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Implementation of a Breathwalk Aware System

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Abstract- Breathwalk is a science of combining specific patterns of footsteps synchronized with the breathing. Breathing and walking comprise two of the most important activities in our daily life. Breathwalk is the place where these elements of deliberate breathing, walking and meditation come together. It combines them consistently into an exercise which everyone can do. Spiritual, emotional and physical vigor can be improved by bringing them together in an organized and speculative way. Breathwalk has an important effect on body composition, lipid profile, and liver enzymes. In addition, it has a beneficial effect on metabolic and mood state in hepatitis C virus patients. However, "walking meditation" is an exercise which uses the principle of Breathwalk. Results show that it might effectively assist beginners in retarding down the walking speed and decreasing incorrect footsteps. Evaluations have shown that the Breathwalk - aware system is a much better feedback mechanism for learning the techniques of Breathwalk rather than walking meditation. The main principle of it is to synchronize the footstep with appropriate breathing rhythm. In this project, an interactive mechanism which is capable of detecting user's walking and breathing conditions and providing appropriate guidance with the help of LABVIEW is developed. The system increases the walking and breathing awareness in the individual. The system can be used in walking meditation in which the user needs to synchronize footsteps along with breathing and each footsteps with toes first. This study may additionally be of importance in providing a mechanism to help users in higher understanding of his pace and improve the walking habits. Within the future, this technique might be utilized in alternative applications, like walking rehabilitation.

Keywords - Breathwalk, Guidance, Synchronize, Walking Meditation, Walking Rehabilitation.

I. INTRODUCTION

Breathing and walking comprise two of the most important activities in our daily life. Breathwalk is the place where these elements of deliberate breathing, walking and meditation come together. It combines them consistently into an exercise which everyone can do. Spiritual, emotional and physical vigor can be improved by bringing them together in an organized and speculative way. Breathwalk has an important effect on body composition, lipid profile, and liver enzymes. In addition, it has a beneficial effect on metabolic and mood state in hepatitis C virus patients. However, "walking meditation" is an exercise which uses the principle of Breathwalk. Results show that it might effectively assist beginners in retarding down the walking speed and decreasing incorrect footsteps. Evaluations have shown that the Breathwalk- aware system is a much better feedback mechanism for learning the techniques of Breathwalk rather than walking meditation. The main principle of it is to synchronize the footstep with appropriate breathing rhythm. Breathwalk is the science of combining specific patterns of breathing synchronized with your walking steps and enhanced with the art of controlled, speculative attention. Breathwalk is effortless, raw and productive. Once the breathing pattern is chosen and known as you walk, then it will give an immediate path to physical and mental fitness. Breathwalk is based on a Kundalini yoga technique and involving determined strides in rhythm with breathing. The benefits of Breathwalking are a perfect match for today's high-stress/low physical activity workplaces, combining mental and physical benefits. Breathing and walking comprise two of the most important activities in our daily life. Spiritual, emotional and physical vigor can be improved by bringing them together in an organized and speculative way. Breathwalk has an important effect on body composition, lipid profile, and liver enzymes. There are evidences that the method of focusing on the external objects or internal images during meditation can effectively alleviate one's anxiety and tension. It is seen that oxygen consumption, heart rate, and skin conductance could decrease after meditation, and the result of electroencephalogram (EEG) showed specific changes in certain frequencies. Also, some studies demonstrated that the breathing control during meditation can reduce the times of asthmatic attack, delay the deterioration of chronic obstruction of pulmonary diseases, and reduce the probability postoperative pain and complications patients. Therefore, the breathing control is important during meditation.

In addition, Breathwalk has an important effect on metabolic and mood states in hepatitis C virus patients. Walking meditation is an exercise which uses the principle of Breathwalk. Walking meditation is one of the popular methods for mind and body development in Buddhism as it is advantageous for both physical and mental health. The main

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principle of it is to align the footsteps with appropriate breathing rhythm.

