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Motorola Scholar Awards : 2013-2014

Judges decision on the Motorola Awards

Note: You can view the details of the project in PDF format by clicking on the link on each heading of the project title.

Winners of Motorola Scholar Awards : 2013-2014

First prize

NITRIC OXIDE DETECTOR FOR THE DIAGNOSIS OF ASTHMA

COLLEGE	**:**	VELTECH MULTI TECH DR. RANGARAJAN DR. SAKUNTHALA ENGINEERING COLLEGE, AVADI, CHENNAI, TAMIL NADU
BRANCH	**:**	BIOMEDICAL ENGINEERING
GUIDE	**:**	DR. C. CHELLARAM
STUDENTS	**:**	Ms. P. SHARMELAA
		Ms. A. KALAIVANI

Second Prize

DESIGN OF LOW COST CHLOROPHYLLMETER

COLLEGE	**:**	KARPAGAM COLLEGE OF ENGINEERING, COIMBATORE, TAMIL NADU
GUIDE	**:**	Dr. B. NAGARAJ
STUDENTS	**:**	Mr. SRIRAM S. R.
		Mr. ARAVINTH KUMAR A.
		Mr. MUBARAK BASHA K.

Third Prize

HANDIFRIEND - LENDING A HELPING LIMB TO PEOPLE SUFFERING FROM REDUCED MOBILITY

COLLEGE	**:**	B.V. BHOOMARADDI COLLEGE OF ENGINEERING AND TECHNOLOGY, HUBLI, KARNATAKA
BRANCH	**:**	COMPUTER SCIENCE AND INSTRUMENTATION TECHNOLOGY
GUIDE	**:**	PROF. AJIT SAMASGIKAR
STUDENTS	**:**	Ms. AKSHATA KULKARNI

	Ms. AMULYA HIREMATH
	Ms. B K SAROJA
	Ms. DIVYA MEHARWADE

Special Prize

IMPACT OF SOCIAL NETWORKING SITES ON HEALTHCARE

COLLEGE	**:**	JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT, SOLAN, HIMACHAL PRADESH
BRANCH	**:**	BIOINFORMATICS
GUIDE	**:**	DR. DIPANKAR SENGUPTA
STUDENT	**:**	Ms. SHIVANGI BOHRA

1. NITRIC OXIDE DETECTOR FOR THE DIAGNOSIS OF ASTHMA

COLLEGE : VELTECH MULTI TECH DR. RANGARAJAN DR. SAKUNTHALA ENGINEERING COLLEGE, AVADI, CHENNAI, TAMIL NADU

BRANCH : BIOMEDICAL ENGINEERING

GUIDE : DR. C. CHELLARAM

STUDENTS : Ms. P. SHARMELAA

Ms. A. KALAIVANI

Introduction

Asthma is one of the respiratory ailments due to chronic airway inflammation. Nitric oxide is produced by the epithelial cells of bronchial wall as part of inflammatory process. Asthma patients will secrete more amount of Nitric oxide and released in the exhaled air. Monitoring the NO production and transport in the lung is necessary for the analysis of respiratory disorders. Thus by measuring the concentration of Nitric oxide in the exhaled air, severity of the asthma can be evaluated which helps the physician to determine the drug dosage level. It can be an additional test for the analysis of the disease.

Problem Definition

Existing method of asthma diagnosis includes airway biopsy and sputum analysis which is an invasive method and also time consuming process. An approach of non-invasive method to diagnose asthma includes nitric oxide measure from the exhaled air.

The Chemiluminscence technique measures the exhaled nitric oxide by reacting it with the ozone and this method is of patient discomfort since it requires forced exhalation. The other drawbacks includes, it needs external clean air for ozone generation and expensive vacuum pump system. Annual check of chemical reaction converters and ozone generators is needed to ensure the supply of ozone for the chemical reaction with the Nitric oxide. Other gases in breath can disturb the chemical reaction of NO with O_3 and may interfere with accurate analysis of nitric acid, especially quenching effects due to carbon dioxide and water.

