Original Article

The software instrumen for gymnast posture analysis

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ABSTRACT

The general aim of this research was to develop an ideal instrument to analyse the ideal anthropometric posture of artistic gymnastic sports so that profiles and proportions of the length of the athletes were ideal through analysis images. Research and development methods used the following paths for problem identification, information gathering, product design, design validation, product testing, trial used and mass product manufacturing. The results of the study contain software design (UNG) with the performance of storing and analysing images by adjusting the real coordinate scale and height digital scale as a reference to measure the athlete's body length and the degree of posture imbalance. Validity was measured in two ways, namely correlating the standard length gauge No. Reg C4 / VI / 250419 with measurements in the software amounting to 0.92 very high categories and averaging in hundreds of assessments of 92 ICT experts and sports experts at 96.5. Reliability using retest was .95 very high category. Posture Image Analysis of 150 male world gymnasts All the figures around depict the average height, Percentage of limb length, posture imbalance. in degree, posture analysis which is suitable and efficient in displaying for each exercise.it describe an average height of 166 cm with a leg length proportion of 54%, Body 26%, Head 13% and neck 5%. The conclusion of UNG software was to effectively analyse the profile image of the sample male artistic gymnastic ideal to produce a profile and the length of anthropometric proportions of the athlete's body members in accordance with the actual object.

Keywords: Posture analysis; Software posture; Height analysis; Anthropometry; Gymnastic.

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INTRODUCTION

Anthropometry is a distinctive characteristic of each individual. The essence of Anthropometry is also a collection of numerical data that shows the size, shape, and strength of humans (Surya & Wardah, 2013). Some scientists study anthropometrics, among others, anthropometry is related to nutritional status (Anggraeni,2014; Indarti & Kartini, 2014). Physical activity is also closely related to anthropometry (Mulyadi et al., 2013). Anthropometric relations with appearance and movement skills include soccer athletes (Fakhrullah, 2017;Harmono, et al., 2020), basic motion skills (Cliff et al., 2009), swimming athletes (Sajber et al.,2013), gymnastics athletes (B. Vandorpe et al., 2011, 2012).

In general, it is concluded that certain sports require anthropometric advantages to support optimal movement skills and appearance. Posture is essentially the posture of the body in a while. Posture is a visual description of a person's anthropometrics. Research to find out a person's condition through posture related to balance control (Ludwig, 2017) overall child psychology (Hepach et al, 2017), sports (Lunde & Gattario, 2017), (Grabara, 2015), (Pawelec et al., 2012). This shows that a person's posture is very important in analysis to provide benefits in developing one's potential, especially in appearance. Professional sports talent identifies sports talent using scientific selection. This method looks and identifies based on coaching theory by paying attention to aspects of forming athletes from an early age (Krasilshchikov, 2010). Scientific selection begins with measurements of anthropometry, posture, physical condition, genetics, fitness, mental and basic techniques that are truly measurable to get superior seeds that are ready to be trained early so that at the peak of appearance they can be achieved at the golden age. The benefits of identifying talent using scientific selection will shorten training time for selected young athletes. To be able to read athlete's giftedness, current standards are needed. These standards are essentially the results of research regarding the characteristics of successful athletes and champions in the sport. For example anthropometric characteristics of athletes in ideal badminton (Maulina, 2018), volleyball sports (De Groot et al., 2012), gymnastics (Bacciotti, Baxter-Jones, Gaya, & Maia, 2017; Čuk et al., 2007; Baskora Aji Putra, 2018), and so on. One of the methods to determine anthropometric characteristics is through an image of the subject. Image is a combination of line and colour points that reflect a real object. The imitation of imaging an object can be in the form of people, objects and so on in two-dimensional or three-dimensional forms. Image / image can also be used as an object of research to be able to describe the profile details of the object. Research on body segments through images (Fujiyoshi & Lipton, 1998), research on the relationship of psychology through posture images (Formisano et al., 2008); Zotev et al., 2014). Anthropometric research through image analysis (Abobakr et al., 2017; Shi et al.,2019). Digital technology enables images that are artificial objects that can be manipulated to reveal facts that only appear through some digital media performance, namely enlarging and minimizing the focus of objects, making real objects clearly visible and estimating the scale of real objects on digital images. Some examples of software that can analyse small biological object records (Bray et al,. 2015; Bray, Fraser, Hasaka, & Carpenter, 2012). From the reference it can be concluded that in the world of sports requires athletes with ideal anthropometrics that are suitable for sports to improve appearance. The ideal athlete's image or image is a real description of the actual athlete who displays his anthropometrics. Anthropometric can be measured manually and digitally. Camera technology can produce instrument products to analyse anthropometrics digitally through images.

This research aims to produce a software product that can identify the athlete's giftedness by comparing the image of the athlete's posture with the champion's gymnastics at an international level. the benefits of the software product that will be generated can detect and analyse the image of the gymnastics athlete through compatibility with the characteristics of champions gymnastics at international level. The software product is also expected to be able to detect early on an athlete's posture abnormalities only through image analysis.

through the analysis results of this software product can provide an overview of the characteristics of gymnastics athletes to the coach for further coaching actions so that achievement is more effective. The problems that will be raised in this article are posture anthropometric analysis through UNG software ("*Ukuran Nyata Gambar*" / Real Size Image).

