

## Development of Sensor-Based Blind Swimming Aids

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**Abstract**—Blindness is a condition where the senses of vision are not functioning (low vision) or overall (total blindness). Persons with visual impairments are who can enjoy swimming with the help of sensors. The aim of the study was to create aids for sensor-based blind visual swimming that can be used during swimming exercises. The method used is a qualitative approach, the main data obtained through observation, questionnaires, interviews, and documentation and procedures of research and development used is the Borg and Gall model. This study is expected to contribute to blind swimming aids material products which are effectively used for swimming exercise skills. This study concluded that the product development sensor based blind learning swimming aids can be used for motion skills training for blind swimming athletes.

**Keywords**—Sensor, Blind, Swimming.

### 1 Introduction

Physical education and adaptive sports generally allow the realization of human life the possibility [1]of human organisms for full life, self-realization, social activity, and integration into society, with the help of motorized activities that are rationally organized as natural incentives for livelihoods, using retained functions, health remaining, natural sources, and mental strength. The emergence of disability can be motivated by health problems that arise from birth, chronic and acute diseases, and injuries that can be caused by accidents, war, riots, disasters, etc. It is estimated that there are 650 million disabled people in the world, around 10 percent of the population. One thing over the last thirty years, life opportunities and opportunities for many people who have disabilities have changed dramatically especially in the fields of education, health and employment. Many disabilities are motivated by health problems, and on the contrary conditions of disability can also affect health. The health sector has a role as a preventive measure until rehabilitation. Sports Disability is a relatively new phenomenon but it is also one that specifically addresses the context of social inclusion so that it attracts a lot of political and academic attention. Physical education and adaptive sports generally enable the realization of the possibility of a human organism for full life, self-realization, social activity, and integration into society, with the help of motorized activities that are rationally organized as natural incen-

tives for livelihoods, using retained functions, remaining health, natural source, and mental strength.

The ability of vision is very influential on the activities of daily life. The fault is physical activity or sports that can be carried out by people with blind people. Blindness is a condition of sensory vision in a person with a partial vision (low vision) or as a whole (totally blind). This can occur before birth, at birth and after birth. One of the potentials that can be developed for people with special needs is through sports. Sport cannot be separated from human life, because human life consists of two aspects, namely physical aspects and spiritual aspects that cannot be separated, sports include swimming. Swimming is a form of versatile training for all persons with disabilities, because it can include therapeutic activities, play, achievement and fun. Swimming is a physical activity carried out in water. This sport has elements such as body shape, basic techniques of motion mechanism, mentality and physical condition as a unity that must be owned by someone to be able to float and move from one place to another. Experience of researchers as a swimmer with special needs, especially people with visual impairments need a long time in providing basic swimming material. Another problem faced by researchers when training is when blind swimmers will make reversals to finish. It needs to be helped by tapping repeatedly in each session. Practice requires that the trainer stay alert on both sides of the pool and drain energy if some athletes do the same and repeatedly. The ability of high mobility in all aspects of life is a dream for each individual, including those who bear blindness. This also affects people with disabilities in physical activity or sports. The researcher obtained results that:

1. The unavailability of facilities and infrastructure specifically for swimming pools for persons with disabilities
2. Disability swimmers are still few who have an interest in swimming
3. Absence of disability specialty swimming clubs
4. Trainers who handle disability swimmers are still very limited

A sensor is a type of transducer that is used to change mechanical, magnetic, heat, light, and chemical quantities into electrical voltages and currents. Sensors are often used for detection when making measurements or controls. In the world of electronics, sensors are a very important component, especially in the field of robotics. By definition, sensors are components that can be used to detect changes, whether physical changes or chemical changes.

## **2 Literature Review**

Research is the activity of collecting, processing, analyzing, and presenting data carried out systematically and objectively to solve a problem or want to test a hypothesis to develop general principles. The link between research and the development process requires an innovation. The UNESCO's Intergovernmental Committee for Physical Education and Sport (CIGEPS) believes that "swimming for all, swimming for life" (swimming for all, swimming for life) "project launched in collaboration with

the International Swimming Federation [2] is making a significant contribution to development humans because the impact is very large in terms of cutting the risk of drowning and water-related accidents caused by the inability to swim. Disabled Persons are those who experience physical, intellectual, mental, and / or sensory limitations for a long period of time in interacting with the environment can experience obstacles and difficulties to participate fully and effectively with other citizens based on the similarity of the rights of Article 5 paragraph (2 ) "Citizens who have physical, emotional, mental, intellectual, and / or social disorders have the right to receive special education.