NIOX MINO developed by Aerocrine and recently developed NO breath by Bedfont uses the electrochemical sensor in which the fractional exhaled Nitric oxide is measured for the analysis. The sensor used must be replaced after 100-200 measurements that make the device costlier.

So a sensor that measures the nitric oxide from the exhaled air in a accurate way must be designed with high sensitivity.

Design approach and Implementation

The IR source reacts with the targeted gas molecule only at the particular wavelength. In case of NO, the fundamental and strongest absorption is in the mid-infrared region at 5.3μm.

Absorptionbands of some gases. Please use all this values for discussion only		
Gas	Absorption in μm and cm^{-1} (Maximum or Range)	
HC (Hydrocarbons)	3.4 6 – 8	2940 1666 – 1250
CO_2 (Carbon dioxide)	4.22 4.26 15	2370 2347 670
N_2O(Nitrous oxide)	4.45 4.50 7.7 - 7.9	2247 2222 1299 – 1266
CO (Carbon monoxide)	4.6 4.7	2174 2128
H_2O (Water)	2.5 - 2.9 5 – 8	4000 – 3450 2000 – 1250
NH_3 (Ammonia)	3.0 6.15 9 – 12	3333 1626 1111 - 633
SO_2 (Sulfur dioxide)	4.0 7.25 7.40 8.6 8.8 18 – 20	2500 1380 1350 1163 1136 555 – 500
NO_x (Nitric oxide)	5.3 5.4	1887 1852

Figure 1. IR Absorption bands of gases

The sensor must be designed in such a way that the frequency of the IR source must be varied using POT which is controlled using PIC microcontroller. IR frequency at which it reacts with the NO will be fixed using the wavelength obtained. (Wavelength= 1/ Frequency). Hence the IR will react with the NO even though the exhaled air contains a mixture of gases such as CO_2, O_2, N_2 etc.

The detector detects the IR and the absorbed IR is correlated to the concentration of the NO which is displayed in the LCD. The LCD will display three readings, the set frequency; reference value obtained from the normal persons after the comparative study and the observed NO concentration from the individuals.

