Navigation System Using GPS and GSM for Visually Impaired Personals with Nerve Stimulation Feedback

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Navigation System Using GPS and GSM for Visually Impaired Personals with Nerve Stimulation Feedback

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Abstract: The main purpose of this work is to design and develop a navigation system for visually impaired personals based on nerve stimulation and ultrasonic distance measurement system by using GSM and GPS technology. Some of the available similar devices for the visually impaired personals use ultrasound pulsed echos, and sound signals into the ear is passed through them. This restricts the normal action of hearing which a blind human uses heavily in getting information of the environment. For primary obstacle detection and decision making nerve stimulation is used. Nerve stimulation circuitry is the salient feature of this system which provides a silent feedback to nerve of a visually impaired person according to the distance of any obstacle. It's more user friendly and reliable to use nerve stimulation using surface EMG electrodes as feedback because it does not disturb any other sense of a person, for example hearing. The blind person can feel the obstacle ahead and point out the distance from it as stimulation increases when distance to obstacle decreases. The hearing aid along with GPS and GSM route finding system is portable and tells details to the blind person about urban routes to identify decisions to make. GPS system aids a facility to find a specific place and GSM system is used if a blind person gets lost than a simple push button can send SMS to someone to rescue him/her describing the location of the sightless person.

Keywords: Ultrasonic Sensor, Muscle/Nerve Stimulation, Navigation, Visual aid, visually impaired person, GPS, GSM,

1. Introduction

Globally, an estimated 39 million people are totally blind, 246 million have low vision and 285 million have some kind of visual impairment [1]. In most industrialized countries, approximately 0.4% of population is blind while in developing countries it rises to 1% which is estimated by the World Health Organization (WHO). Also according to WHO, 90% of the world's blind people lives in the developing countries. Unfortunately, the visually impaired persons have to depend on guides like blind cane, people information, trained dogs, etc. to live on with their lives, which is a challenging task for them. To improve the living standard of the visually impaired persons moreover, to make these persons as a work force little research work has been done in Bangladesh. For this purpose, the main goal of this research work is to design and develop a navigation system using GSM and GPS technology which will elevate the living condition of visually impaired person. Here in the designed system an electronic goggles will be placed upon the visually impaired person. An ultrasonic sensor attached to the electronic goggles will detect the obstacles using ultrasound, and will give electrical stimulation (nerve stimulation) to the person [5]. Upon receiving the nerve stimulation the person can sense obstacle and can adjust his/her position. The GPS (Global Positioning System) will provide information about current location to the visually impaired person and GSM (Global System for Mobile Communication) is used to sending SMS/Call in case of the visually impaired person is lost or facing any difficulties.

2. Methodology

2.1 Block Diagram of Obstacle detection and Nerve Stimulation System

Figure 1 shows the block diagram of obstacle detection and nerve stimulation system. Here the Ultrasonic sensor (HC-SR04) emits ultrasonic wave for obstacle detection. The reflected signal received by the ultrasonic sensor is provided to the input of microcontroller (ATmega328). The microcontroller then generates PWM (Pulse Width Modulation) signals according to the feedback signal found from ultrasonic sensor and this PWM signals are given to stimulator circuits **[10]** as input. Stimulator circuit creates stimulation and the nerve stimulated signal is then amplified by a transformer and BJT amplifier network. After that, the stimulation control circuitry is used to adjust the nerve stimulated signal which is suitable for the human. Next, the optimum stimulated nerve signal is provided to the human muscle using electrodes.

