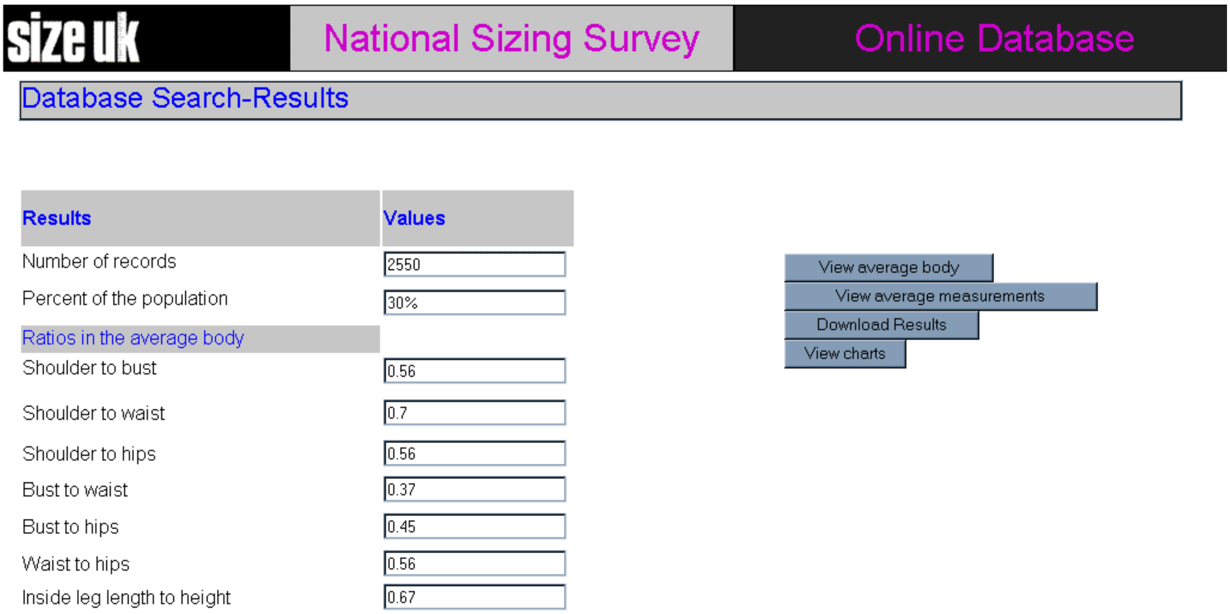

Figure 5: Query Results: Basic Aggregate Statistics

Figure 6: Query Results: Average 3D body and cross-sections visualisation and statistics.

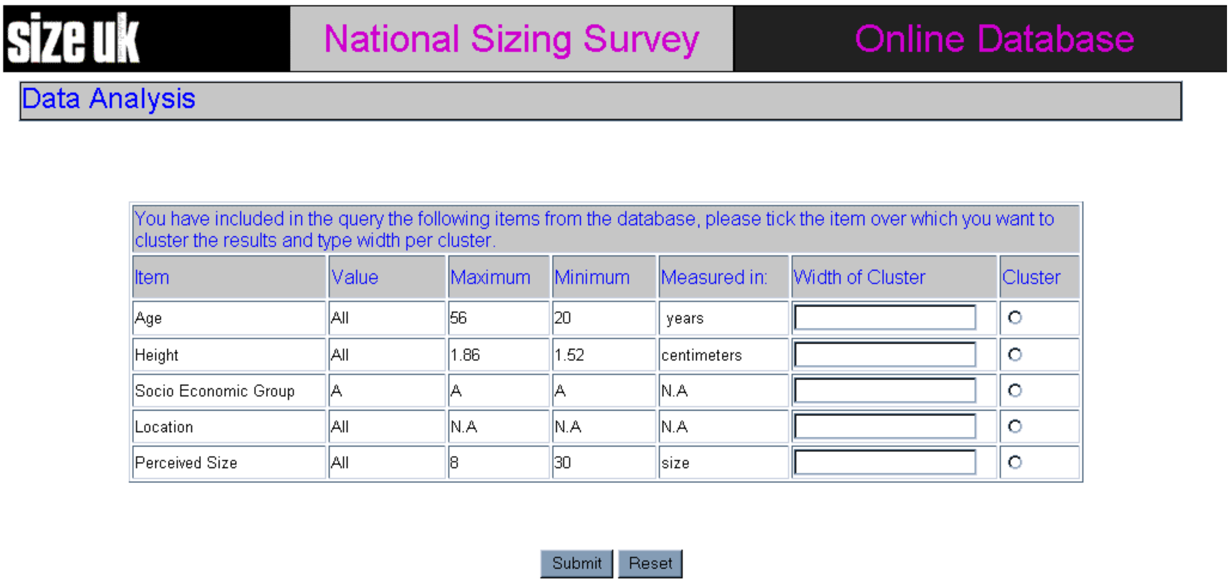

Figure 7: Basic Data Analysis: Specification of clustering of query results

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Data Analysis-Clustering Data- General Results

Chart Clustered by:	Number of Clusters:
Size	12

Fields	Value
Age	All
Height	All
Socio Economic Group	All
Location	All

Number in sample	2500
Average (mean)	14
Average (mode)	2
Minimum	8
Maximum	22
50% of set	14
75% of set	16
90% of set	18
Standard Deviation	1.717
Variance	2
Confidence Level	96%

Download Data Analysis

View Clustered Data

Figure 8:Basic Data Analysis: General results of data clustering

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Data Analysis Clustered Data

Chart Clustered by:	Number of Clusters:
Size	12

Fields	Value
Age	All
Height	All
Socio Economic Group	All
Location	All

Values	8	10	12	14	16	18	20	22	24	26	28	30
Number in sample												
Average (mean)												
Average (mode)												
Minimum												
Maximum												
50% of set												
75% of set												
90% of set												
Standard Deviation												
Variance												
Confidence Level												

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Figure 9: Basic Data Analysis: Template of data clustering for perceived size