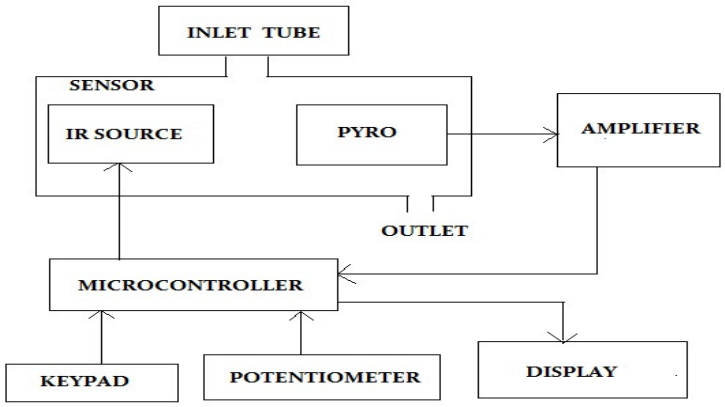

Figure 2. Block Diagram of NO Measurement

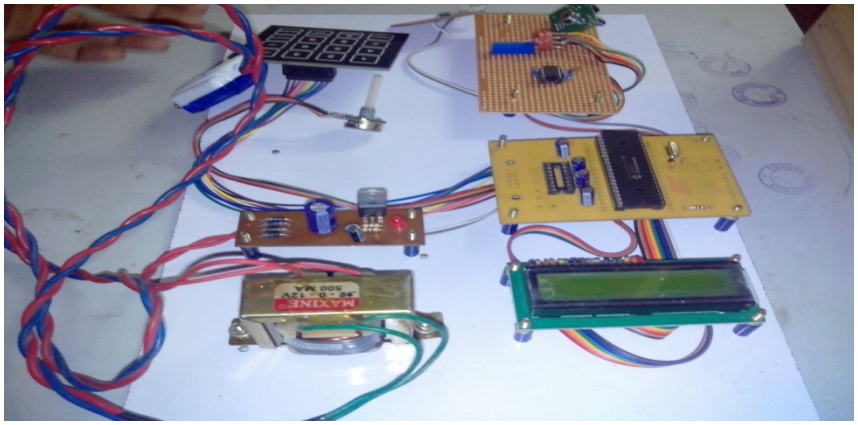

Figure 3. Completed Kit Design

Testing

The designed kit has been tested with the normal and the individuals with the asthma and the results have been correlated with the other existing devices.

STUDY 1

The individuals are asked to blow deeply for 40 - 50 secs through the tubing and the NO detecting mechanism was done.

Exhaled Nitric Oxide values were measured for the normal persons with the following characteristics

Age : Adult: 25±10years Children: 10±4 years

Sex : Male and Female

BMI : 20±5 ($Kg/m^{2)}$

Smoking Habit : No

FeNO values were obtained in the range of 18 – 30 ppb.

And the average value is set as the reference value for the comparison of exhaled NO values with that of the diseased patients.

STUDY 2

Same procedure is repeated for the asthmatic patients with the following characteristics

Age: Adult : 25±10 years

Children : 10±4 years

Sex : Male and Female

BMI : 20±5 (Kg/m^2)

Smoking Habit : Yes/No

Disease Duration : 10±10 years

The FeNO values Obtained is >60ppb for adults and >55ppb for the children.

Problems encountered

The sensitivity of the sensor is in the range but the difficulty in this design is calibration. Each time after the device has been used it should be cleaned with fresh air. The sensor should be enclosed as it should not be reactive with the atmospheric air and these results in calibration difficulties.

Conclusion

Infra red sensors for monitoring NO in exhaled breath were presented. Each existing technology fulfils most of the mentioned criteria, but not all. Therefore it is important to

review the clinical application information carefully before deciding on the best suited technology. The chemiluminescence instruments are expensive, and not user friendly for use in clinical research and clinical practice. The electrochemical instruments too are set for one flow sampling; have questionable reproducibility, although according to some authors it is clinically accepted (up to 10 ppb); and high running costs. Due to their small size they were tested in general practice and by patients at home.

In contrast, the laser-based sensors are slowly penetrating the clinical area, being carefully developed to overcome the drawbacks of the two aforementioned technologies. But this proposed technology offers an additional advantage by measuring simultaneously the exhaled CO2 which is required to follow the different phases of exhalation.

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14. DESIGN OF LOW COST CHLOROPHYLLMETER

COLLEGE	:	KARPAGAM COLLEGE OF ENGINEERING, COIMBATORE, TAMIL NADU
BRANCH	:	ELECTRONICS AND TELECOMMUNICATION ENGINEERING
GUIDE	:	Dr. B. NAGARAJ
STUDENTS	:	Mr. SRIRAM S. R.
		Mr. ARAVINTH KUMAR A.
		Mr. MUBARAK BASHA K.

Introduction:

Recent research indicates a close link between leaf chlorophyll content and leaf N content, which makes sense because the majority of leaf N is contained in chlorophyll molecules. The Minolta chlorophyll meter (model SPAD 502) enables users to quickly and easily measure leaf greenness which is affected by leaf chlorophyll content. Chlorophyll content or leaf greenness is affected by a number of factors, one being N status of the plant. Since the chlorophyll meter has the potential to detect N deficiencies, it also shows promise as a tool for improving N management.

Problem definition:

The chlorophyll meter has several advantages over other tissue testing methods. A reading that indicates adequate nitrogen (or critical value) is not affected by luxury consumption; a plant will only produce as much chlorophyll as it needs regardless of how much N is in the plant. It is not necessary to send samples to a Laboratory for analysis, saving time and money. Producers can sample as often as they choose, and can easily repeat the procedure if they question the results. Using a chlorophyll meter to monitor leaf greenness throughout the growing season can signal the approach of a potential N deficiency early enough to correct it without reducing yields. Monitoring crop N status during the growing season accomplishes little unless it is possible to correct an N deficiency before it reduces yields. Using a chlorophyll meter as an N management tool is especially appropriate where additional N can be applied through the irrigation system.