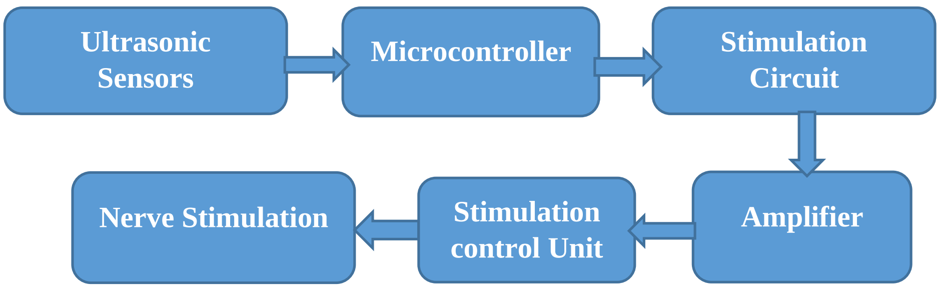

Figure 1: Block Diagram of Obstacle detection and Nerve Stimulation System

2.2 Obstacle detection and Nerve Stimulator Circuitry

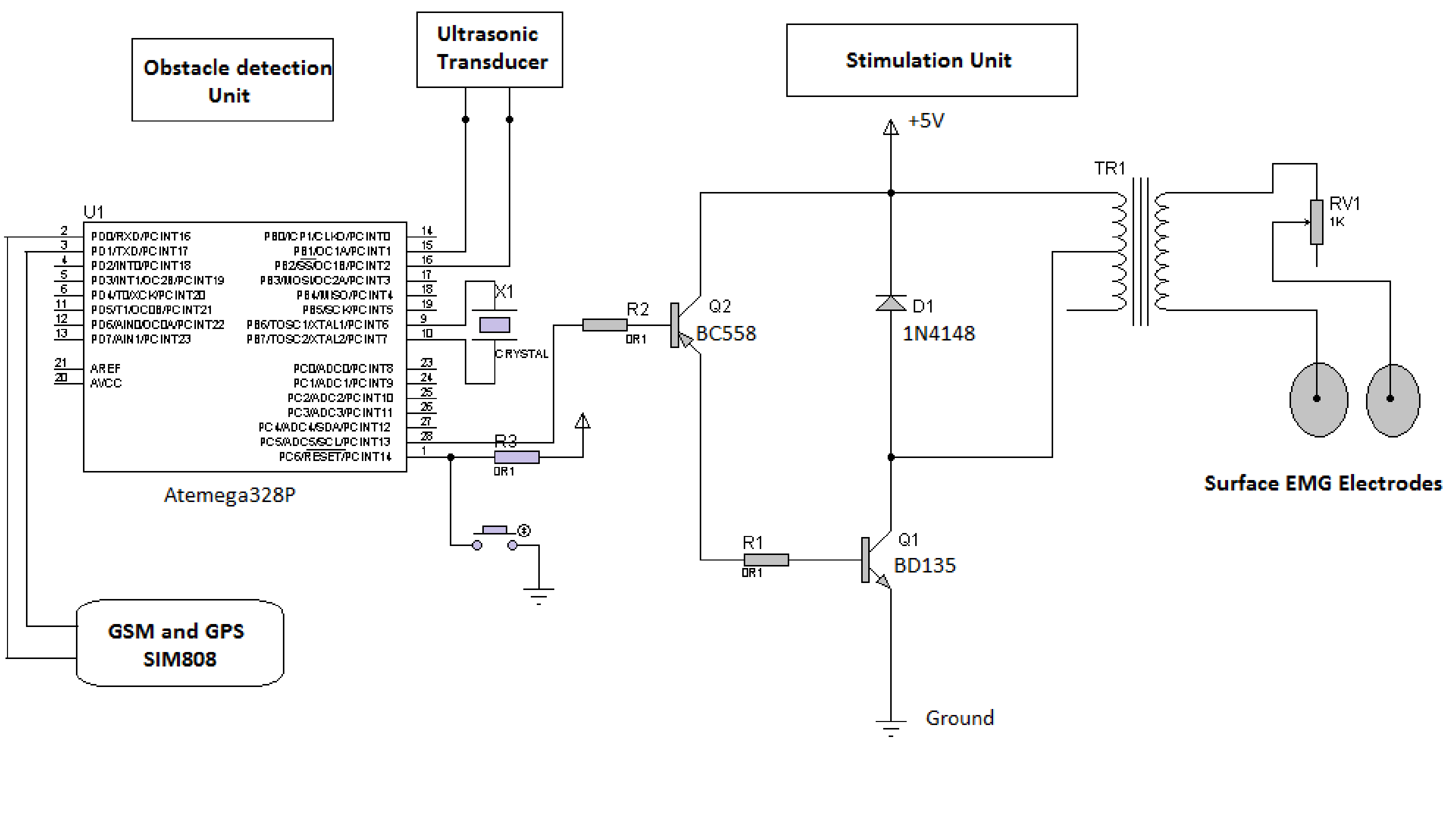

Figure 2: Obstacle detection and nerve stimulator Circuit

Figure 2 demonstrates the circuit diagram of the obstacle detection and stimulation circuitry along with GPS, GSM units. Here the ultrasonic sensor (HC-SR04) has the maximum range of 10.7 meters but for the prototype it has been programed to work within 100 cm. The ultrasonic transmitter continuously transmits the sound waves with a frequency of 40 kHz using the oscillator inbuilt in the ultrasonic sensor [6]. The received analog signal in the ultrasonic receiver is then converted into the digital signal and given to the microcontroller (ATmega328). The microcontroller is interfaced with the ultrasonic sensor is programmed to distinguish the distance between the ultrasonic transceiver and the obstacle. Here, the ultrasonic sensor provides an echo pulse proportional to distance. If the width of the pulse is measured µS, then dividing by 58 will give the distance in cm, or dividing by 148 will give the distance in inches. Microcontroller generates PWM (Pulse Width Modulation) signals according to the feedback signal found from ultrasonic sensor and this PWM signals are given to stimulator circuits input. Pulse width modulation signal is supplied to stimulation circuit on the basis of distance. If distance is less the PWM signal given to stimulation circuit has congested time period and higher frequency and vice versa. A blind person can take decision whether to make a step or not by sensing the nerve stimulation level. If the stimulation is more, then the obstacle is very close. And if nerve stimulation is less than a blind person can go ahead until it object is detected.

The visually impaired person needs to be trained well to make the system familiar to him/her. For nerve stimulation almost 100mA current is needed. But the microcontroller can supply only 30mA which is not enough to cause nerve stimulation. Hence a transformer is used to provide the required nerve stimulated current (maximum 1 A). A variable resistor is added to one front end of transformer output to control the current input to human muscle.

