SMART MOBILITY SYSTEM FOR PHYSICALLY CHALLENGED

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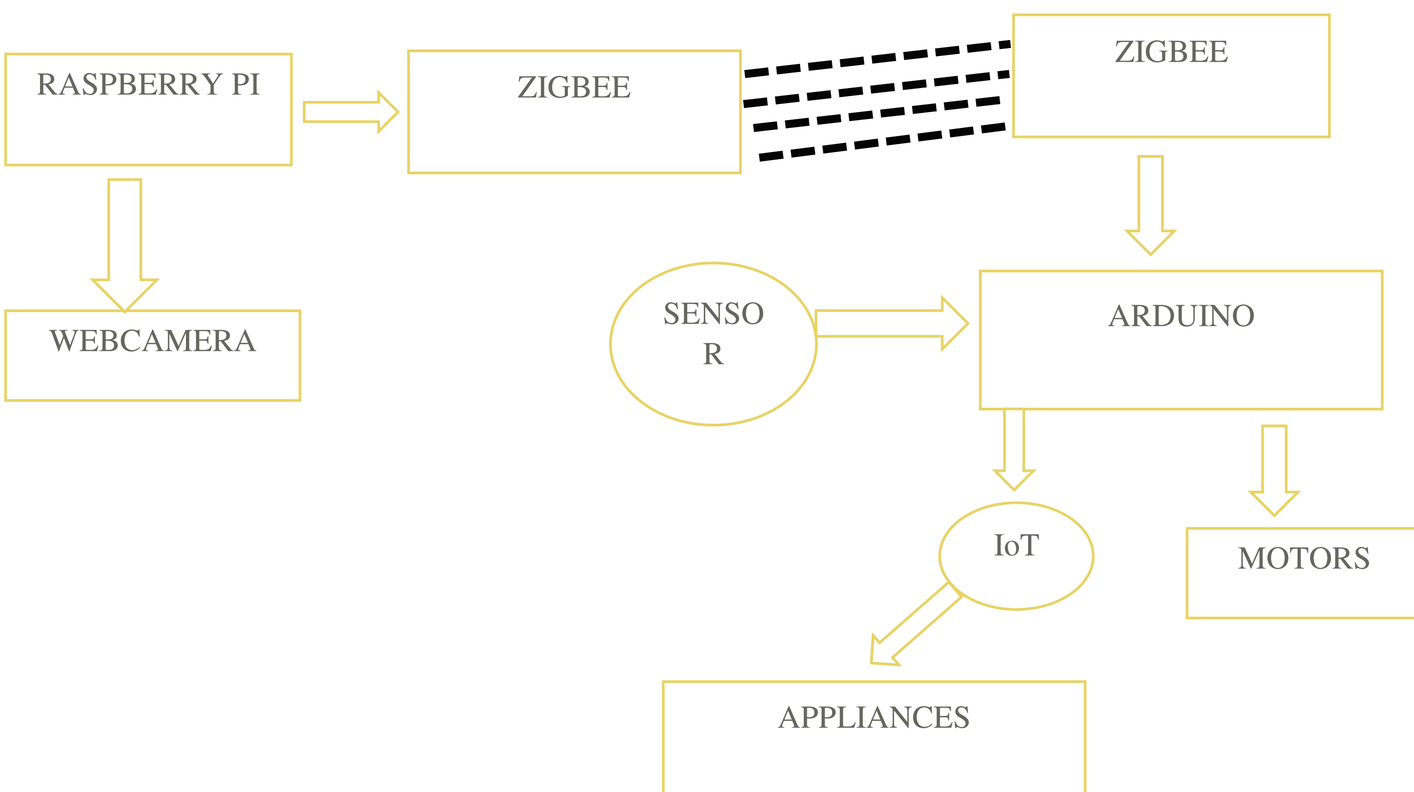
ABSTRACT