Design:

In order to reduce the cost of chlorophyll meter I have implemented a low cost chlorophyll meter (meter cost reduced to Rs.5000) in this project. Compared with the traditional destructive methods of chlorophyll extraction, the use of this equipment saves time, space, and resources. The goal of rice farmers should be to apply enough nitrogen fertilizer to avoid deficiency without applying too much. Over fertilization with nitrogen can lead to increased insect and disease occurrence, maturity delays, and lodging in rice crops. Therefore, assessing nitrogen status in a quick and reliable fashion is critical in rice production.

Description of Hardware

In chlorophyll meter, a clip containing two LEDs (sometimes more, depending on the complexity of the measurement algorithm) and the light sensor (photodiode) is placed on the finger or earlobe of the patient. One LED emits red light (wavelengths of 600 nm to 700 nm), and the other emits light in the near IR (wavelengths 800 nm to 900 nm) region. The clip is connected by a cable to a processor unit. The LEDs are rapidly and sequentially excited by two current sources (one for each LED) whose dc levels depend on the LED being driven, based on manufacturer requirements. The detector is synchronized to capture the light from each LED as it is transmitted through the tissue. Low power, precision current sources (if the

current flows into the load) or current sinks (if the current flows out of the load) used in chlorophyll meter designs are required to deliver a few decades of milliamps (hundreds of milliamps for legacy products). The active elements in these circuits are a low power precision operational amplifier, a precision shunt voltage reference, and a MOSFET or a bipolar transistor. To save power an analog switch can be added to power off the current source/sink when it is in the standby mode. If ultra precision design is required, then an ultra precision series voltage reference can be utilized instead of the shunt voltage reference. An excellent low power, low cost precision amplifier to use in this medical application is the dual 10 μA rail-to-rail zero crossover distortion ADA4505-2.

Description of Software

Atmel Studio 6 is the integrated development platform (IDP) for developing and debugging Atmel ARM Cortex™-M processor-based and Atmel AVR microcontroller applications. The Atmel Studio 6 IDP gives you a seamless and easy-to-use environment to write, build and debug your applications written in C/C++ or assembly code. Atmel Studio 6 supports all 8- and 32-bit AVR, the new SoC wireless family, SAM3 and SAM4 microcontrollers, and connects seamlessly to Atmel debuggers and development kits. Additionally, the IDP now includes two new features designed to further enhance your productivity Atmel Gallery is an online apps store built in to Studio 6, allowing you to purchase both in-house and third-party development tools and embedded software. Atmel Spaces is a collaborative workspace where you can securely share embedded design and track progress of projects.

Chlorophyll meter design set up:

A miniaturized and low cost chlorophyll meter is designed according to the proposed methodology as shown in Fig 3.