MATERIALS AND METHOD

Development research is used in making this software product, namely, reference studies, needs analysis, system design, implementation and testing and program socialization.

Data collection

Image samples and gymnast information in this trial software totalled 150 world gymnasts. Image data and trial information are taken from internet facilities such as youtube.com, google.com and the official website of the International Gymnastics Federation (FIG) https://www.gymnastics.sport/site/. The initial design of the application with the height and sample input prerequisites in the form of a graphic display of athlete data input in the form of jpg format and in posture anatomical position. Frame picture properties in software with a frame width of 265 pixels, height 330 pixels. However, when analysing the image can be duplicated. or taken from images of athletes, both regional and top athletes, gymnastics data including name, height, gender, gymnastics specialist number. The actual coordinate scale of the object is shown by the height data as a prerequisite. From the example of an athlete's height of 156 cm The international standard unit (SI) will be seen at the point in the image between the head on the digital coordinates (344.275) and the feet on the coordinates (344.675), so to get the digital scale in the software, the coordinate scale is adjusted to the scale digitally by dividing the subtraction coordinates of the Y digital scale at the tips of the head and feet by the height in centimetres. The red dots represent the ends of the distances being analysed, including the head, neck, torso, legs and arms by clicking on the ends of the corresponding body parts in the anatomical image.

The unit of resolution is the number of image pixels per inch which is called ppi. Then the equation will appear to measure the actual size conversion of cm on the image coordinate scale as follows Figure 1:

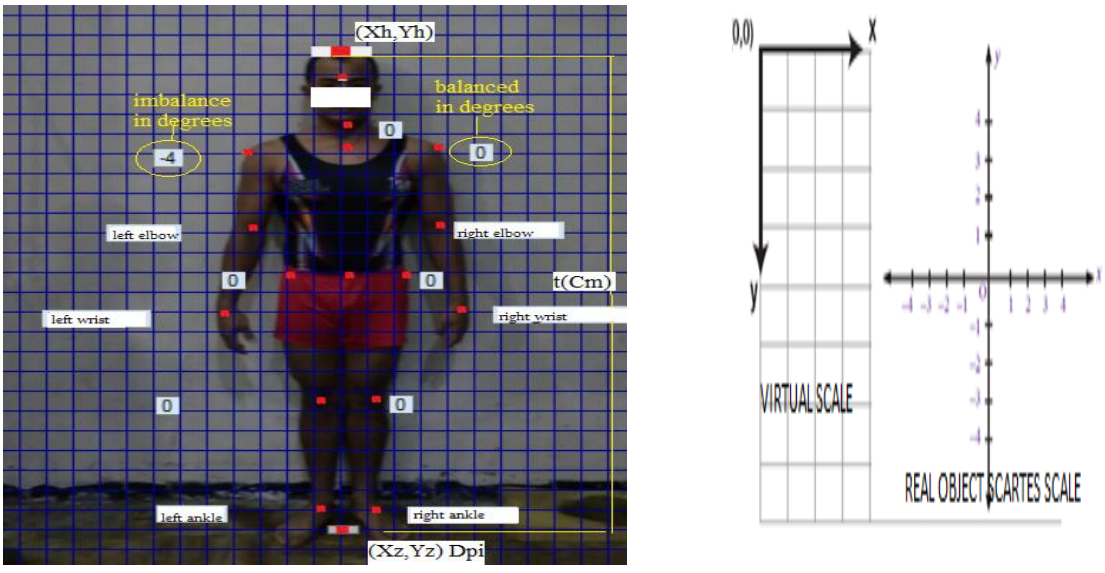


Figure 1. Converting real object scale to virtual scale and a description of the degree of posture imbalance caption.

$$(1\ cm) = \frac{\text{ys}-\text{yh(Dpi)}}{\text{t(cm)}} = \frac{400(\text{Dpi})}{156(\text{cm})} = 2.56 \text{ ppi (Pixel per Inci)}$$

Where:
Yz = The coordinates of the point Y image on feet.
Yh = The coordinates of the point Y image at the tip of the head.
T = Real Size. The height of the athlete gymnastics (in cm).

The validity of UNG software / software analysis by correlating the standard length measuring device Reg C4 / VI / 250419 which has been tested in the Calibration Laboratory with measurements in the software. Content validation test from information technology experts using ISO 9126 (International Standard for Software) and experts sports form assess contents of posture analysis.

RESULTS AND DISCUSSION

Characteristics UNG Software

The developed UNG software has general specifications as follows which can operate on the Microsoft Windows OS with a minimum RAM memory capacity of 16 Megabyte and an external hard drive. The software program contains the athlete's database, posture image analysis (measurement of limb length, and the degree of posture imbalance), the output of the analysis using a printer print or using the excel * .xls format for further data processing. This application has a capacity of only 99 megabytes. This application requires a mouse tool to move the focus of the anatomical point appropriately. These application requirements are compatible with the characteristics of software that are easy to learn and available. In accordance with the opinion of information technology experts who read that One of the characteristics of good software is that it is easy to run and data can be transferred easily using technology that can be used for novice users (Ula, 2019) (Baresi & Pezzè, 2006) (Zeng, Zhang, Kwong, Sun, & Li, 2014).

