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CHILD (Chivalrous Humanitarian Ideological Loiter Device)

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Abstract: The CHILD is basically a 'smart' wheel chair, entrusted with the task of looking after its parent (disabled person).By densely deploying the lightweight sensor nodes, in a highly distributed manner, it is possible to build a collaboration that transform parameters into desired action. The purpose of this project would be to render the people unable to walk, a livening pulse through development of a low cost performance optimized motion control, user assistance and monitoring system. Motion control based on Gesture, Strain, IR Remote and DTMF has been developed. Haptic Arm and Tray for user's assistance. Obstacle and wall avoiding is enabled. Emergency stop and emergency correspondence are active. Authentication based on RFID and passwords are provided for the user's security. A prototype has been developed with the above mentioned functionality. A three wheeler with solar and regenerative power production alongside multiple mechatronic benefits is designed and the power generation has been tested.

1. INTRODUCTION

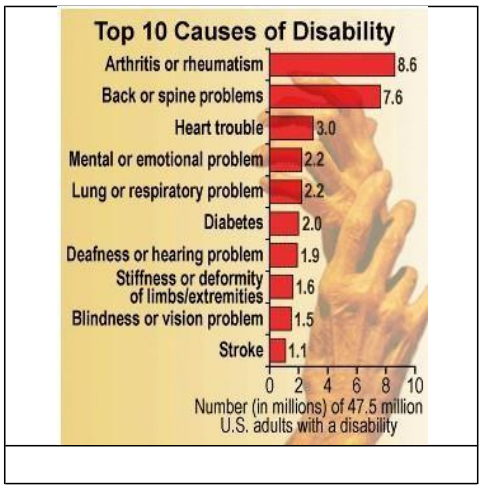


Figure1: Causes for disability

It is human nature to strive to be independent, but we do have the tendency of developing a low self-esteem and feel bad to have to depend on others. Globally, the count multiple-utility bestowing 'smart' mechatronic wheel chair/ bike, thus the goal is the optimization of cost and performance.

1.1 Technical Background

The previous models include, optical fiber curvature sensors [2], joystick [3], MEMS accelerometer [4],eye ball movement [5]brain wave (Electro Encephalogram) [6]based wheel chair. Considering the MEMS accelerometer, optical fiber curvature sensors and eye ball movement based wheelchair it is evident that the freedom of the user is curtailed. For example, if the accelerometer is attached to the hand or the neck, the person cannot do as he wishes, because he will unintentionally navigate to some direction. Also, the cost is comparatively high. Considering the EEG based wheel chair, the design complexity and sensor requirement is high, therefore it is highly priced. The joystick means of navigation requires continuous input from the user. Also, the referred models have not provided a choice to the user. CHILD provides a choice of four means of navigation and does not require continuous user interaction and is

of people succumbing to physical disability due to various reasons is on the rise. This can be understood from the statistics in Figure 1 [1]. These people are under emotional stress that they require constant assistance and certainly it is a physical and mental strain for the caretakers. The constraints of speed, the distance that the wheel chair can cover after being fully charged, a trendy design uncompromised on comfort and most importantly the cost per kilometer. Its ability to be used both as a bike and a wheel chair, by proper demarcation of size and features is to be highlighted. The ultimate challenge is to offer multiple features at a lower cost, because innovation that cannot be afforded by those it is designed for is pointless. The perception of the above facts is the motivation behind the proposal. The CHILD is motivated and powered by a Social theme, featuring it to be a low cost, user friendly without constraining the user's freedom. The referred are restricted strictly to navigation, but CHILD is multiple- utility based. Cost of the system is given prime importance to,

ensuring that it is affordable. User assistance is maximized and user interference is minimized, hence the optimization is focused upon. Coming to the mechanical design, the bikes available for differently-abled are actually after- market fitted with two extra wheels. It generally costs an extra Rs.5000 to fit these wheels on to the bikes. But these bikes come with added disadvantages. Firstly, adding two extra wheels reduces the mileage. Secondly, these wheels add to extra un-sprungmass. The suspension needs to be modified to take into account the extra un-sprung mass. This is normally ignored, which leads to a rough ride for the user. So, the users tend to suffer from frequent back pains and body pains. Moreover, they face difficulty in parking the vehicle as there is no provision to reverse it. Hence, based on the comparative analysis CHILD stands unique and highly beneficial both in terms of its mechanical and electronics capabilities.