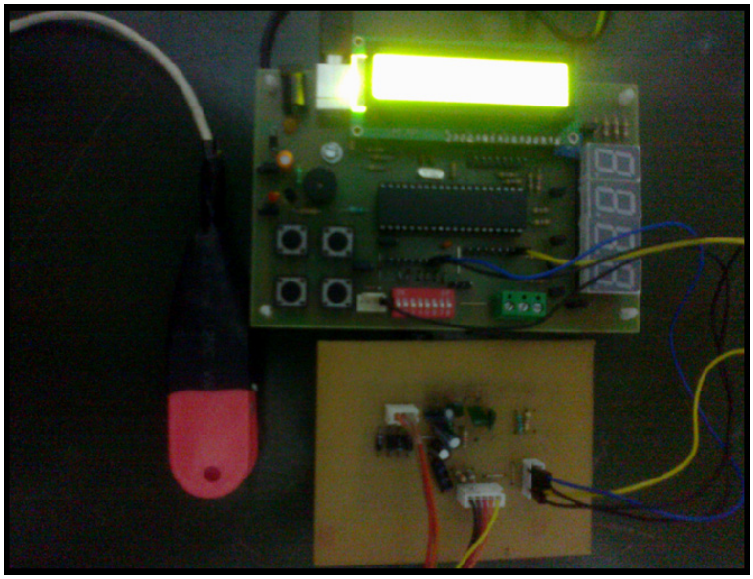

Fig. 1 : Chlorophyll Meter Set Up

Control Signals For Led Driver Circuit

The timing signals for LED driver circuit are generated by ATmega16 microcontroller. These waveforms are pulses with duty cycle of approximately 25% and a typical period of 1 ms (1 kHz). This means that each current sink is on during 250 μs in a 1 ms period.

Chlorophyll estimation:

The instrument measures transmission of red light at 650 nm, at which chlorophyll absorbs light, and transmission of infrared light at 940 nm, at which no absorption occurs .Before the measurement, instrument is calibrated - transmission is measured with no leaf inside. Thus, when a leaf is clamped by the meter, a certain portion of red light is absorbed and the meter can calculate a relative value showing how green the leaf is. Basically, SPAD value correlates with actual chlorophyll content in the leaf, but measurements have to be taken at many points

of the same leaf to be representative and calibration is to be performed for every plant species or cultivar to know the exact relationship between SPAD values and chlorophyll contents per unit area.(i.e. after measuring chl. contents with the chlorophyll meter, pigments are to be extracted from the same leaf and its contents measured, for example, by spectrophotometry). The meter measures how much of the light of a certain wavelength (best absorbed by the chlorophyll molecules) is absorbed by the sample.

The optical sensor will give different output current depending on the intensity of light that it can sense. This will also be the reference for the chlorophyll content. Current mirror and Kirchoff's law are used in our chip design. The current mirror is used to mirror the optical current and using Kirchoff's law and operational amplifier to enlarge the current signal and change to voltage. The voltage will send to the incremental delta sigma ADC to convert the analog voltage to digital signal. And the relative chlorophyll value is calculated by microcontroller and displayed using LCD.

Results

The absorptivity of the different leaves were calculated using Beer Lambert law and the corresponding Chlorophyll index value is shown in the below tabular column.

Leaves with different colours and thickness	Chlorophyll Index(CI)
	**47%**
	**53%**
	**70%**
	**80%**

Conclusion

The device developed in this project is a successful prototype that could measure chlorophyll values and satisfy the nitrogen requirements of plants.

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4. HANDIFRIEND - LENDING A HELPING LIMB TO PEOPLE SUFFERING FROM REDUCED MOBILITY

COLLEGE	:	B.V. BHOOMARADDI COLLEGE OF ENGINEERING AND TECHNOLOGY, HUBLI, KARNATAKA
BRANCH	:	COMPUTER SCIENCE AND INSTRUMENTATION TECHNOLOGY
GUIDE	:	PROF. AJIT SAMASGIKAR
STUDENTS	:	Ms. AKSHATA KULKARNI Ms. AMULYA HIREMATH Ms. B K SAROJA Ms. DIVYA MEHARWADE

Problem definition:

The proposed idea focuses on areas in which progress leads to the betterment of the society. The field of healthcare technologies gives us an ample scope to help people suffering from reduced mobility to make use of their limbs whose function was compromised before.

The orthotic constructed here does not work according to the conventional sense of orthoses, but is an added appendage for people who still possess the paralytic limb. It consists of a exoskeleton made of high density polythene(HDP) supporting the bone structure of the leg taking into consideration what all dextrous movements the limb is subjected to i.e. with all appropriate positioning of joints, the orthotic will be able to mimic the normal functioning of the leg.