A. Significance of the Project

Breathwalk is the place where these elements of deliberate breathing, walking and meditation come together. It combines them consistently into an exercise which everyone can do. Combination of these elements gives a greater impact, with effective results. People who Breathwalk often report that it increases the efforts they put for other exercises or meditation endeavors. Breathwalk provides exercise, personal growth, meditative experience, stress control and a clear mind. It builds on the base of whatever you have experienced with breath, exercise and meditation. It takes you one step ahead in enhancing your practices and adding another dimension of choice to your experience.

In this paper, we present a user interactive system that uses force sensors in shoes to visualize phases of footsteps in order to raise the awareness for the user's walking behavior and to help him improve it.

II. SYSTEM DESIGN

System Overview

The Breathwalk-aware system includes a sensing shoe, breathing rate detector, wireless communication module and a visualization module (LABVIEW). The sensing shoes detect the force distributions of the foot. Tri-axial accelerometer and micro-switch is used for sensing the footsteps. The tri-axial accelerometer is placed in front of the shoe to measure the foot motion and micro-switch is embedded in the shoe. The sensing module consists of Atmel's high-performance, low-power, and 8 bit AVR ATmega16 microcontroller. The breathing rate detector which uses thermistor based circuit for monitoring breathing rate is placed over the mouth or nose and checks the difference in temperature of the expired and inspired air with the help of a mask. The output of the sensing shoe and breathing rate detector are given to ADC port of ATmega16 microcontroller as shown in fig. 1 and converts the analog voltage to digital voltage.

These data's are transmitted wirelessly from the ATmega16 microcontroller through the wireless communication module and received through the wireless communication module in laptop for working in LABVIEW. In LABVIEW the values are received through the visa module. LABVIEW provides for the visual guidance for the users. It helps to correct the incorrect footsteps and gives indication for inhalation and exhalation. It also helps to know whether the toe is touching first on the ground. If the correct pattern of walking is not achieved audio indications and visual indications are produced. Synchronization of footsteps and breathing rhythm is done here in LABVIEW.

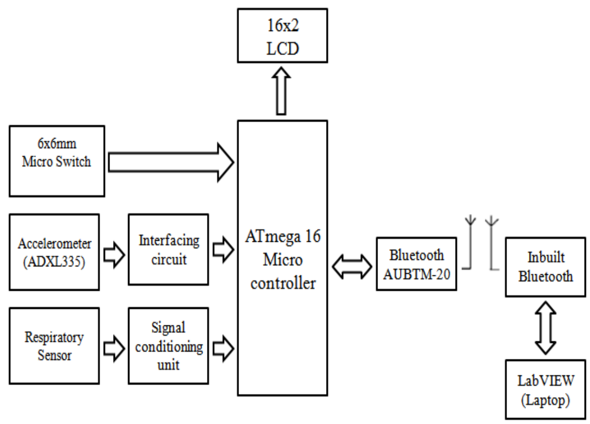

Fig. 1 Block Diagram of Breathwalk Aware System

Sensors

Respiratory Sensor

A thermistor based circuit as shown in fig. 2 is designed to monitor respiration. The sensor is placed over the nose or mouth and senses the difference in the temperature of the expired air and inspired air.

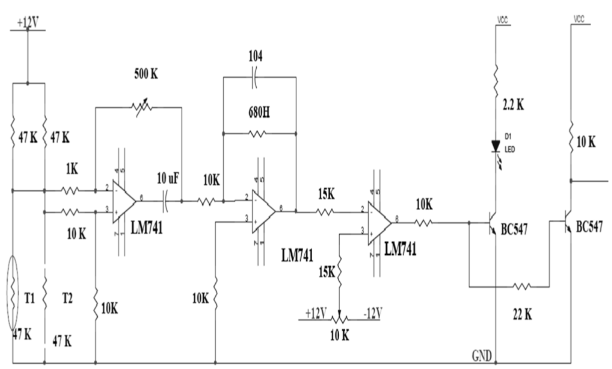

Fig. 2 Respiratory Sensor Signal Conditioning Circuit

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Thermistor used for the respiration measurement is connected in the resistor bridge network. Under constant current, a thermistor will change its resistance a function of the temperature. This value is converted as voltage by using voltage divider circuit with 10K resistor. The difference in the voltage is amplified by LM741 op-amp. In this configuration, an op-amp produces an output potential (relative to circuit ground) that is typically hundreds of thousands of times larger than the potential difference between its input terminals. In order to achieve high input impedance two resistors of 1kΩ is added to the differential input voltage. A resistor of 10kΩ is inserted between the non-inverting input and ground (so both inputs "see" similar resistances), reducing the input offset voltage due to different voltage drops due to bias current, and may reduce distortion in some op-amps. The feedback resistor value is determined by the impedance levels to be established. The feedback resistance is chosen to be 470K variable one and the input resistance is 1K so it can amplify differential voltage. So the required amplification can be made by adjusting the variable resistor.