The smart wheelchair based on eye tracking is designed for people with locomotors disabilities. Thecontrolled module added to the system can be used with any electrical wheelchair. The smart wheelchair consists of image processing, IoT and safety provision for the disabled person. The image processing comprises of a webcam and customized image processing software. The webcam takes image of the eyeball continuously, allows user who suffer from severe disability such as amyotrophic lateral sclerosis (ALS) or Parkinson's disease to move forward, left or right by moving their eye to the corresponding location. The captured image which is transmitted to Raspberry Pi microcontroller will be processed using OpenCV Python. Appliances control with IoT based application help to control lights, fans, etc. of disabled persons room independently, entertainment purposes such as games, videos, sports for the disabled and alert system where emergency SMS or call to caretakers are provided in a single application developed. Adequate safety precautions are added to this system such as an IR obstacle sensor which stops the wheelchair in front of any obstacle as safety of patients is our major concern.

INTRODUCTION

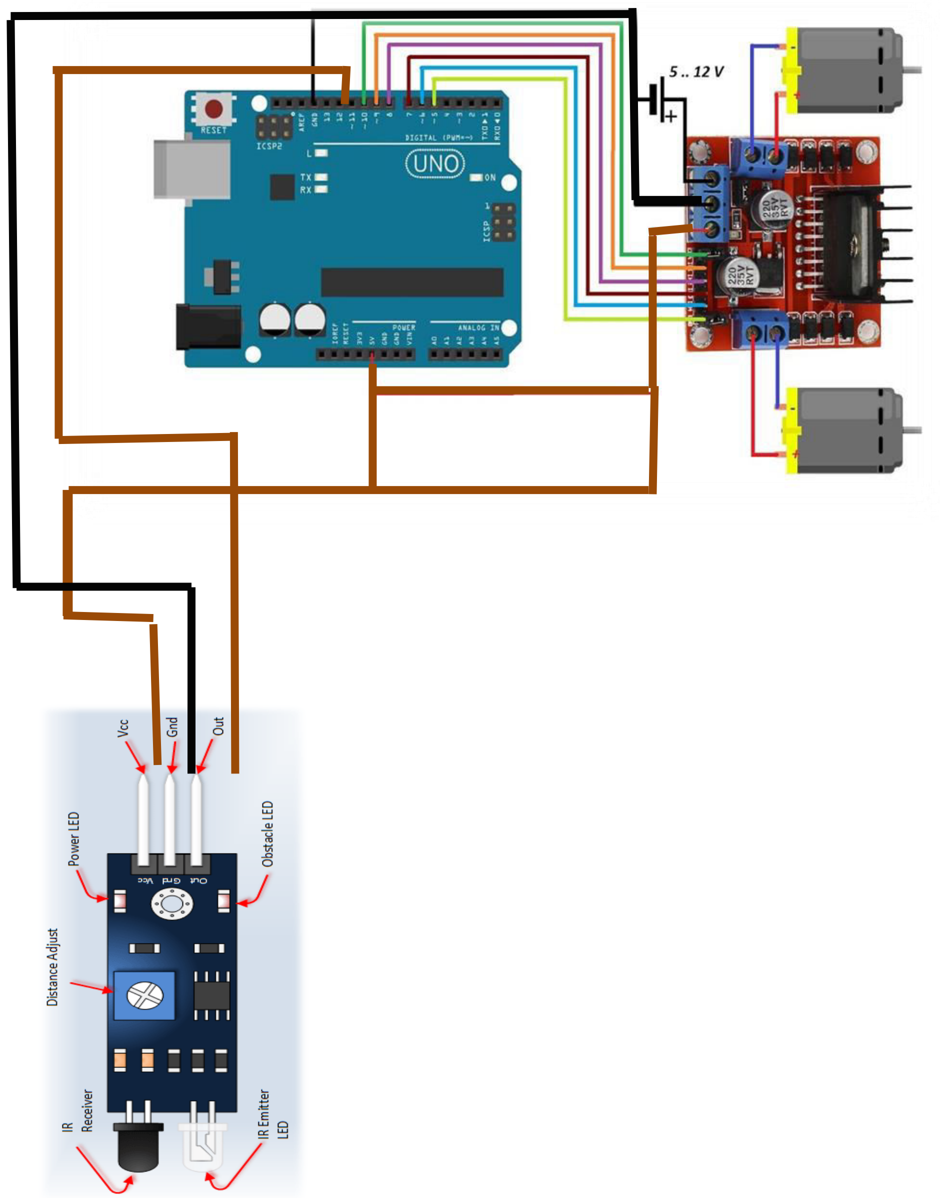
The idea of eye controls is of great use to not only the future of natural input but more importantly the handicapped and disabled. People who are physically challenged are using wheel chairs which exert great amounts of energy using physical strength to move the wheels. As eyesight being their guide, those peoplecould save their energy and could use their hands for other activities. There are no products on the market as per now, but there are other applications such as the virtual reality using eye trackingin order to control the vision of the game. Eye tracking is not much used in mainstream products but now it's beginning to pick up as input to electronics which become more and more natural. The purpose of this projectis to develop a wheelchair that will be controlled by the eyes of the person seated in the wheelchair. This will allow people without full use of their limbs the freedom to move about and provide a level of autonomy. The wheel chair model is a well-equipped and flexible motorized wheelchair for paralytic and disabled patients to move the wheelchair without straining any of their physical posture. The eye movement is tracked autonomously and the wheelchair is directed according to the eye position. It is an ecofriendly and cost-effective wheelchair that dissipates less power and can be fabricated using minimum resources. System has been designed taking into consideration the physical disability, thus it won't affect the patient physically. Also, appliances control together with emergency alert system and entertainment system helps the patient to become more independent. Obstacle and ground clearance sensing is performed to ensure patient's safety. An application has been developed to control the appliances, for emergency and entertainment purposes. IoT is incorporated into this system in order to control the home appliances by the patient itself. The mostimportant thing is to automatically ON and OFF the home appliances without inclusion of caretakers. In present days most of the automation system utilizes the combination of hardware and wireless system for controlling appliances. Here we use Node MCU for controlling appliances via the Wi-Fi module using Arduino. The user will communicate to Arduino through internet via Wi-Fi network. The system is less costly, allowing additional home appliances. The application also provides emergency alert system which send SMS to the caretaker in case of emergency. The appliance control together with emergency alert system and entertainment system helps the patient to become more independent.