Design:

The motion of "Handifriend" will be governed by the user through a remote, where the preset patterns of several regular and predetermined movements of the limbs can be controlled and can be relayed to the limb by the use of wireless technology to the limb. Upon receiving the signals, the actuators function accordingly to the input relayed to it hence facilitating movement. For example, the actuators when placed all the position of all the joints which connect the different bones will cause the particular portion of the exoskeleton to bend that are connected by the actuator.

When several actuators work in synchronism which each other, this will lead to the completion of a particular movement. For example, bending of the foot which is a prerequisite for a person to be able to walk. The sequential execution several steps along with proper timing between the various actuators is realized through designing of appropriate circuitry The orthotic also relays a feedback signal back to the controller through the casing of the exoskeleton. The feedback signal is vital for the application to calculate its next move according to the nature of the signal relayed back.

A **limb** or **extremity**, is a jointed, or prehensile appendage of the human or other animal body. In the human body, the upper and lower limbs are commonly called the arms and the legs. Most animals use limbs for locomotion, such as walking, running, or climbing. Some animals can use their front limbs (or upper limbs in humans) to carry and manipulate objects. Some animals can also use hind limbs for manipulation.

Of all human movements, walking has by far received the most study. What we learn from biomechanical analysis of walking provides a framework for studying all kinds of movements, such as reaching and grasping, sucking, mastication and swallowing, and movements of the eyes. Even for those clinicians who will not directly treat gait deviations, an understanding of gait biomechanics and a familiarity with normal gait will provide a quick window into the patient's level of function because gait is such a common and readily observable activity that involves so much of the body.

A detailed study of the gait will result in a clear understanding of the abnormalities in a particular individual.

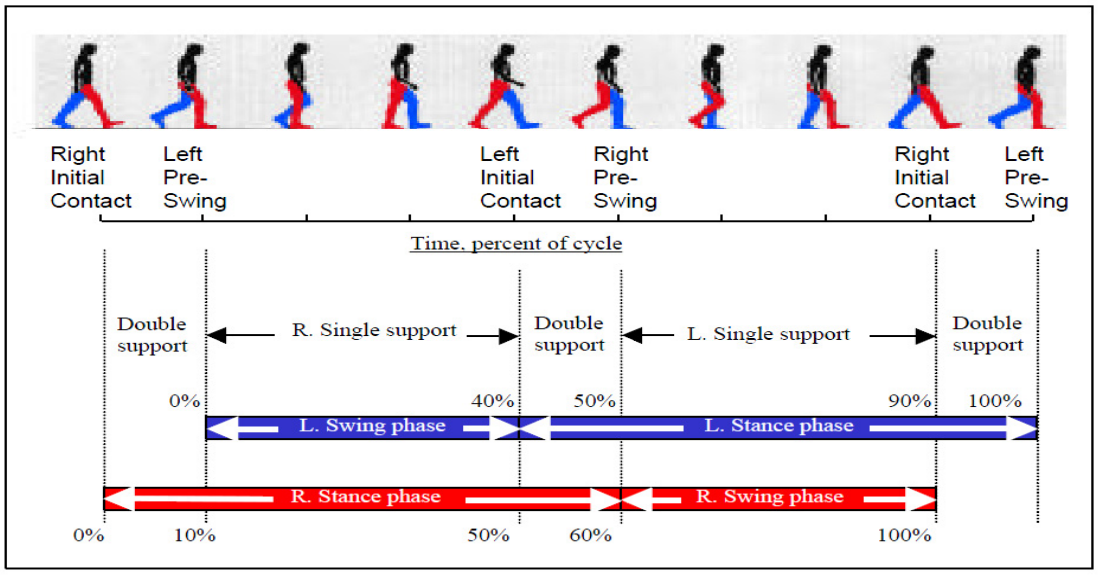

Fig.1 showing the phases of the gait cycle

Figure 1 depicts a single gait cycle for the left and right legs during walking. A gait cycle is the period of time for one stride, that is, the time from one event (usually initial foot contact) to the next occurrence of the same event with the same foot. For each leg, the gait cycle can be divided into a stance phase and a swing phase. Within the stance phase, there is a period of double support: both feet on the ground.