Next stage the amplification is done with the active low pass filter. This circuit is used to filter the high frequency in the respiration side. This amplified output is directly given to the comparator circuit. Here two input voltages are compared where one is the reference voltage and another one is from integrator.

This output is directly given to the BC547 Transistor. So when it gets the positive voltage that means respiration voltage high it gives low as output to the LED as well as NOT Gate so the LED lights up and the high output is generated by the NOT gate and given to the microcontroller. So when the negative voltage is given to the transistor it will be in OFF state and no more conduction between collector and emitter terminal so the high output from the LED directly given to the NOT Gate and low output is taken. So as to avoid the high voltage flowing through the Transistor Base terminal there is a potential divider by using two 10K resistors. So the half amount of the voltage will be given to the Base. Then the final output voltage is given to microcontroller in order to monitor the respiratory flow.

TRI-AXIS ACCELEROMETER FOR FOOT MOTION MEASUREMENT

Tri-axial accelerometer is placed in front of the shoe to measure the foot motion. A micro-switch is embedded inside the shoe which gives the position of toe and heel part at the time of placing the steps. The footsteps are divided into six phases as shown in fig. 3 starting from raising, lifting, pushing, lowering, stepping and pressing. To enhance the measurement accuracy, first we must calibrate the sensing signals. Therefore, users need to lift the feet to calibrate the force sensing values. Then, the center of gravity in every foot can be estimated.

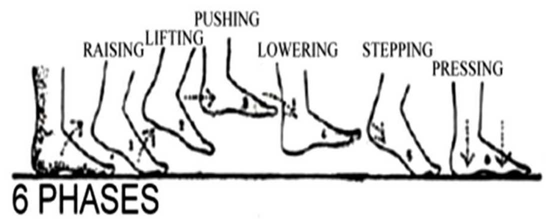

Fig. 3 Six Phases of Footsteps

MICRO SWITCH

A micro switch is an electrical switch which can be operated using a very small force and also possibly using a small movement. Micro switch is a general term and not all micro switches use the same principle but most of them use a stiff metal strip supported by a spring which suddenly flips when a certain force on the switch button is applied. It flips back with a high speed too when the force decreases under certain limit. The switches use hysteresis so the activation force is higher than the deactivation force. Also the quick moving of the metal strip produces the typical clicking sound. In this paper micro switches are used to know the placement of the foot, whether toe or heel part is touching the ground. There is a pattern described for foot placement and in that toes should fist touch the ground and then the heels. So if a micro switch is placed at the toe part, a signal will be got at the time of touching.

III. HARDWARE ARCHITECTURE

The hardware is composed of Tri-axis accelerometer sensor for measuring the foot motion, thermistor based respiratory sensor for breathing rate measurement, microcontroller, wireless communication module and a visualization module (LABVIEW). The analog signals from the 3 axis accelerometer and the respiratory sensor gets into an A/D converter and we get the digital signal. Synchronization of both these signals is the next step. Signals from both left shoe module and right shoe module need to be synchronized. Footsteps guidance and breathing guidance are provided through LABVIEW. Through LABVIEW the system provide

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guidance for landing the toes first. The hardware setup showing the positioning of accelerometer and micro switch is shown in fig. 4.

Fig. 4 Sensors Attached to the Shoes

There are six phases in the footstep movement includes raising, lifting, pushing, lowering, stepping and pressing. There will be an indication for starting inhalation and at that time first the feet should be raised then lift, push and then lower. During exhalation the toes should first land and then press the heels.