Use of UNG software

The advantages of this application are as follows:

1. General data of gymnast athletes along with images stored neatly in a data base file in the hard drive, so that at any time displayed can be opened again.
2. The athlete's anatomical picture can be doubled size or even more with the track bar control facility in the analysis menu.
3. The size of the athlete's body anthropometry in the image along with the degree of imbalance of the anatomical point can be directly seen on the screen when pressing the button with the name of the evaluation.
4. The results of the analysis can be printed by the printer and stored in the form of an excel file for further data processing.

Ease of use in software is one of the good technological advantages (Rahayu et al., 2017; Nowicki et al., 2013).

Good software can display suggestions which results of analysis are tangible data and can be processed quickly using other data processors such as statistical processing (Rahayu et al., 2017; I., S., & M., 2016;Sharma & Vyas, 2014).

The usefulness and superiority of this program are:

1. Through this software, you can quickly find out the sports anthropometry of centimetre units and can be used for further research in the gymnastics field, (Putra et al., 2019) special sports, soccer branch, (Fakhrullah, 2017) etc.
2. Providing information to users / trainers regarding anatomic postural imbalances that result in disruption of dynamic equilibrium. This is in line with the opinion that posture imbalances when standing upright influence movement and result in body mass enhancement. (Greve et al., 2013) Preliminary information can determine how the athlete's training program is planned (Morgenlander & Hainline, 2018; Lankton & Luft, 2008; Laursen & Jenkins, 2002).

Posture evaluation prerequisites that must be fulfilled:

1. The height of the sample image file to be analysed must absolutely be manually inputted in the height record. This is because through height that has been stored for real will be converted to a digital scale so that the length of each limb can be searched. This technique is in line with research on converting sizes to digital scales (Katz & Koutroumpis, 2013; Gil, Reisin, & Rodríguez, 2006).
2. The position of the body in the image file must be in an anatomical position standing up straight arm down. Anatomical position of the body can see the overall picture of the characteristics and body composition visually (Katz & Koutroumpis, 2013; Brenner, 2014).

Validity and Reliability of the Instrument

The validity of the software is measured by correlating the standard ruler number Reg C4 / VI / 250419 has passed the test in the calibration laboratory of the Faculty of Sport Universitas Negeri Semarang Indonesia with a size that shows the image in the "*UNG*" software with a sample of 35 people with an average correlation as follows at Figure 2 below:

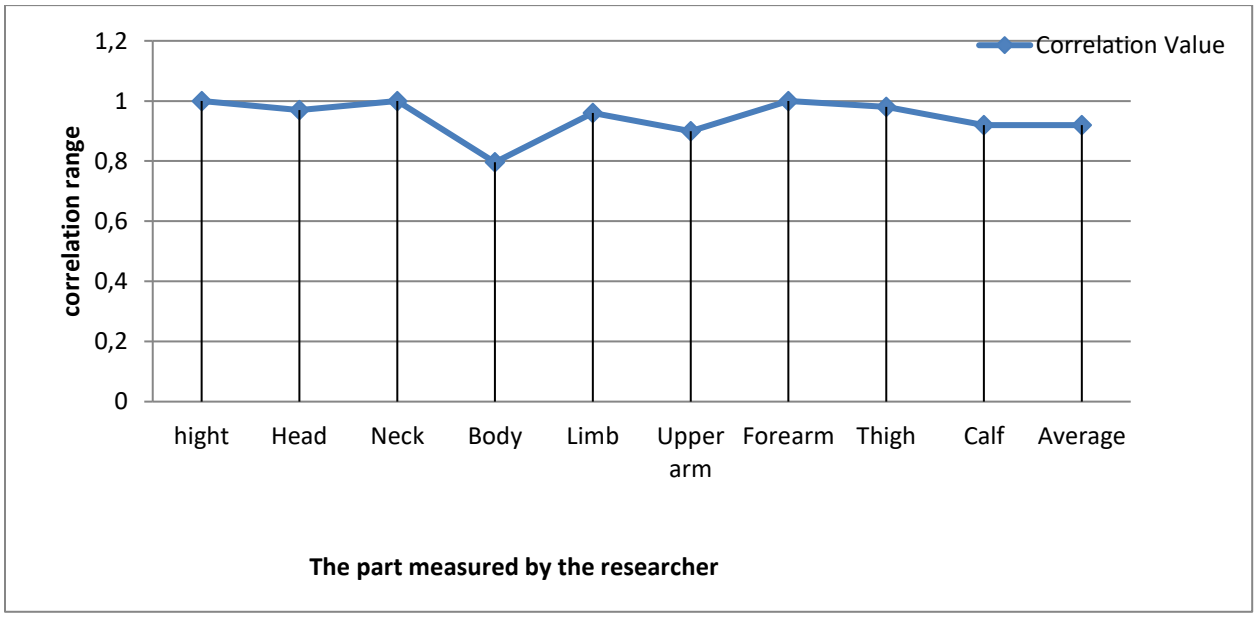


Figure 2. The description of the correlation results between the UNG Software and Reg C4 / VI / 250419 standard measuring instrument numbers.