As, various individuals have different sensitivity to stimulation (that is someone has very soft skin with low impedance others have hard skin with high impedance), the nerve stimulation current must be controlled via nerve stimulation circuitry. The stimulation control circuit provides sensible amount of stimulation which will not cause any harm to human being.

2.3 Voice Controlled Location System and Emergency Rescue System (Proposed)

Figure 3 shows the block diagram of GPS based voice controlled system. GPS technology will be used in navigating the visually impaired person. The GPS module (SIM808) will provide location to the voice module (APR9600). Which will alert the visually impaired person of his/her destination area. Figure 4 shows the block diagram of GSM based emergency rescue system [3]. If the visually impaired person becomes unaware of his/her location, or face any difficulties, upon pressing a switch, he/she will be able to send a SMS or Call to a desired mobile phone number. Once the rescue switch is pressed the GSM SIM808 module will send an SMS\ Call to the desired number. Both the voice controlled location system and emergency rescue system are still in work in progress.

Figure 3: Block Diagram of Voice controlled location system

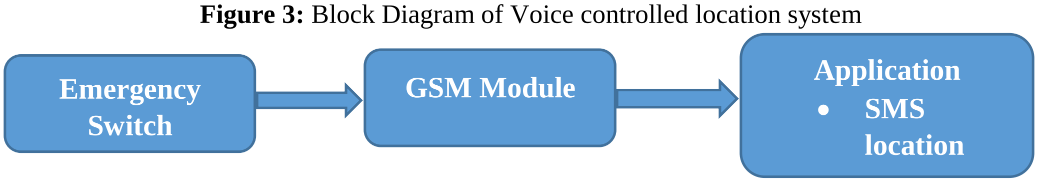

Figure 4: Block Diagram of emergency rescue system for visually impaired persons

2.4 Related works: Blinds man guidance system deployed using infrared sensors [12] are available although Ultrasound is more reliable than infrared based system as sound gets reflected from any object but light cannot, rather light gets refracted through transparent objects. Motor vibration feedback or sound feedback is used in some cases, but motor consumes much power than stimulation and sound feedback curtails some of the sense of a blind persons. That is why nerve stimulation is chosen for feedback which is also appreciated by most of the user who used our device.