BLOCK DIAGRAM



The system consists of three main functions, wheelchair movement based on eye tracking by image processing techniques, obstacle detection and appliances control. The webcam receives input (i.e., image) from the user and transmits the corresponding data to microcontroller. The Microcontroller used isRaspberry pi, which controls the movement of the wheelchair by the motors interfaced with motor driver. The programs used in Raspberry Pi are written in OpenCV Python.Wheelchair can be moved to forward, left and right directions according to the desired eye movements. Appliances, emergency call to caretakers and entertainment purpose for patients are provided using an application developed using IoT. Also, an Infrared Obstacle detection Sensor is used to detect presence of any obstacle in front of it, which provides safety. According to theXY direction, a threshold value is set in the program such a way that some characters aregiven to the ZigBee module. If Y < 50, then the 'up' is printed on the serial port, character' F' is forwarded the ZigBee module and if X <250 then 'right' is printed and letter 'R' is encoded and if X > 380 'left' is initialized by sending the character 'L' to the ZigBee. These characters are sent to the Arduino through ZigBee after a count equal to 5. Arduino is programmed to move the wheelchair in forward, right and left directions according to the letters received from ZigBee that is F for forward, R for right and L for left. When the Arduino receives a character F, it set all the four input of the motor high thus the wheel moves forward. If a character R is received then the Arduino sets the first motor high and the second motor low i.e., if the motor needs to turn left then right motor is activated and it moves left, similarly for the right movement vice versa. Wheelchair can be moved according to the desired eye movements. Appliances, emergency call to caretakers and entertainment purpose for patients are provided using an application developed using IoT. Through this app the person can control lights and fans available in his home, which is connected to the Node MCU module. When the Wi-Fi is turned on this light and fans get linked through the internet through the Adafruit software. So, that when the person touches the screen on his app the corresponding appliances is switched on or off. An Infrared Obstacle detection Sensor is used to detect presence of any obstacle in front of it, which provides safety and this is given as input to the Arduino when the obstacle appears in front of the wheelchair, an input signal is give to the Arduino which makes all the four inputs of the motor LOW thereby stopping the motors for further rotation which results in the hindrance of the motion.