Related to mobility also delivered by [3] Blindness can cause low physical work capacity, posture problems, orientation difficulties, depressions and problems with balance. Previous studies include information about these disturbances. Physical activity possessed by blind people is explained in Disability and Health Journal [4] Children with visual impairments (VI) often reveal higher levels of sedentary time and lower levels of fundamental motor skills (FMS), health-related fitness (HRF) and physical activity (PA) than peers without visual impairments. (Aspenes, S.T., & Karslen, 2012) "Swimming is unique among sports in combining factors such as the simultaneous contribution of arms and legs to propulsion, water immersion, and prone position".

Especially for the Blind class explained according to [5] as follows: Sport Classes S/SB11-13 visual impairment. Athletes with a visual impairment compete in three sport classes from S/SB11 to S/SB13. (1) S/SB11: These athletes have a very low visual acuity and/ or no light perception. (2) S/SB12: Athletes have a higher visual acuity than athletes competing in the S/SB11 sport class and/ or a visual field of less than 5 degrees radius. (3) S/SB13: Athletes have the least severe visual impairment eligible for Paralympic sport. They have the highest visual acuity and/or a visual field of less than 20 degrees radius. In order to ensure a fair competition athletes in the S/SB11 sport class are required to wear blackened goggles. To ensure safety all S/SB11 swimmers must use a tapper, swimmers in the S/SB12 and S/SB13 sport classes may choose whether or not they wish to use one.

**Table 1.** Swimmers with Vision Loss. [6]

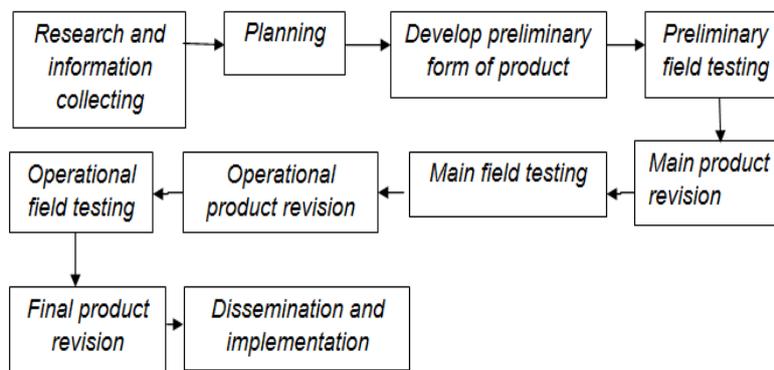
<b>Disability Characteristic</b>	<b>Effect on Stroke Technique</b>	<b>Coaching Hints</b>
Inability to use vision to determine proper head position. Inability to see demonstrations. Reluctance to move hands and arms away from torso.	Poor horizontal alignment (head too high or low). Poor lateral alignment (head not returned to neutral position after breathing).  Inefficient stroke techniques.  Inefficient stroke techniques, especially length of pull and distance of hand from torso during underwater pull.	Use orientation and mobility techniques. Move swimmer's head through desired movements. Use rich verbal descriptions. Move swimmer's body through desired actions.  Use resistance and assistive training such as hand paddles, stretch cords, and fins to help swimmer experiment with propulsion movements. Teach arm movements on swim bench.
Inability to see end of pool and related fear of collision.	Stroke technique deteriorates and speed decreases as swimmer approaches end of pool.	Use tappers, sprinklers hanging from backstroke flags, or other methods to notify swimmer about end of pool. Teach swimmers to use stroke counts to estimate length of pool. Use padding in swim cap.

For blind swimmers an assistant who knocks swimmers is needed, this is conveyed by [7] following: Visual impairment can range from complete blindness to partial sightedness combining loss of visual acuity and field loss. Adaptations to sport include a sound-emitting ball for goal ball or cricket or a tandem cycle with a sighted pilot rider. In swimming, an assistant taps the head or shoulder of the swimmer with a soft-ended pole to indicate the pool end to enable turning and finishing. Research can be divided into several forms, namely basic research, applied, evaluation, and development. The division of research is based on the function and application in education and how long the results can be used. One research model that is relevant and can always be used is development research. Development research finds patterns, sequences of growth, change and especially has the intention to develop the object of research.