2.5 Implementation of Obstacle Detection and Nerve Stimulator Circuit: The most challenging part of making wearable devices [7] is to make it smaller, so that they can be easily be carried without any discomfort and irritation. Currently work is going on to replace the transformer by inductor capacitor network with high current amplifier circuit.

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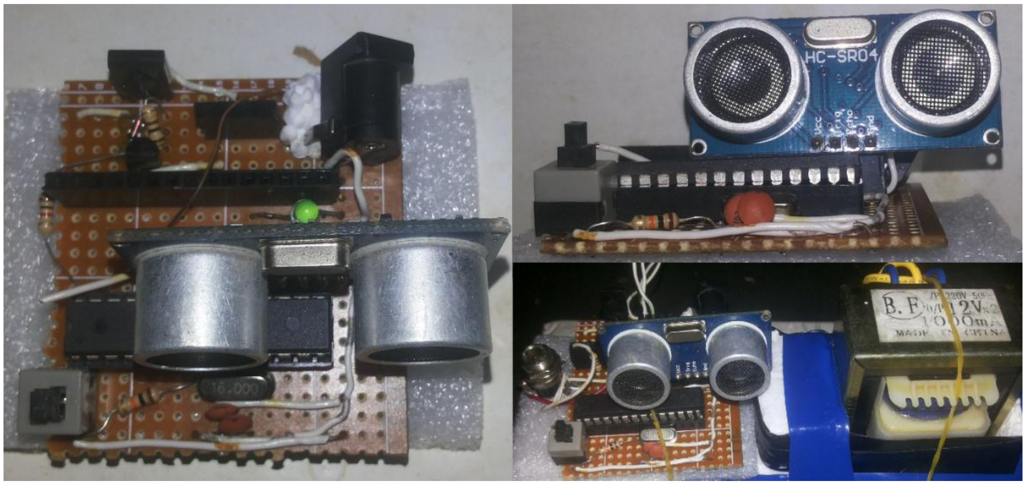

Figure 6: Fully Implemented Circuit with stimulation control unit

3. Data Analysis

3.1 Signal Pattern at different distance

When there is no obstacle, no step signal is observed in the digital storage oscilloscope, as shown in figure 7. The parameter values for no object detection are voltage level = 0, time = 50 ms, frequency = 2.0 Hz. At first seen of obstacle, a step (pulse) signal is observed as shown in figure 8. The obstacle at a distance of 36 cm, when time is 400 ms, voltage is 2V and frequency is 2.5 Hz. From figure 9 and 10, it can be concluded that as distance of obstacle becomes closer the pulse width modulation increases.

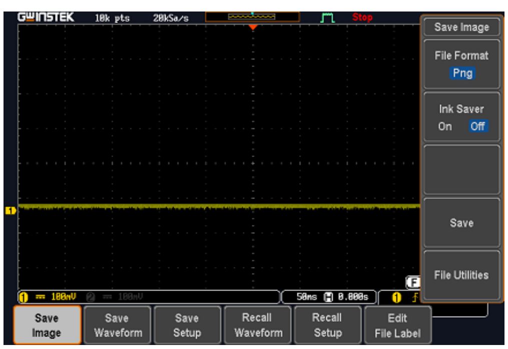

Figure 7: No obstacle detection

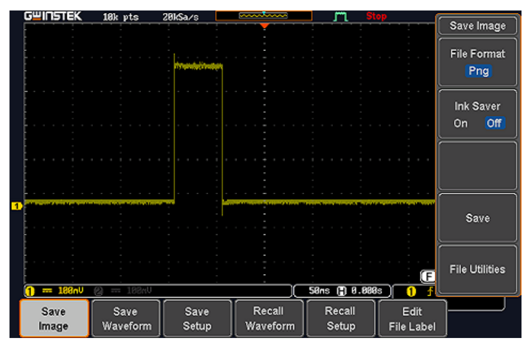

Figure 8: Object detect (36cm)