1.2 Organization of the report

The report is organized to start with the proposed solution, which provides an overview of the project. Thereon the system level block diagram and the software architecture is explained diagrammatically. Following this is the detailed explanation of hardware and software in a modular basis. Post explanation of the electronic modules, the mechanical aspects of the project are focused upon. The design considerations and the overall outcome of the outcome of project is explained with the aid of CAD and images of the completed modules. Finally the paper ends with the results and conclusion, which describe the goals achieved, future scope, the strength and limitation.

2. PROPOSED SOLUTION

The fundamental block of the CHILD is an edge and wall avoider circuitry. The next step would be the provision of three motor powered 'Haptic arm' with six degrees of freedom for the purpose of picking and placing things. At the base is a tray which can be accessed by angular - linear motion conversion for placing objects. Movement is through pointing of fingers using IR transmitter and receiver combination (Gesture Based) or in special cases by usage of movable strain gauges(Strain Based), which are to be placed in locations as specified by the user based on his comfort(Current consideration is operation using feet). DTMF based control by those authorized when the physically challenged person is within visual range. IR Remote based control to ensure that the attendant is close to the wheel chair. GSM is tailored to ensure correspondence in case of emergency and when the RFID is passed over the reader. LCD based interaction with the user to intimate the detection of emergency stop criterion, so that the user is not confused. RFID based authentication and Password initialization are achieved for the purpose of security in the event of occurrence of un- anticipated situations. Additional devices can be installed for medical monitoring and summoning on detection of abnormality. The constraints that had to be factored into the design were cost and form-factor. It is very essential to achieve the lowest cost possible. Hence, striking a balance between the features and the cost, the electronic modules are as described in the system level block diagram as shown in Figure The special mobility vehicle which incorporates key features like Hub motors, Regenerative shock absorbers, Solar panel and Torque vectoring system . These features coupled with a ergonomic frame design, adjustable seats and independent suspension makes this vehicle more safer, economical and comfortable than any other bike available in the market today. The solar panels, regenerative shock absorbers and regenerative braking makes this vehicle more eco-friendly than a conventional electric vehicle. These renewable technologies effectively increase the range efficiency of the vehicle.

3. HARDWARE AND SOFTWARE IMPLEMENTATION

3.1 Navigation mode selection

The selection of the mode of navigation, among the four available modes is by using a potentiometer. Using an ADC the value is read and based on the reading between 0 and 1023, the mode is selected. While traversing

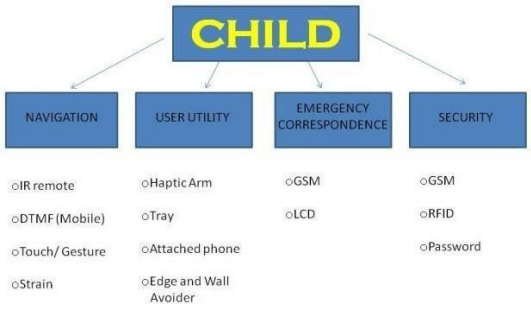


Figure 2: System level block diagram of CHILD

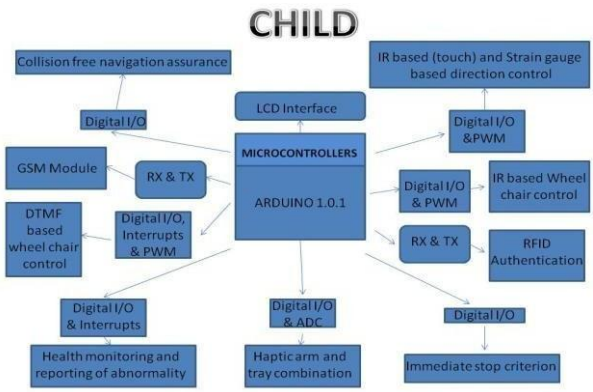


Figure 3: CHILD pin configuration

through the modes, there will be no effect because the Remote and Mobile modes are protected by password and touch and strain have zero as inputs unless triggered. The motors are driven using the driver IC L293DNE. The real time model has the voltage regulated from IC 7805.