Average in the hundreds unit rating, ICT expert according to ISO 9126 (International Standard for Software), namely Initial Mr. A F, Mkom, master of ICT graduate institute Bandung technology according to the review

of internal and external quality consists in several characteristics including: Functional, Usability, Reliability, Performance, Maintainability, Portability (Abran, Al-Sarayreh, & Cuadrado-Gallego, 2010). The ICT expert assesses total point 90.4 with the following details at graph 3 below:

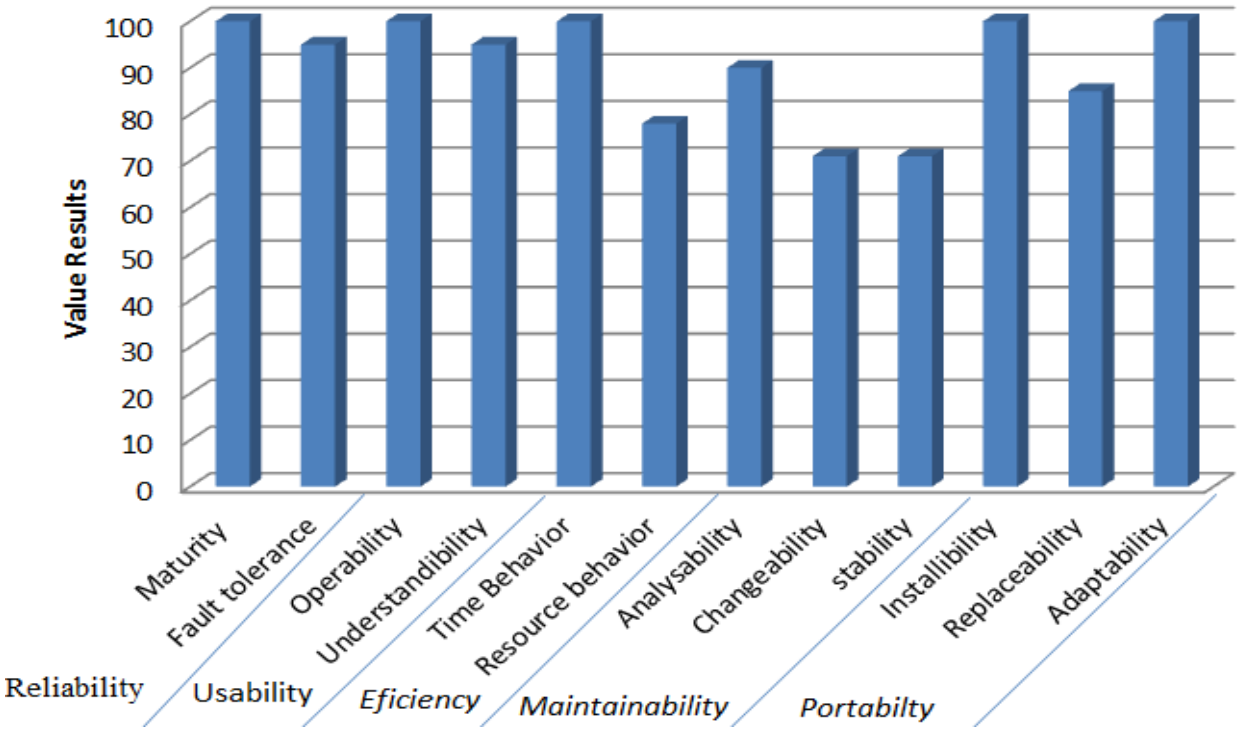


Figure 3. The results of the assessment of information technology experts.

While sports experts and coaches amounted to 93.6 with details regarding the program's performance. the results in detail are correlated in Table 1 below:

Table 1. Results of expert gymnastic assessment.

Nº	Name of expert	Expert	Valuation
1	Mr. B P (initials)	Gymnastic academics	100
2.	Mr. T S (initials)	Gymnastic academics	97
3.	Mr. A.D (initials)	Jury international and Coach gymnastic	92.85
4.	Mrs. F.J(initials)	Jury International and Coach gymnastic	81.64
5.	Mr. FI (initials	Coach Gymnastic	97

Reliability uses a retest of .95 very high categories with detailed correlation tests - re-test. The retesting procedure used UNG software by taking 2 times the subject's image then analysed using this application.