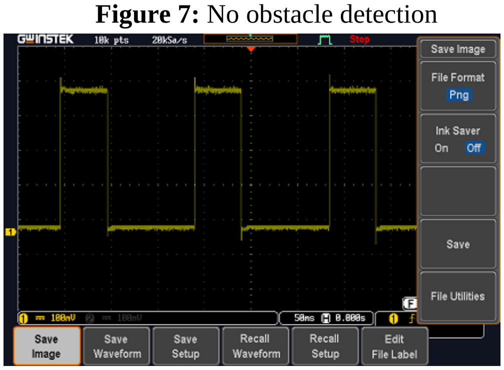

Figure 9: Object detect (D=12cm, t=400ms, V=1.5v f= 2.5 Hz)

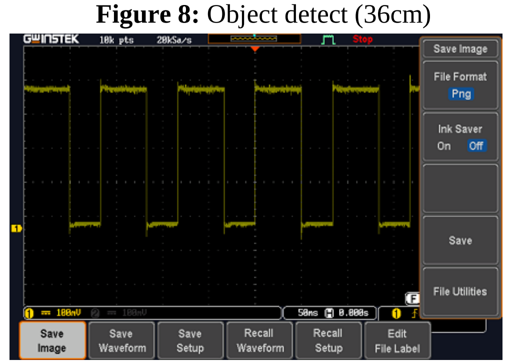

Figure 10: Object detect (D=5cm, t=160ms, f = 6.25 Hz V=1v)

3.2 MATLAB simulation: MATLAB software has been used to see that obstacle detection. Figure 11 and figure 12 shows obstacle detection at distance of 30 cm and 60 cm in matlab software.

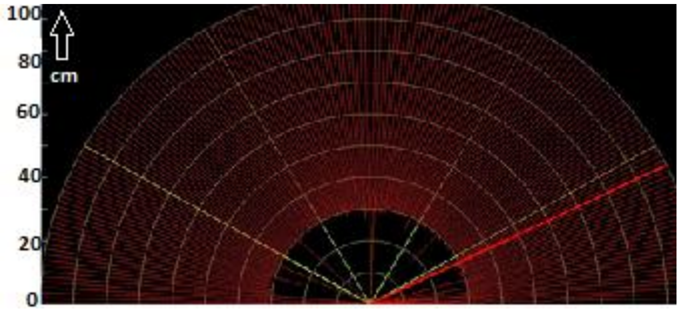

Figure 11: Object at 30 cm observed in MATLAB

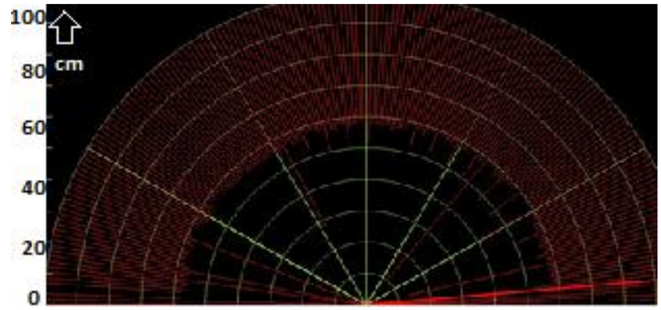

Figure 12: Object at 60 cm observed in MATLAB

3.3 Muscle stimulation pattern at different distance:

By viewing the the figure 12 to 16 it can be conccluded that, as the obstacale become closer nerve stimulation pulse increases and the voltage is decreased.