3.2 Remote based navigation and RFID Authentication

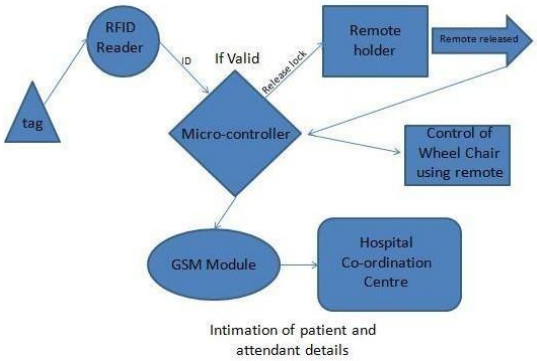
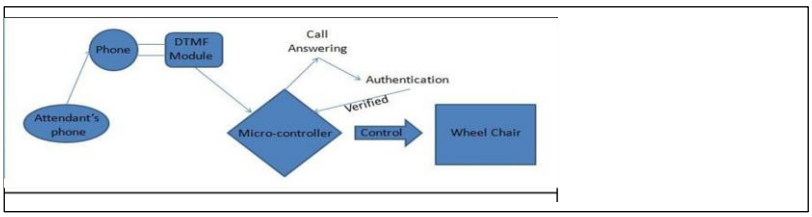


Figure 4: RFID authentication and Remote based navigation

The IR reader in the micro-controller recognizes the frequency corresponding to each button we toggle in the remote. The IR remote sends a series of pulse trains, which are received using the TSOP and counted using loops. Hence, the number is recognized. To each key, assigning of tasks is done. The cause is rather than having someone to push the wheel chair, it would solve the dual purpose of having someone close and reducing the person's physical effort. RFID based authentication will ensure that the control remote is used only by an authorized person. Unless the ID is valid, the

remote remains locked in the holder. Once, an valid is used, the remote holder is unlocked and the remote is accessible. When, the holder unlocks, a message is sent and the centre will be intimated of the wheel chair number that operates on the remote based navigation. Serial communication is done through Max232N. Hence, security and ease of use are achieved

3.3. DTMF (Mobile) based navigation



The first step would involve the decoding of the frequency generated as and when the keypad is used. This involves the use of the IC CS9370DGP, which is a DTMF to decimal decoder. There on it gives output in BCD. By using the left shifting operation, the decimal number is decoded. To exercise control over the wheel chair, the user will have to enter the password. Only if the password matches, the navigation is done. DTMF can aid two types of control. Primarily by the person with the disability, the sixteen key based control can help control the direction of motion. Secondarily in conditions wherein a person from long distance would prefer to control the motion of the wheel chair, this is most likely to happen when distance of travel is restricted to the vision span of the person controlling.

3.4 Gesture and Strain based control

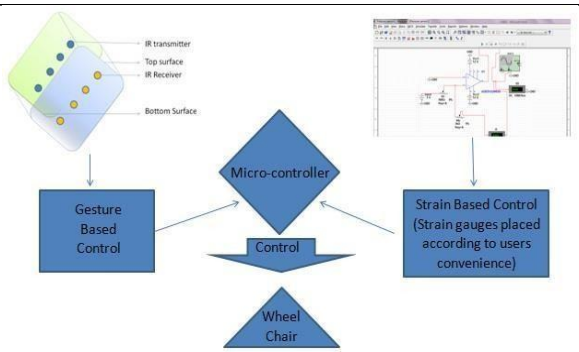


Figure 6: Gesture and Strain based control.

IR proximity based gesture recognition is developed. The signal received by the photodiode is weak and hence it is amplified using the IC LM358P.The amplified signal is fed to the controller. The control segment is basically cubical in shape, but the front surfaceis left open to provide entry to the fingers. The IR LEDs photodiodes are placed consecutively on the top surface. Hence, when the person makes the choice of the direction he wants to move in, logic 1 is the output of the photodiode. Hence, the direction to be taken corresponds to the gestures. Therefore, the IR based control works out to be cheap and efficient replica of a touchpad. Considering the Strain based navigation, since the amount of strain is not an issue of concern, push buttons work out as the cheap replica of the strain gauge. The push buttons are labelled and can be placed in accordance to the user's convenience. In, the demonstration the push buttons is placed at the foot rest. Inclinations are made and the push buttons are placed on the same, so to avoid accidental toggling. The consideration made is that the person can't walk and his hands are fractured, so he uses his feet for navigation. The push buttons are of the NO type. When pressed provide a logic 1 and based on that the loops are developed to perform the action.