The results obtained are as follows:

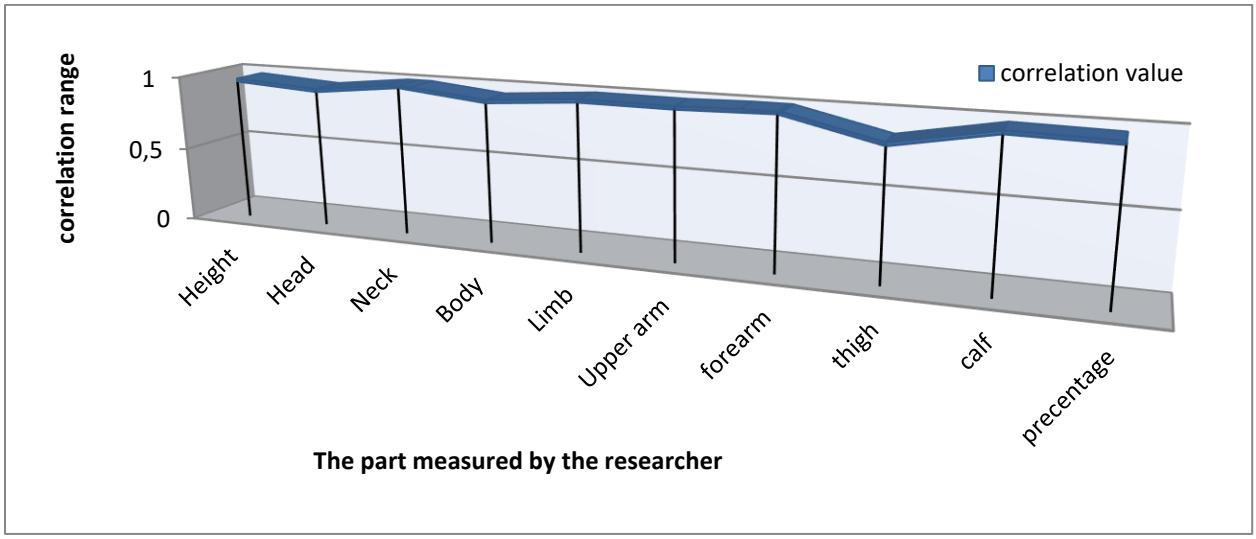


Figure 4. Correlation test results and retest measurements in gymnasts.

UNG Software Design

This UNG Software application is designed using a menu button where each button contains a command. Menu button contains inputting data, "*new record*", Calling data, "*open record*", data analysis by clicking on the image. In the analysis of the data place the anatomic red dots into the athlete's image so that the real size will appear on a digital scale automatically by clicking "*set dot*" and "*grid*" to display the background line of the image. Then click "*save*" for the process of storing data. Figure 5 below contains the design of using the "*UNG*" software through the menu and the working width of each slide.

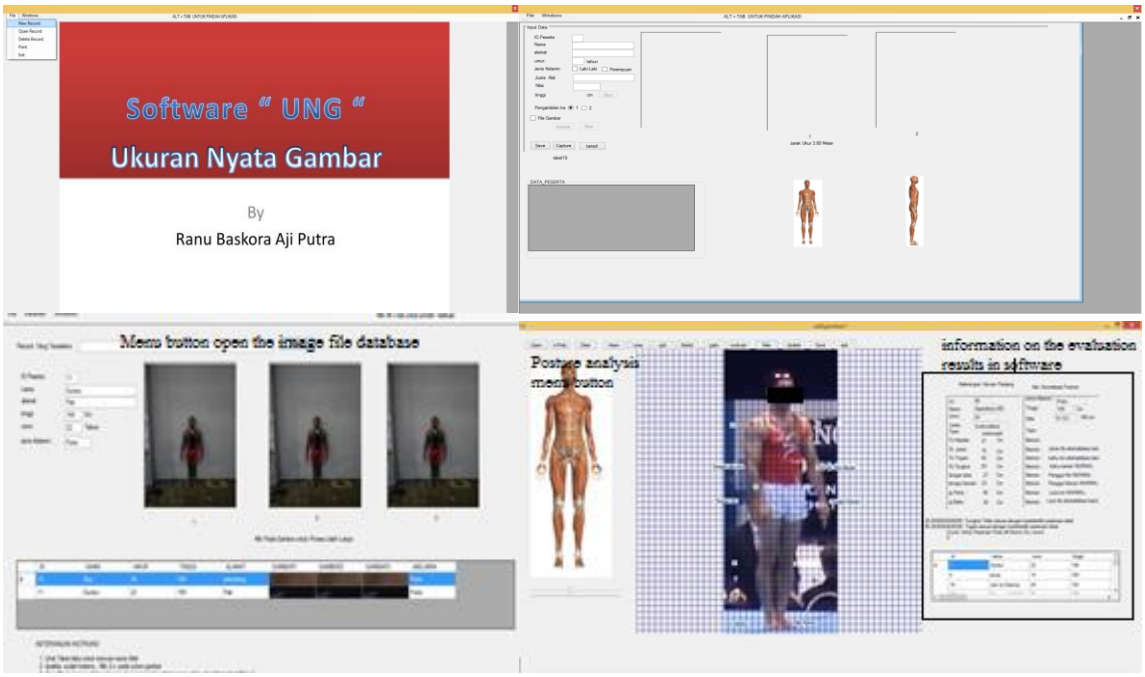


Figure 5. Picture at a glance Software worksheet "*UNG*" Menu, Input data, Open data, Evaluate data.