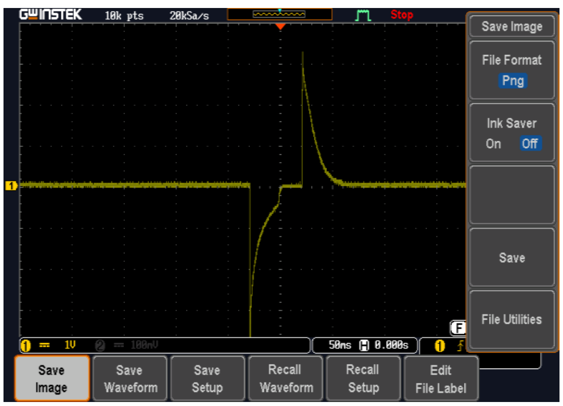

Figure 13: Nerve Stimulation at 97 cm (V=2.5 V)

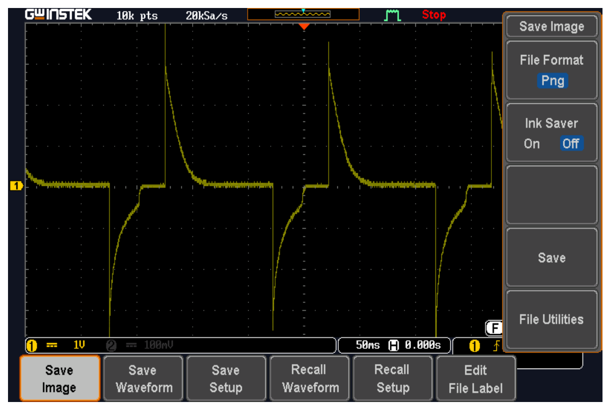

Figure 14: Nerve Stimulation at 66 cm (V=2 V)

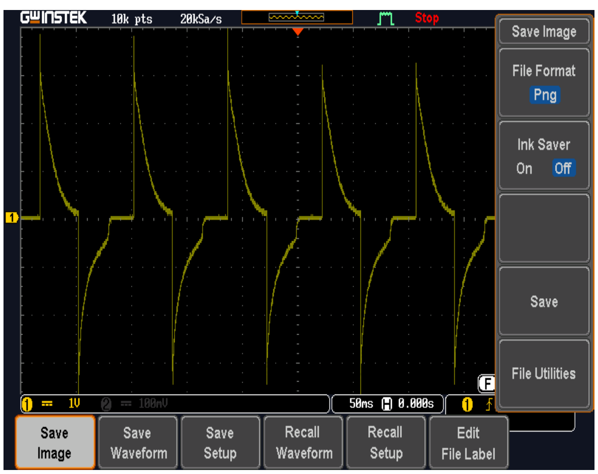

Figure 15: Nerve Stimulation at 15 cm (V= 1.5 V)

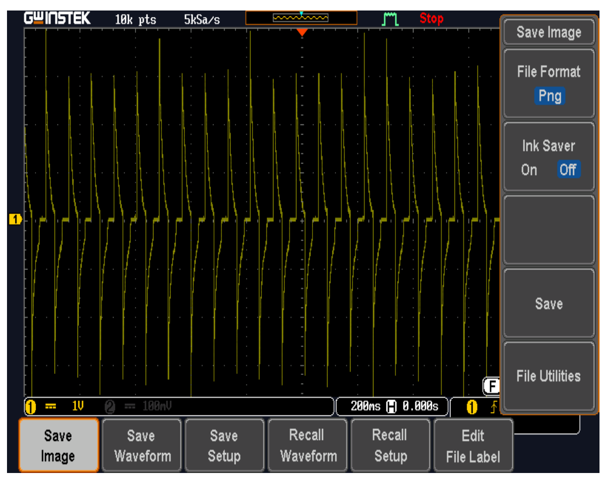

Figure 16: Nerve Stimulation at 5 cm (V= 1 V)

4. Conclusion

This paper has proposed the design and architecture of a new concept of electronic goggles which will be placed upon the eye of visually impaired persons [8]. This design consists of GPS and GSM module, voice module, stimulator circuit which are interfaced to the microcontroller. The main goal of this research work was to device a system that will give more independence to the visually impaired and blindness in terms of their navigational ability in unknown areas and to improve their comfort and safety during walking and without taking any help such as human guides, sticks etc. Part of the goal was successful as the obstacle detection and nerve stimulator circuit has been working perfectly. Although, GPS based location and voice recognition system and GSM based emergency based rescue system yet to be developed it is expected that this part will be concluded soon.