3.5 Haptic Arm and Tray combination

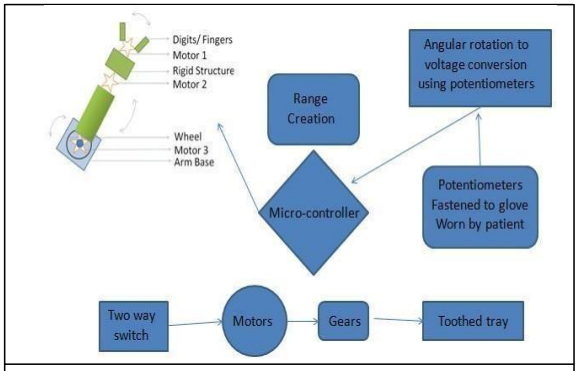


Figure 7: Haptic Arm and Tray Combination

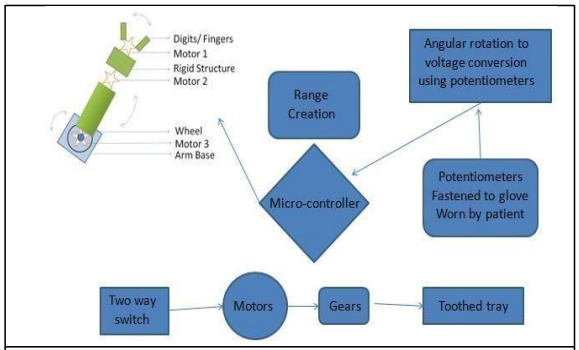
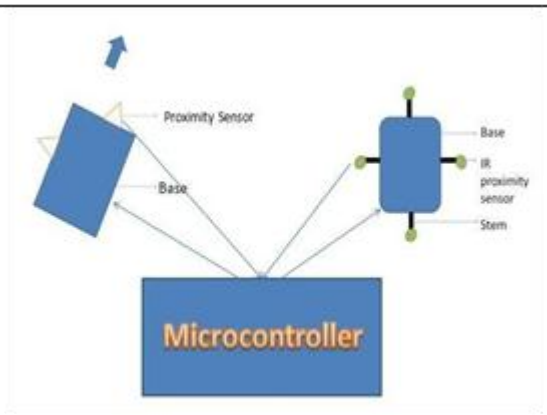


Figure 7: Haptic Arm and Tray Combination

The haptic arm is controlled using a three motor combination, thus allowing it to move along six axes. The picking of goods is enabled by two metallic structures which act as fingers. The persons elbow, wrist and two fingers are strapped. The rotation of the elbow is bequeathed with the potential to take a 360 degree turn. The wrist can induce a 180 degree motion. The movement of the elbow and the wrist contribute to reach the object. The action performed by the user is detected through the potentiometers. Since the movement of these joints is angular, the movement causes the rotation of the variable arm of the potentiometer, hence producing a change in voltage. This change is made use of to produce the corresponding rotation. The picking up of the object is facilitated by gripping using the fingers. A two way switch is used to move the tray in and out.Hence, this serves a very essential tool adding to the rider's ease. Edge and Wall avoider circuitry: colliding on a wall, though the rider directs the CHILD in a haphazard manner. Also since it is obstacle based, it will also prevent chances of colliding with other people. Whenever the obstacle is detected, the stop loop is executed. In a stipulated time from then on, the wheel chair continues to the direction as chosen by the user. So, after a pause for a stipulated time, it then gets back. There is toggle switch to turn on/ off the safety measure, since if the place is over-crowded the CHILD will consider people to be obstacles and so will not move. Thus, the basic circuitry will enable the CHILD from preventing the occurrence of collisions. To ensure that the user has knowledge of what is happening, LCD interface is made to intimate the user of the criterion being executed.