Additional properties in this software are the ability to process databases with open, delete and print and export database facilities into MS Excel which allows for advanced processing of statistics. Figure 6 shows additional "*UNG*" Software properties:

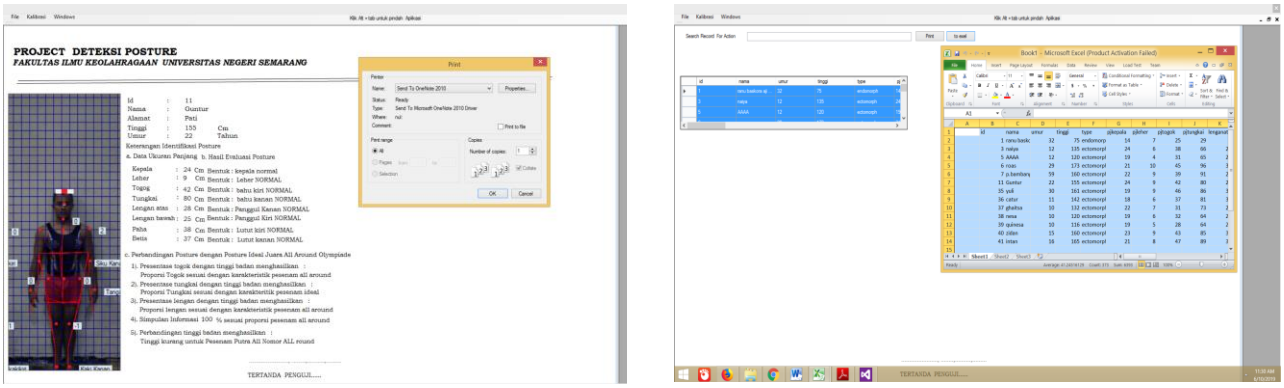
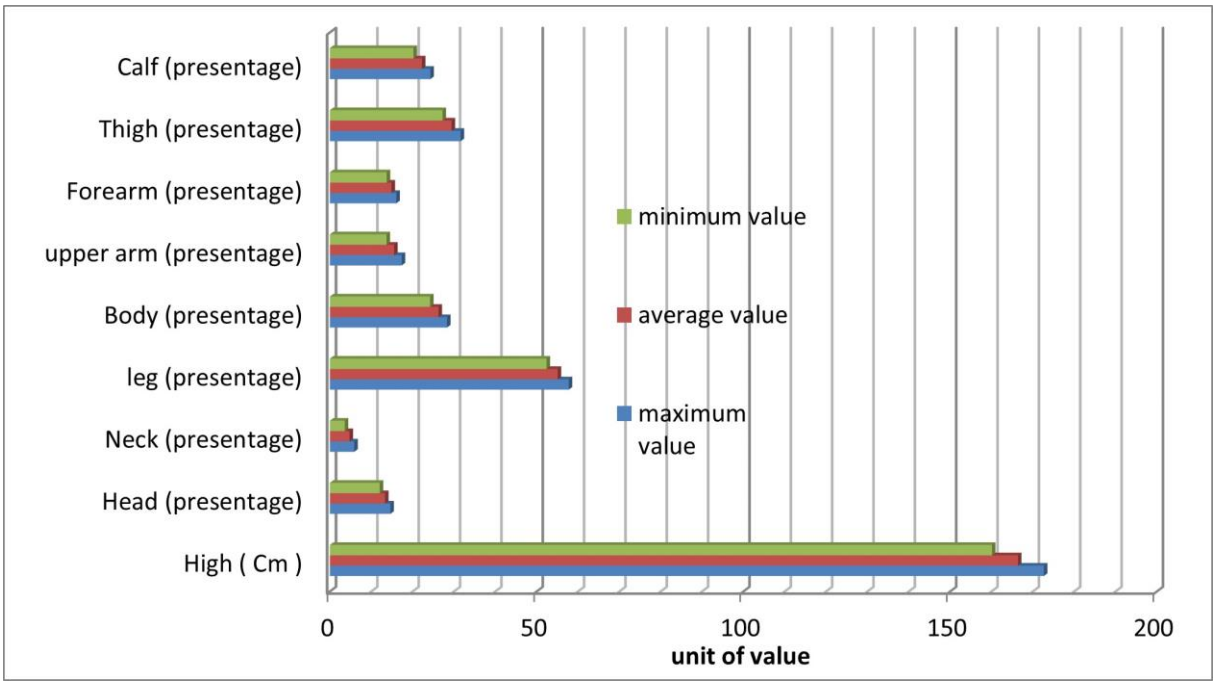


Figure 6. Picture at a glance Menu, print to printer "*Print*" and Export data to MS. Excel.