HARDWARE IMPLEMENTATION



The whole system is implemented on a two wheeled wheelchair prototype. A webcam arrangement is interfaced and integrated with the wheelchair. Raspberry pi is used as the microcontroller which is the brain of the system.Here Arduino UNO is interfaced with web camera, IR sensor IoT and motors are interfaced through L293D driver for movement. In this system power to all the interfaced components are given through adapter. Arduino Uno has 14 digital input output pins and 6 analog input pins. It can be easily plugged to Raspberry Pi for loading programs using USB ports. The IR modules are connected to the digital pins of the Arduino UNO. Based on the comparison with programmed text and the input received, the DC motors are driven by L293D. The distance calculated by the IR sensor is also given to the microcontroller for obstacle detection.

SOFTWARE IMPLEMENTATION

IMAGE PROCESSING

IMAGE PROCESSING METHODS

The first stage of any vision system is the image acquisition stage. After the image has been obtained, various methods of processing can be applied to the image to perform the many different vision tasks required today. However, if the image has not been acquired satisfactorily then the intended tasks may not be achievable, even with the aid of some form of image enhancement. Here using a web camera, the image of the eyeball is taken with which the help of OpenCV python is retrieved. So to capture and save a number of images from webcam using OpenCV. This is the code currently: "import cv2 camera = cv2.VideoCapture (0) for i in range (10): return_value, image = camera.read() cv2.imwrite('opencv'+str(i)+'.png', image) del(camera). "

The obtained image will be a colored image which is represented as a combination of Red, Blue, and Green, and all the other colors can be achieved by mixing these primary colors in correct proportions.

The next step is the Pre-processing which is a common name for operations with images at the lowest level of abstraction — both input and output are intensity images. These iconic images are of the same kind as the original data captured by the sensor, with an intensity image usually represented by a matrix of image function values (brightness). The aim of pre-processing is an improvement of the image data that suppresses unwilling distortions or enhances some image features important for further processing, although geometric transformations of images (e.g. rotation, scaling and translation) are classified among pre-processing methods here since similar techniques are used. Here Gaussian Kernel is used. It is done with the function, cv2.GaussianBlur(). We should specify the width and height of kernel which should be positive and odd and also should specify the standard deviation in X and Y direction, sigmaX and sigmaY respectively. If only sigmaX is specified, sigmaY is taken as same as sigmaX. If both are given as zeros, they are calculated from kernel size. Gaussian blurring is highly effective in removing Gaussian noise from the image. Hence, the image obtained is smooth can be used for the further procedure. Then the image is converted into grayscale using OpenCV Python grayscale (or gray level) image is simply one in which the only colors are shades of gray. The reason for differentiating such images from any other sort of color image is that less information needs to be provided for each pixel. In fact, a `gray' color is one in which the red, green and blue components all have equal intensity in RGB space, and so it is only necessary to specify a single intensity value for each pixel, as opposed to the three intensities needed to specify each pixel in a full color image. Often, the grayscale intensity is stored as an 8bit integer giving 256 possible different shades of gray from black to white. If the levels are evenly spaced then the difference between successive gray levels is significantly better than the gray level resolving power of the human eye. Grayscale images are very common, in part because much of today's display and image capture hardware can only support 8-bit images. In addition, grayscale images are entirely sufficient for many tasks and so there is no need to use more complicated and harder-to-process color images.