Implementation:

Effectiveness of leg joints relating to the walking.

It is found that the walking was not affected even if there were no fingers and that the roots of the fingers and heel are more important for supporting the body weight. As far as the ankle joint and walking function are concerned, if the ankle joints were fixed

- there will be a lack of contact feeling with ground surface and the fore-and-aft
- standing still is difficult if eyes were closed and
- when side crossing a sloped surface, the feeling of contact with ground surface stability will be weak.

As far as the knee joint, it is found that if the knee joints were fixed, walking up and down staircase is not possible.

Locations of leg joints.

The location of leg joints affects the kinematic and dynamic properties of leg. These have been explained in detail in later part.

Movable extent of leg joints.

Again the length of the leg links and location of leg joints affect the movement and reach of the legs which determines the gait of walking on flat surface and up and downs of staircase.

Dimension, weight and center of gravity of a leg.

Placing the actuator at the knee joint adds various dynamic effects to the leg which have to be compensated for by the controller. This adds complexity to the control algorithms needed to

move the leg. It also requires more powerful motors at the hip joint to move the added mass of the leg. Remote actuation, in which the actuators are located at the base of the leg, eliminates some of these problems, at the cost of increasing the complexity of the mechanism.

Torque placed on leg joints during the walking.

This is one of the most important aspects. The whole moment of leg depends upon the torque requirement on leg joints. If the actuators are not powerful enough to provide the required torque the expected gait cannot be achieved.

Sensors relating to the walking.

The project uses pressure sensor to estimate the step length for the user using a feedback mechanism.

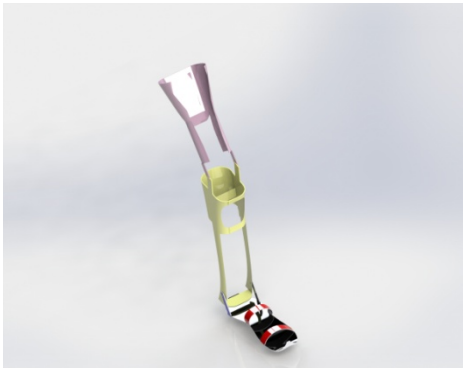

Fig 2. Side view of CAD model of KAFO Fig 3. Front view of CAD model of KAFO

Fig 4. Lateral view of CAD model of KAFO

Results:

Fig 5. The resulting fabricated caliper

Joint Position	DOF	Description
Foot	1	Extension for metacarpophalagela joint
Ankle	2	Flexion-extension, Inversion-Eversion
Knee	1	Flexion

Cost of building the equipment:

Caliper fabrication	Rs 1300
Microcontroller 8051/Arduino	Rs 1400
Geared Stepper motor	Rs 4000
Lead Acid Battery 12v 1amp	Rs 1000
Misc	Rs 500
Total	Rs 7800

Challenges Faced

- The buckling of the knees in a polio patient is very common, the resulting issue dramatically increases the chances of falling.
- Difficulty with balance is one of the most common security issues in Post-Polio. This is caused by a combination of weak or no muscle power and progressive deformities
- Precision in the calculation of torque.
- The coordination of the wireless controller with the actuators.

Potential Future Work

Indispensable piece of equipment at Polio and Paralysis Rehabilitation Centres.

Making orthotic procurement and utilisation more convenient and easy.

Conclusion:

This project brings the feature of a remote which is still new and unheard of hence taking

assisted mobility with the help of an orthotic to newer heights. The product here is not only intended for people who have completely lost mobility to paralysis but also for people who are suffering from restricted mobility issues.

The above said qualities can make the product indispensable for people requiring Rehabilitative care and treatment. The idea of interfacing the orthoses with a remote for enhanced mobility. Performance expected to increase as the motion of the orthotic is monitored real time due to the continuous feedback signal given to the controller to realise its next movement to be relayed.

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