Test Data

150 male gymnasts competed in a number of World Artistic Gymnastics Championships namely Euros AA, Stuttgart TQ, American Cup in 2019 with supporting height data and body posture images that can be viewed on the official FIG member website (https://www.gymnastics.sport/site/athletes/) or other sites. Following are the anthropometric summary details of the male artistic gymnast on the entire number of tools recorded in the image recorded on the YouTube channel is as follows:

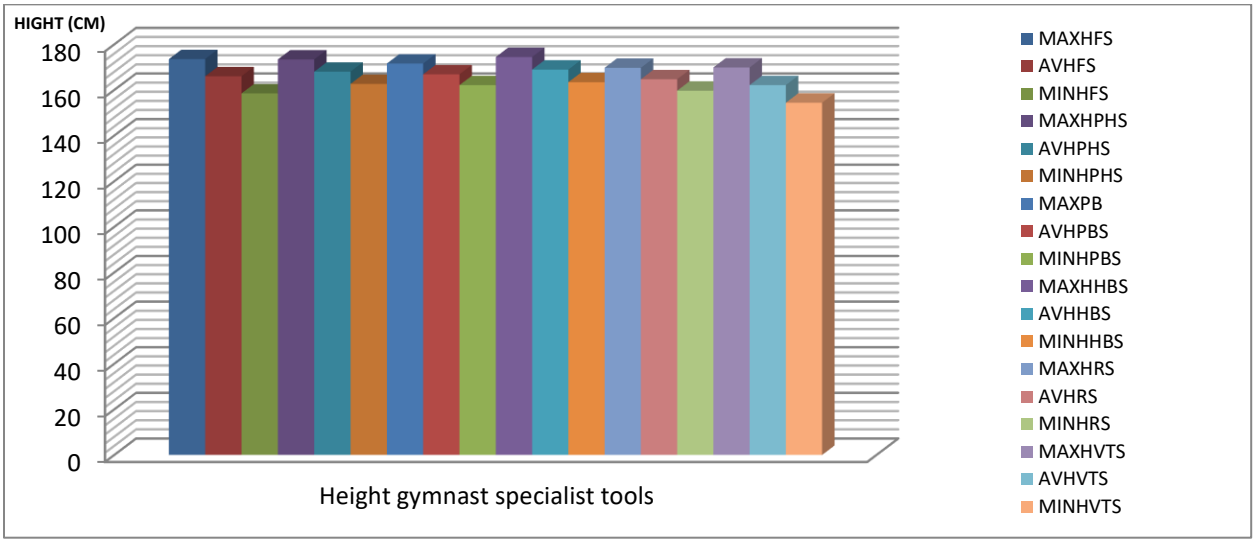


Note: Research data source 2019.

Figure 7. Descriptive Anthropometric Statistics for all samples of World Gymnasts.

In the table above, the gymnast with the All-around number has certain characteristics, with an average height of 166.4 cm. That the beginner gymnast physically identifies and studies the anthropometric advantageous factors. Then the Trainer needs to adjust the training program specifically individually and adjust what motion techniques are appropriate and can be learned with the gymnast's anthropometric advantages. Efforts to reach the peak of gymnast achievement should be supported by the surrounding environment as a motivator in addition to innate talent and physical as their main capital is developing persuasion. Height and overweight in balance and agility in moving so that is one of the limiting factors in gymnastics. (Parseh & Solhjoo, 2015) it because of in artistic gymnastics required balance, agility and speed and high coordination of motion to support the appearance of motion according to the type of exercise that is studied in various apparatus. Trainers who support the athletes they need are needed by applying the science of biomechanics, physiology is one of the considerations in choosing movements that are easier to learn with the physical requirements of certain athletes.

When analysed, male gymnast anthropometrics based on the specialization number of the equipment have similarities and differences that affect the movement. Shown in Figure 8 below:



MAXHFS: Maximum Height floor Specialist; AVHFS: Average Height floor Specialist; MINHFS: Minimum Height floor Specialist; MAXHPHS: Maximum Height Pommel Specialist; AVHPHS: Average Height Pommel Specialist; MINPHS: Minimum Height Pommel Specialist; MAXPB: Maximum Height Parallel Bar Specialist; AVHPBS: Average Height Parallel Bar Specialist; MINHPBS: Minimum Height Parallel Bar Specialist; MAXHHBS: Maximum Height High Bar Specialist; AVHHBS: Average Height High Bar Specialist; MINHHBS: Minimum Height High Bar Specialist; MAXHRS: Maximum Height Ring Specialist; AVHRS : Average Height Ring Specialist; MINHRS: Minimum Height Ring Specialist; MAXHVTS: Maximum Height Vaulting Table Specialist; AVHVTS : Average Height Vaulting Table Specialist; MINHVTS: Minimum Height Vaulting Table Specialist.

Figure 8. Descriptive of height gymnast specialist tool.

Table 2 shows lists the specific percentage mean of body parts compared to height in the specialist gymnast and range deviation.

Table 2. Percentage of body parts Specialist gymnast Apparatus number compared to body height.