To get started, the cv2 module is imported, which will make available the functionalities needed to read the original image and to convert it to gray scale. import cv2 To read the original image, simply call the imread function of the cv2 module, passing as input the path to the image, as a string. As additional note, which will be important for the conversion to gray scale, the imread function will have the channels stored in BGR (Blue, Green and Red) order by default. image=cv2.imread('C:/Users/N/Desktop/Test.jpg') Next, to convert the image to gray scale, call the cvtColor function, which allows to convert the image from a color space to another. As first input, this function receives the original image. As second input, it receives the color space conversion code. Since we want to convert our original image from the BGR color space to gray, we use the code COLOR_BGR2GRAY. gray=cv2.cvtColor(image,cv2.COLOR_BGR2GRAY) Now, to display the images, we simply need to call the imshow function of the cv2 module. This function receives as first input a string with the name to assign to the window, and as second argument the image to show. Finally, we will call the waitKey function, which will wait for a keyboard event. This function receives as input a delay, specified in milliseconds. Nonetheless, if we pass the value 0, then it will wait indefinitely until a key event occurs. Once the user pressed a key, we call the destroyAllWindows function, which will destroy the previously created windows. cv2.waitKey(0) cv2.destroyAllWindows() The final code can be seen below. importcv2image=cv2.imread('C:/Users/N/Desktop/Test.jpg')

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gray=cv2.cvtColor(image,cv2.COLOR_BGR2GRAY)

cv2.waitKey(0) cv2.destroyAllWindows() To make the image simpler it converted into a binary image. Binary image is a digital image that has only two possible values for each pixel. Typically, the two colors used for a binary image are black and white. The color used for the objects in the image is the foreground color while the rest of the image is the background color. In the document-scanning industry, this is often referred to as "bi-tonal". Binary images are also called bi-level or two-level. This means that each pixel is stored as a single bit i.e., a 0 or 1. The names black-and-white, B&W, monochrome or monochromatic are often used for this concept, but may also designate any images that have only one sample per pixel, such as grayscale images. In Photoshop parlance, a binary image is the same as an image in "Bitmap" mode. Binary images often arise in digital image processing as masks or as the result of certain operations such as segmentation, thresholding, and dithering. Some input/output devices, such as laser printers, fax machines, and bi-level computer displays, can only handle bi-level images. A binary image can be stored in memory as a bitmap, a packed array of bits. A 640×480 image requires 37.5 KiB of storage. Because of the small size of the image files, fax machine and document management solutions usually use this format. Most binary images also compress well with simple run-length compression schemes. Binary images can be interpreted as subsets of the two-dimensional integer lattice Z2; the field of morphological image processing was largely inspired by this view. Now to find the boundaries of the eye ball a library function of find contours is included in the program. In OpenCV, finding contours is like finding white object from black background. So, remember, object to be found should be white and background should be black. Let's see how to find contours of a binary image: there are three arguments in cv.findContours () function, first one is source image, second is contour retrieval mode, third is contour approximation method. And it outputs a modified image, the contours and hierarchy. contours are a Python list of all the contours in the image. Each individual contour is a Numpy array of (x, y) coordinates of boundary points of the object.

To draw the contours, cv.drawContours function is used. It can also be used to draw any shape provided you have its boundary points. Its first argument is source image, second argument is the contours which should be passed as a Python list, third argument is index of contours (useful when drawing individual contour. To draw all contours, pass -1) and remaining arguments are color, thickness etc. Contours are the boundaries of a shape with same intensity. It stores the (x, y) coordinates of the boundary of a shape. cv.CHAIN_APPROX_NONE, willstore the boundary points. It removes all redundant points and compresses the contour, thereby saving memory. Thus the contours are found, the program is inversed to find the

eyeball. The threshold values are set according to the x, y directions to respond to each movement.

IMPLEMENTATION OF SAFETY FEATURES

The wheelchairsystem is integrated with multiple safety features, an ultrasonic sensor and dual bump sensor. The ultrasonic sensor was to create a threshold distance between the user and obstacle in front and to prevent collision The bump sensor works as a failsafe, where an object that is in contact with it will reverse the robotic wheelchair to a safe distance. This research combined both ease of access navigational technology with a safety features to help those who are in need of such technology to move with a high safety element. The ultrasonic sensor is attached at the top of the wheelchair. The use of the device was to set a threshold between the user and an obstacle. The ultrasonic sensor can detect an object up to a distance of 200 cm where the detection can also be calibrated accordingly up to a minimum of 2 cm.