Colliding on a wall, though the rider directs the CHILD in a haphazard manner. Also since it is obstacle based, it will also prevent chances of colliding with other people. Whenever the obstacle is detected, the stop loop is executed. In a stipulated time from then on, the wheel chair continues to the direction as chosen by the user. So, after a pause for a stipulated time, it then gets back. There is toggle switch to turn on/ off the safety measure, since if the place is over-crowded the CHILD will consider people to be obstacles and so will not move. Thus, the basic circuitry will enable the CHILD from preventing the occurrence of collisions.
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3.7 ***Emergency Stop Criterion***

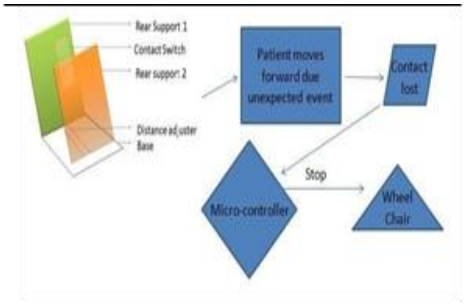
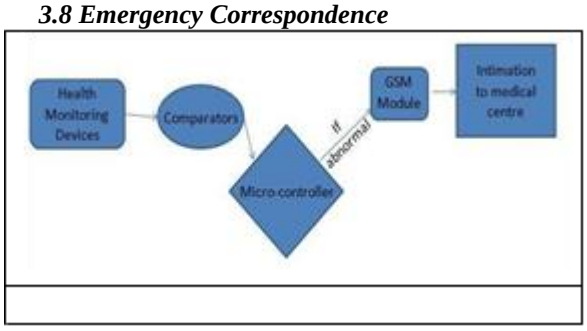


Figure 9: Emergency Stop Criterion

In many cases, like when the person sneezes or coughs, the device considers the gesture to be an instruction and takes the turn suitably leading to haphazard motion. To prevent the same, a NC contact switch is used. This ensures that the device is in motion only when the person leans on the backrest. Based on the patient the back rest can be moved to and fro, so that it is ensured that he leans on it.Also if the person wants to simple stop, the easiest thing for him to do irrespective of the mode of navigation, he can simply lean forward. Then on, once he rests back he will continue along his chosen direction. This is again a sort of gesture control.

3.8 Emergency Correspondence



The purpose of the edge and wall avoider would be to prevent the wheel-chair from toppling over at an edge or TL082CNis used for building the comparator. The input to the negative terminal is the reference voltage. The voltage from the health monitoring device which may be for example, heart beat monitoring or temperature measuring, is passed to the positive terminal. If the voltage is beyond the reference an input of Logic 1 is received .On receipt of this signal, a message is sent mentioning the wheel chair number and that it is an emergency. Hence, the measures are taken suitably.

4. RESULT

With regard to CHILD, the results include software testing and visualization through hardware implementation. As of the software testing, the results are as expected and the code has been included in the Appendix B of the report.

It is evident from the results that the development of a market ready CHILD will be highly beneficial. To ensure that the cost benefit is maintained, each CHILD can be custom made, i.e. the user can choose the modules he wants to make use at the time of purchase, making it becomes all the more user specific and cheaper.

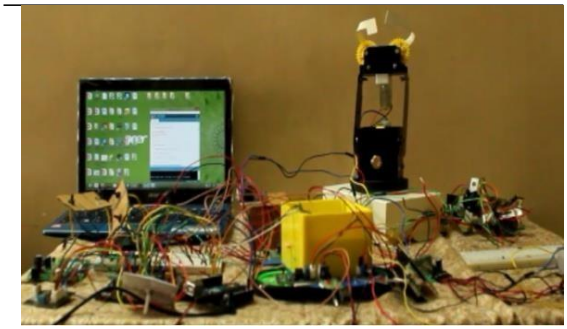


Figure 11: Completed prototype

5. CONCLUSION

The development of the prototype with the proposed modules has been achieved. The future scope of the project includes addition of a GPS module, thereby the exact location can be added every time a message is sent. Also, addition of a rotating camera and online publishing of the footage will ensure that DTMF based control can be made use of from any part of the world to navigate to the destination. An added advantage would be that, if emergency correspondence is made, looking at the person will be made possible. Hence, the prototype has promising utility and benefits with scope for future work.

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