Classification Part of Body	Specialization Apparatus											
	Floor		Pommel Horse		Parallel Bar		High Bar		Rings		Vaulting Table	
	Mean	Std. Dv	Mean	Std. Dv	Mean	Std. Dv	Mean	Std. Dv	Mean	Std. Dv	Mean	Std. Dv
Head (percentage)	14.67	0.912	14.23	1.24	13.28	1.65	11.95	1.38	12.34	1.56	13.62	0.98
Neck (percentage)	4.32	1.07	4.69	1.11	5.05	1.32	5.50	1.09	4.71	1.37	4.26	0.944
Leg (percentage)	54.36	3.20	55.36	2.27	55.33	1.60	57.25	3.24	55.48	2.50	52.80	3.31
Body (percentage)	26.53	1.79	26	2.61	26.33	2.48	26.60	1.43	25.95	1.91	26.31	2.09
Upper arm (percentage)	17.31	2.33	14.67	1.37	16.34	1.81	15.66	2.33	12.29	1.43	16.99	1.75
Forearm (percentage)	15.00	1.01	14.23	1.24	15.03	1.24	14.85	1.31	15.17	0.93	15.19	1.23
Thigh (percentage)	29.60	2.77	29.77	1.99	29.25	1.85	30.33	1.80	29.60	2.513	28.10	2.2
Calf (percentage)	22.30	2.15	22.33	1.79	22.77	1.89	21.81	1.8	22.70	2.37	21.70	2.28
Value	14.430	0.267	14.63	0.412	14.67	0.30	14.28	0.26	14.60	0.332	14.72	0.25
Valid N (Number Gymnast)	32		26		27		26		23		16	

Research data source 2019.

Artistic Gymnastics is a sport that requires high movement skills. Physically, anthropometrics are needed in accordance with the type of movement and adjustment to the specialization number of the instrument. Balance, speed and good coordination are absolutely necessary for gymnasts (Mulyadi, 2013). An analysis of body mechanics, a gymnast has been honed, is formed to be more efficient in his work (Huston, 2013) Gymnasts with specialized hanging devices such as single bars, parallel bars will benefit in the appearance of motion if it has a longer leg than the other gymnast, this is because a long leg will add a wide swing radius so it will make it easier to make movements with a high difficulty factor. The dominant motion floor tool involving the legs and feet will be different from the pommel horse tool which involves a lot of the shoulders and arms for the circular motion. Gymnast anthropometric characters on a certain number of devices will support efficient and effective movements.(Bradshaw & Le Rossignol, 2007) The tool specialist gymnast will adapt his body to the movements and appearance of his specialist numbers. In Table 2, it is evident that there are differences between the individual characteristics of world elite gymnasts in one equipment with another. This research produces an information system that can store, process and analyse data regarding the identification of artistic gymnasts through images. This system can help coaches, coaches and parents to be able to direct athletes in accordance with their characteristics with a successful gymnast world champion as a reference.

CONCLUSION

Based on the reliability validity analysis above, the UNG software effectively product that will be generated can detect and analyse the image of the gymnastics athlete through compatibility with the characteristics of

champions gymnastics at international level. The software product is also expected to be able to detect early on an athlete's posture abnormalities only through image analysis.

AUTHOR CONTRIBUTIONS

Tandiyo Rahayu: methodology and discussion. Woro Kasmini: literature review, introduction and conclusions. Ranu Baskora Aji Putra: results and data analysis. Sulaiman: material, conclusions and general review.

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No potential conflict of interest was reported by the authors.

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ANNEXE 1. ITEM QUESTIONS OF VALIDITY INSTRUMENTS AND SOFTWARE RELIBALITY.

N	Reliability question	Strongly disagree	Assessment							Strongly agree
Maturity			1	2	3	4	5	6	7	
1	The system runs correctly and in accordance with user requirements									
2	Even though old users do not use this system, they can quickly recall.									
3	This application is easy to learn even though people use it for the first time									
Fault tolerance										
4	If the User encounters a problem, the provider is ready to resolve									
5	This system has a low error rate									
6	If an error occurs the system can recover origin quickly									

N	Usability question	Strongly disagree	Assessment							Strongly agree
Operability			1	2	3	4	5	6	7	
1	This system is simple in operation									
2	Users quickly adapt to this system									
3	The tools used are simple and easy to operate									
Understandability										
4	If the User encounters a problem, the provider is ready to resolve Users will understand the contents / contents in the system									
5	Buttons and applications are easily known without a long description									

N	Efficiency question	Strongly disagree	Assessment							Strongly agree
Time Behaviour			1	2	3	4	5	6	7	
1	Connections between systems in this application require a relatively short time									
2	Users can quickly operate all content									
3	The tools used are simple and easy to operate. This system efficiently and quickly runs from beginning to end									
4	This system is efficient in summarizing data									
Resource behaviour										
4	This system has a database to store data									
5	The amount of memory used by this system is optimally efficient									

6	Between data connected to each other so it's easy to find data									
7	In this system there are file settings									
8	The operating system application can be easily saved and exited									

N	Maintainability question	Strongly disagree	Assessment							Strongly agree
Analysability			1	2	3	4	5	6	7	
1	This system will detect process failures and inform activities through error messages									
2	The user will immediately understand the error in the input data									
3	Process analysis will be recorded all through a message									
Changeability										
4	This system can work with newer Windows operating systems									
Stability										
6	This system remains stable even if it is used on different tools and times									

N	Portability question	Strongly disagree	Assessment							Strongly agree
Insatiability			1	2	3	4	5	6	7	
1	In the Install Process to another hardware can be easily done									
2	There is clarity of instructions when installing to another laptop									
Replaceability										
4	This system can work with Windows operating systems									
5	If there are additional application sets, this system will be able to accommodate them									
Adaptability										
6	This application can convert data to excel format without having to modify again									
7	This information can be displayed by printing out using printer hardware									
8	This application can work in other laptop work environments									