APPLIANCES CONTROL

An application has been developed to control the appliances, for emergency and entertainment purposes. IoT is incorporated into this system in order to control the home appliances by the patient itself. The most important thing is to automatically ON and OFF the home appliances without inclusion of caretakers. In present days most of the automation system utilizes the combination of hardware and wireless system for controlling appliances. Here we use Node MCU for controlling appliances via the Wi-Fi module using Arduino. The user will communicate to Arduino through internet via Wi-Fi network. This system is less costly, allowing additional home appliances. It is more secure. The application also provides emergency alert system which send SMS to the caretaker in case of emergency. The appliance control together with emergency alert system and entertainment system helps the patient to become more independent

RESULT AND OBSERVATION The following table shows the observation and result of the proposed system when input from web camera is given based on eye movement

DIRECTION	MOTOR 1	MOTOR 2
FORWARD	HIGH	HIGH
RIGHT	HIGH	LOW
LEFT	LOW	HIGH

In order to achieve movement in forward direction, both the motors are programmed to move forward in the code. When the direction of movement has to change towards right, the motor on left side is programmed to be high and the motor on the right side is programmed to be low. Similarly, when left direction is to achieved, the motor on right side is programmed to be high and the left motor is low. If obstacle distance <100cm, wheelchair stops. The proposed system is very much effective than the existing system in many aspects. Proposed system has two ways of controlling the wheelchair and also has an obstacle detecting system. Thus, the proposed system is very much helpful and effective in a handicapped person's life and it also will help them to live a colorful life without depending others for their basic needs.

CONCLUSION

The project aims to enhance the life's of disabled people suffering from diseases such as Amyotrophic Lateral Sclerosis (ALS) and Parkinson disease, which replaces the idea of joystick control wheelchair to a much more convenient, independent and accessible platform. The smart eye tracking system will not only used to control wheelchair movement but also control appliances in order to make the user independent and to have a colorful life. The user has to only look forward, left or right to move the wheelchair towards the desired direction. The safety of the patient is one of the most critical aspects of our concern. Therefore, adequate safety precautions are added to this system, such as obstacle detection sensor. The obstacle detection sensor was to create a threshold distance between the user and obstacle in front and to prevent collision. This system will be good enough to be used for people with disability and is easy to be operated by the user. The actual implementation of the project requires changes in the wheelchair mechanical construction.

FUTURE SCOPE

ARTIFICIAL INTELLIGENCE

Artificial intelligence is the simulation of human intelligence processes by machines, especially computer systems. These processes include learning, reasoning and self-correction. Artificial intelligence is a wide platform which can make the daily tasks of a disabled person's life to be easy.

IMPROVED MECHANICAL DESIGN

The mechanical design of wheelchair can be improved with tilting mechanism by which the patient can tilt the wheelchair in required angle so that the patient can be safe from back pain and other sort of difficulties. Along with that the wheelchair can be modified to a structure of bed so that the patient can become more independent without depending much on caretakers.

PATIENT MONITORING SYSTEM

Implementation of Patient monitoring system becomes helpful and effective in a disabled person's life and it also will help them to live a colorful life without depending much on others. It can be achieved by temperature sensor and pulse sensor and according to sensed value which exceeds the threshold value, alert message is sent to the doctor's phone using GSM module.

IRIS RECOGNITION

Iris pattern of disabled person who owns the wheelchair can be recorded and hence only that person can activate the wheelchair for security purposes. This will reduce abnormalities in eye detection as well as improve security of the wheelchair. Incorporating all these features can be made into a commercial product for the physically disabled with affordable cost. It also reduces the effort of family members to attend for caring the aged/disabled people at home and also helps in saving the time.

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