### 3 Methodology / Materials

The malfunctioning of the receiving channel of information in the sense of sight like a normal human being is an obstacle for people with visual impairments in carrying out daily activities. The general term used for this condition is blind people. The ability of vision is very influential on the activities of everyday human life. People who have normal visual abilities can get more information than those who experience vision problems. Research and development is expected to provide solutions to provide answers to the problems faced. Development research procedures basically consist of two main objectives, namely developing procedures for development research basically consists of two main objectives, namely developing products, and testing the effectiveness of products in achieving goals. Conceptually, the research and development approach includes 10 general steps, as described [8] as follows:

1. Research and information collecting
2. Planning
3. Develop preliminary form of product
4. Preliminary field testing
5. Main product revision
6. Main field testing
7. Operational product revision
8. Operational field testing,
9. Final product revision
10. Dissemination and implementation



**Fig. 1.** Instructional Design R and D Borg & Gall

The descriptions are as follows:

### 3.1 Research and information collecting

The first step of the preliminary study includes needs analysis, literature study, literature study, small-scale research and the required standard reports.

- Need analysis and literature study there are several criteria including:
  - Are people who will be developed important?
  - Does the product have the possibility to be developed?
  - Do Human Resources who have the skills, knowledge and experience that will develop the product exist?
  - Is the time to develop the product enough?
- The literature study is conducted for a temporary introduction to the products to be developed. This literature study was conducted to collect research findings and other information related to the planned product development.
- Small-scale research conducted by developers has questions that cannot be answered by referring to research learning or professional texts. Therefore, develop-

ers need to do small-scale research to find out some things about the products to be developed.

### **3.2 Planning research**

The second step in planning research includes:

- Formulate research objectives
- Estimating funds, energy and time
- Formulate researcher qualifications and forms of participation in research.

### **3.3 Design development (develop preliminary of product)**

The third step of design development includes:

- Determine the product design to be developed (hypothetical design)
- Determine the facilities and infrastructure needed during the research and development process
- Determine the stages of implementation of the design test in the field
- Determine the task description of the parties involved in the study

### **3.4 Initial field test (preliminary field testing)**

The fourth step of the initial field test is limited product testing including:

- Conduct an initial field test of product design
- Limited nature, both the substance of the design and the parties involved
- Initial field tests are carried out repeatedly so that a decent design is obtained, both in substance and methodology.

### **3.5 Revised limited field test results (main product revision)**

The fifth step is a model or design improvement based on a limited field test.

Improvement of the initial product will be carried out after a limited field trial. At this stage of refining the initial product, more is done with a qualitative approach. The evaluation is more on the evaluation of the process, so that the improvements made are internal improvements.

### **3.6 Extensive test (main field test)**

The sixth step is to test the product more broadly. This step includes:

- Test the effectiveness of product design
- The design effectiveness test generally uses the repetition model experimental technique.

- The results of the field test are processed in an effective design, both from the basic and methodological aspects.

### **3.7 Revision of operational product revision**

The seventh step is the second improvement after a wider field test from the first field test. The product improvement from the results of a wider field test will further strengthen the product developed, because at the previous field testing phase it was carried out with the existence of a control group. The design used was pretest and posttest. Besides improvements that are internal. This product improvement is based on evaluation of results so that the approach used is a quantitative approach.

### **3.8 Operational field test**

The eighth step of the feasibility test should be carried out on a large scale. This step includes:

- Test the effectiveness and adaptability of product design
- Test of effectiveness and adaptability involving potential product users
- The results of the field test obtained a design model that is ready to be applied both in terms of substance and methodology.

### **3.9 Final revision of the final product revision**

The ninth step is the improvement of the product being developed. This refinement is needed to more accurately develop the product. At this stage a product that has a level of effectiveness can be accounted for. The results of the final product refinement have a reliable "generalization" value.

### **3.10 Dissemination and final production implementation (Dissemination and implementation)**

Publish to accredited national journals and international journals referred to and provide/present research results through scientific forums, or through mass media. Product distribution must be done after going through quality control.

The researcher chose the model from Borg and Gall to have the following reasons:

1. Produce a product that has a high validation value through a series of field trials and validated by experts;
2. Providing solutions to address needs in the field.
3. Generate new knowledge and knowledge of products developed through theoretical and practical research in the field.
4. Encouraging the creation of innovation processes based on current needs.

The thinking about blind swimming aids in this study is based on problems encountered in the field. The following is a table that presents the foundation for developing blind swimming aids products.