References

[1] World Health Organization (2014) Visual impairment and Blindness – Fact Sheet N°282. Available online at: http://www.who.int/mediacentre/factsheets/fs282/en/

[2] Book: "Human nervous system" written by Peter B.C. Matthews, Charles R. Noback, Duane E. Haines, Graham Ratcliff, Peter W. Nathan, Arthur D. Loewy

[3] GSM World Coverage Map, Available online at: http://www.worldtimezone.com/gsm.html

[4] M Muwyid Uzzaman Khan, M Shamiul Fahad and K Siddique-e-Rabbani, "Ultrasound mobility aid for the blind using frequency modulated nerve stimulation"", 6th International Conference on Electrical & Computer Engineering, ICECE,Dhaka,Bangladesh. (Paper Id: p102: 171-174; IEEE Catalog Number: CEP 1068A-CDR; ISBN-978-4844-62979-7), 2010

[5] Brindley GS and Lewin WS, "The sensations produces by electrical stimulation of visual cortex", J Physiol. 196(2):479-493, 1968.

[6] Paweł Kogut , Andrzej Milewski, Piotr Kluk, Witold Kardyś, "Designing the 40 kHz Piezoelectric Sandwich Type Ultrasonic Transducer" , Mechatronics: Ideas, Challenges, Solution and Application, Vol 414, pp. 173-187, 2015

[7] Abhishek Basak; Vaishnavi Ranganathan; Swarup Bhunia "A wearable ultrasonic assembly for point-of-care autonomous diagnostics of malignant growth Catalog Number: ISBN- 978-1-4673-2767-1; ISSN- 2377-5270, 2013

[8] Digvijay S. Raghuvanshi , Isha Dutta and R. J. Vaidya "Design and analysis of a novel sonar-based obstacle-avoidance system for the visually impaired and unmanned systems", Inrenational Conference on Embedded Systems (ICES), IEEE Catalog Number: ISBN- 978-1-4799-5026-3, 2014

[9] SIM808 GPS/GPRS/GSM Shield. Available online at: https://dfrobot.com/wiki/index.php/SIM808_GPS/GPRS/

[10] Kyle D. Slater, Nicholas C. Sinclair,corresponding author Timothy S. Nelson, Peter J. Blamey, and Hugh J. Mcdermott neuroBi: neuroBi: A Highly Configurable Neurostimulator for a Retinal Prosthesis and Other Applications

[11] L. Mesin, R., Merletti R., Merletti, A. Rainoldi "Surface EMG: The issue of electrode location", J Electromyogr Kinesiol, 19(5): 719-26, 2009.

[12] Amjed S. Al-Fahoum, Heba B. Al-Hmoud, and Ausaila A. Al-Fraihat "A Smart Infrared Microcontroller-Based Blind Guidance System" , Active and Passive Electronic Components, Vol 2013, Article ID-726480, 7 pages, 2013

[13] G S Dodgson, B H Brown, I L Freestone and J C Stevens, "Electrical stimulation at wrist as an aid for the profoundly deaf" , Clin. Phy. Physiol. Meas., vol. 4, pp. 403-416, 1983.

[14] Heyes AD "The Nottingham obstacle detector: atechnical description." , J. Vis. Impair Blind, Vol. 75, pp.206-209, 1981

[15] Barshan B, Kuc R "A bat like sonar system for object localisation" , IEEE Transcations on Systems, Man and Cybernetics. Vol 22, pp. 636-646, 1992