IV. RESULTS

The voltage variation according to the position of the foot at the time of inhalation and exhalation is given in table I. For detecting the position of foot both micro switch and accelerometer is being used. Micro switch is used to find when the toe and heel is touching the ground. When the micro switch gives a zero, it means, that part of the foot is touching the ground. There will be a time set for inhalation and exhalation. The system also shows incorrect footstep alarm and speed of walking.

The voltage variation on inhalation and exhalation is shown in table II. The voltage reading is at the highest point at the time of inhalation and lowest at the time of exhalation.

Table I: Voltage Variation According to the Position of Foot

SUBJECTS	INHALATION										EXHALATION			
	RAISING		LIFTING		PUSHING			LOWERING			STEPPING		PRESSING	
					X AXIS (v)	Y AXIS (v)	Z AXIS (v)	X AXIS (v)	Y AXIS (v)	Z AXIS (v)				
A	0	1	1	1	1.84	1.78	1.54	1.56	1.64	1.37	0	1	0	0
B	0	1	1	1	1.86	1.70	1.60	1.56	1.66	1.38	0	1	0	0
C	0	1	1	1	1.84	1.65	1.56	1.54	1.68	1.40	0	1	0	0
D	0	1	1	1	1.80	1.77	1.54	1.58	1.66	1.47	0	1	0	0
E	0	1	1	1	1.88	1.78	1.60	1.58	1.68	1.38	0	1	0	0
F	0	1	1	1	1.83	1.75	1.58	1.57	1.69	1.38	0	1	0	0
G	0	1	1	1	1.88	1.69	1.65	1.54	1.66	1.36	0	1	0	0
H	0	1	1	1	1.86	1.66	1.58	1.58	1.65	1.40	0	1	0	0
I	0	1	1	1	1.85	1.74	1.60	1.59	1.68	1.36	0	1	0	0
J	0	1	1	1	1.88	1.72	1.55	1.60	1.64	1.38	0	1	0	0

. Table II: Voltage Variation on Inhalation and Exhalation

SUBJECTS	INHALATION		EXHALATION	
	MAX VOLTAGE (v)	MIN VOLTAGE (v)	MAX VOLTAGE (v)	MIN VOLTAGE (v)
A	0.58	0.18	0.25	0.05
B	0.56	0.18	0.26	0.05
C	0.58	0.17	0.24	0.08
D	0.54	0.16	0.27	0.06
E	0.56	0.20	0.25	0.08
F	0.50	0.19	0.25	0.09
G	0.54	0.16	0.24	0.05
H	0.54	0.16	0.26	0.06
I	0.48	0.18	0.23	0.07
J	0.50	0.17	0.24	0.08

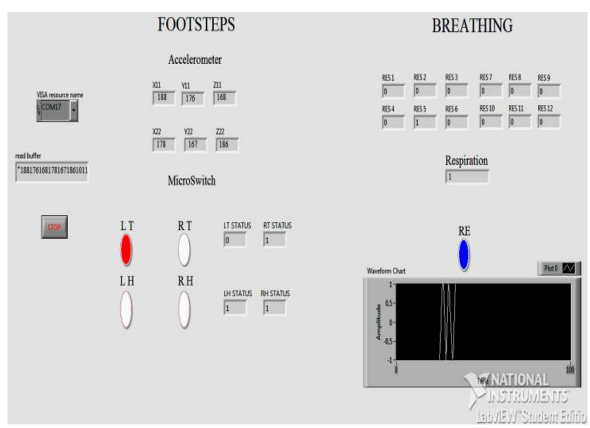

Fig. 5 Front Panel View in LABVIEW

The front panel view of the program in LABVIEW is shown in fig. 5. It provides a visual guidance for the user. The signals from the accelerometer, micro switch and respiratory sensor are transmitted through the wireless communication module and will be received in LABVIEW through the visa module. Here the synchronization process takes place.

V. CONCLUSION

The motivation of this study is to develop an effective assistive technique for helping chronic liver disease patients. Therefore we developed a breathwalk aware system that embraces an interactive mechanism to help users synchronize their footstep and breathing rhythm. This could help people in slowing down their walking speed and thus decreasing the incorrect footsteps. Another advantage of this system is that visual-auditory mechanism can also help in reducing the incorrect footsteps, step retardation time and breathing retardation time. As this study has many positive effects there is scope for future research.