**Table 2.** Platform for the Development of Blind Swimming Aid Models

<b>Factual Conditions</b>	<b>Obstacles</b>	<b>Solution</b>
Disability swimming training especially blind people do not use the science and technology approach of swimming aids.	The time the trainer is seized to give instructions to the swimmer when doing pleasure, reversal and finish.	Creating and developing swimming aids that have quality by meeting aspects of originality, innovation excellence, safety, comfort and complete supporting data, so that clubs, athletes and coaches can use it to exercise and correct blind swimmers.
Disability swimming training especially blind people do not use the science and technology approach of swimming aids.	When making corrections and evaluations of one athlete, the other athletes are ignored considering the trainer must be upright and focus on just one athlete	Creating and developing swimming aids at affordable prices for blind swimmers
There is no single disability swimming club that has technology-based blind visual aids	Beginner blind swimmers must be given special assistance in handling both a series of movements and direction.	
	Swimmers experience obstacles when doing swimming movements even in the trajectory that is determining the direction with a straight swim	
	Swimmers experience obstacles when doing swimming movements even in the trajectory that is determining the direction with a straight swim	
	Touch instructions from the trainer in swimmer swimming athletes do different reversals and finishes so that it is very influential on the swimmer's movements	

Based on the table above, it can be explained that the development of swimming aids for visually impaired disabilities is a solution to the practical problems of factual conditions and obstacles encountered in swimming practice. The following is an overview of the tools used so far.

#### 4 Results and Findings

Disabled people involved in sports are the first and foremost athletes, and they have the same basic needs and dreams as other athletes. For them, coaching is an important factor in the experience of the quality of their sport. The development and success of exercise is almost always determined by several factors and perhaps even

more so for athletes with disabilities. Blind swimmers have many unique challenges to swimming, including the concept of swimming pool space, coaching methods, and the availability of tools. If this challenge is handled properly, then the problem faced will be a potential for the blind in swimming. The following swimming aids are available and have been used:



Fig. 2. Swimming Aids For The Blind

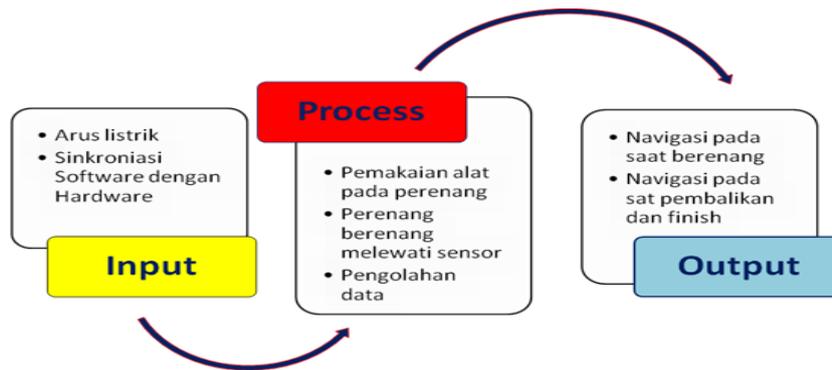
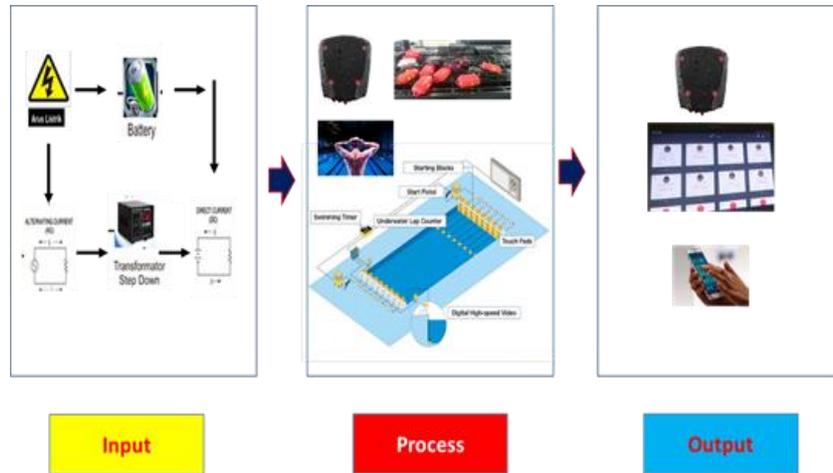


Fig. 3. Build a Swimming Aid System

The following is a simple scheme of blind visual aids which is developed:

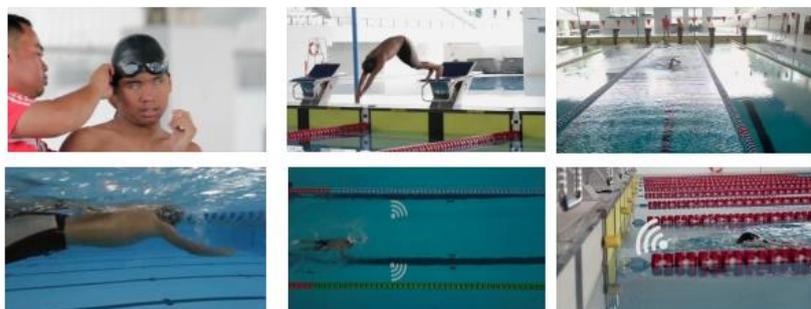


**Fig. 4.** Simple Scheme of the Blind Swimming Pool System

The idea or idea of developing blind swimming aids is in accordance with the problems faced by researcher and it occurs in the field (swimming pool) where as a trainer has difficulty in giving instructions to athletes. The development of the tool is intended as an effort to meet the needs of assistive devices for athletes to improve swimming skills through the fulfillment of training facilities, so as to improve the quality of training and support the development of disability swimming sports. Products Swimming aids for blind people produced:



Application for use of tools for blind swimmers:



The results of the effectiveness test are as follows:

The control group without tools there is a difference in swimming scores between pre- test and post-test at 11.25125 (in the Paired Samples Test table, mean column) with significance below (0.05) that is equal to 0.000, in other words that swimming exercises with no tools increase at 11.25125 or an increase of 10.05% from the pre-test score (in the Paired Samples Statistics table, the mean column) significantly.

**Table 3.** Paired Samples Statistics

Paired Samples Statistics					
		<i>Mean</i>	<i>N</i>	<i>Std. Deviation</i>	<i>Std. Error Mean</i>
Pair 1	Free_Test Without Tools	100.7100	8	19.72210	6.97281
	Post_Test Without Tools	111.9613	8	21.22119	7.50282

Paired Samples Test									
		<i>Paired Differences</i>					<i>t</i>	<i>df</i>	<i>Sig. (2-tailed)</i>
		<i>Mean</i>	<i>Std. Deviation</i>	<i>Std. Error Mean</i>	<i>95% Confidence Interval of the Difference</i>				
					<i>Lower</i>	<i>Upper</i>			
Pair 1	Free_Test Without Tools - Post_Test Without Tools	-11.25125	4.24426	1.50057	-14.79954	7.70296	7.498	7	.000

The experimental group with a tool, the difference in swimming scores between pre-test and post-test amounted to 12.49875 (in the Paired Samples Test table, mean column) with significance below (0.05) that is equal to 0.000, in other words that swimming exercises using tools have increased amounting to 12.49875 or an increase of 11.32% from the pre-test score (in the Paired Samples Statistics table, the mean column) significantly.

Paired Samples Statistics					
		<i>Mean</i>	<i>N</i>	<i>Std. Deviation</i>	<i>Std. Error Mean</i>
Pair 1	Free_Test with Tools	97.8813	8	19.67484	6.95611
	Post_Test with Tools	110.3800	8	19.79460	6.99845

Paired Samples Test									
		<i>Paired Differences</i>					<i>t</i>	<i>df</i>	<i>Sig. (2-tailed)</i>
		<i>Mean</i>	<i>Std. Deviation</i>	<i>Std. Error Mean</i>	<i>95% Confidence Interval of the Difference</i>				
					<i>Lower</i>	<i>Upper</i>			
Pair 1	Free_Test with Tools - Post Test with Tools	-12.49875	4.29267	1.51769	-16.08751	-8.90999	-8.235	7	.000

Looking at the data above, the group results without the mean tool are 111.9613 and the results of the groups using the mean tool are 110.3800 (in the group statistics

table). From these data it can be seen that the value of the group using the tool is better than the group without the tool. The difference is also reinforced by a significant value smaller than 0.05 (5%), which is 0.008

Group Statistics										
		Group	N	Mean	Std. Deviation	Std. Error Mean				
Post Test Values		Group A	8	111.9613	21.22119	7.50282				
		Group B	8	110.3800	19.79460	6.99845				
Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Value	Equal variances assumed	.709	.414	.154	14	.008	1.58125	10.26015	-20.42458	23.58708
	Equal variances not assumed			.154	13.933	.008	1.58125	10.26015	-20.43455	23.59705

From the whole it can be concluded that the group without tools and groups using the tool showed the results of increased training. The group using the tool has increased by 11.32% with a significant value of 0,000 and the group without tools has increased by 10.05% with a significant value of 0,000. From the two groups, it can be seen that the percentage increase between groups using tools and groups did not use a tool with a significant value of 0.008.

There is a difference in the percentage of increase in training outcomes between groups without tools (10.05%) and groups using tools (11.32%), this indicates that the results of the increase in groups using tools are higher than those in groups without tools. This means that the blind swimming aids model has been proven to be effective in significantly increasing the swimming training results of blind athletes.

## 5 Conclusion

This study concluded that groups using tools have increased by 11.32% with a significant value of 0,000 while groups without tools have increased by 0.05% with a significant value of 0,000. From the two groups, it can be seen that the percentage increase between groups using tools and groups did not use a tool with a significant value of 0.008.

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