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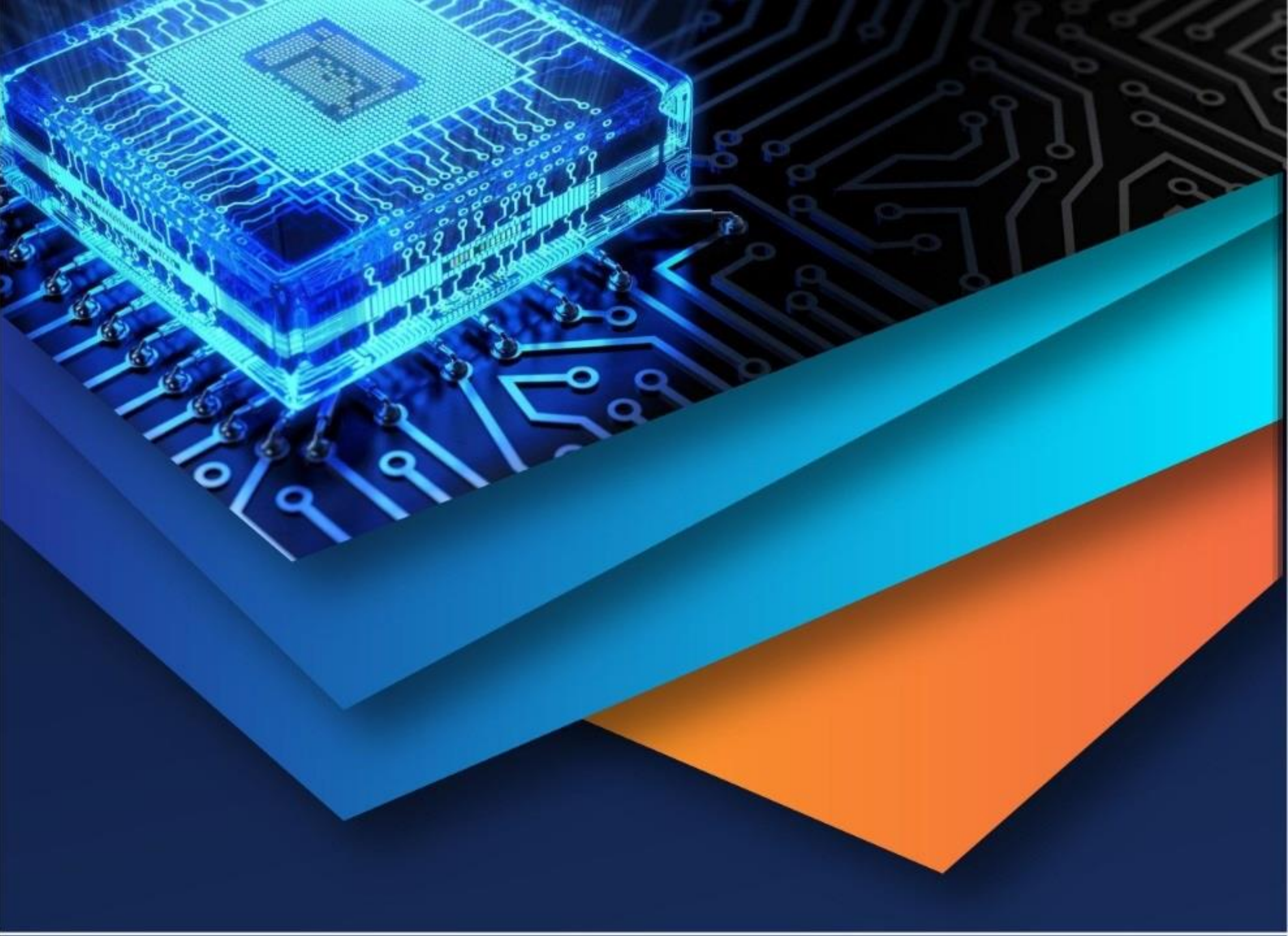

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