Android Controlled Smart Wheelchair for Disabilities

Tarun Debnath [α], AFM Zainul Abadin [σ] & Md. Anwar Hossain [ρ]

Abstract- This paper describes a control technology of wheelchair which may feel more flexible than traditional joystick controlled one. The main objective of our research is to develop new control architecture for a motorized wheelchair as well as an embedded system for monitoring critical patients. Such a smart wheelchair is designed for the disabled people in the developing countries as it will be very low-cost than existing others. Controlling is possible by android operated mobile or tab. In addition to button control, motion sensor controlling mechanism also has implemented. Moreover, bio-metric features have made wheelchair more suitable for critical patients. If the patient is in hostile condition, the wheelchair will produce an alert by raising the alarm with the measurement of the heartbeat at a particular interval.

Keywords: handicapped, motorized wheelchair, android controller, motion controlled wheelchair, SOS, smart monitoring, bio-metric, accelerometer and GSM.

I. Introduction

Human being is the most beautiful creation of the universe, but much unexpected accidental disabilities or autistic by born have to carry through the tenure of life. Such a disable person feels helpless and becomes disappointed to lead their life. The physically disable, and paralyzed individuals accomplish their movement through manual or powered wheelchair. While manual wheelchair operation involves other's help, the power wheelchair can be operated using joystick, touch screen, voice gesture based or any other control technologies [1]. As many of the wheelchair users do not feel comfortable with joystick and speech recognition is often creates problems and difficulties when we target more than a single user [2]. Researchers are developing sophisticated control technologies for physically disables. An android controller can be a better substitution of joystick and voice-controlled. Like a touch screen button, a person can control his wheelchair by pressing the android button. Besides that, it is also possible to control the devices using the tilt of the mobile. Tilting feature can be supportive of one-sided paralyzed patients who do not get enough strength in their fingers. Biometrics feature also has been implemented in the system.

If the patient or disabled person is in hostile condition, the wheelchair will produce an alert signal through ringing alarm with the measurement of patient's heartbeat. If required an SMS can be sent to any individuals mobile using GSM shield [3]. The whole system development has accomplished in two phases. Initially, the simulation-based prototype has developed and finally, the developed prototype has implemented as a smart wheelchair. The hardware development platform has implemented using PIC Microcontroller, and software development has completed in Java and Android programming. The system tested on various surfaces by some disabled persons with required moderation to test the effectiveness and evaluate performance.

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II. Transmitting Unit Architecture

a) System Block Diagram

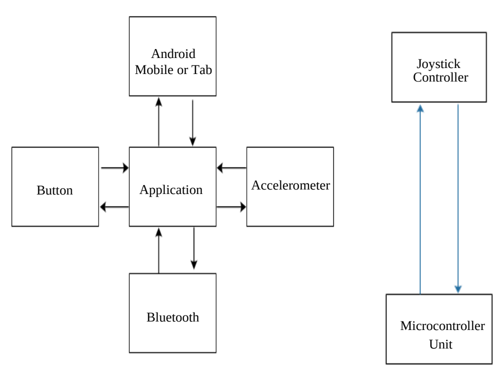

Fig. 1: Block diagram of android & joystick to receiving unit transmission architecture.

Fig. 1. shows separate control architecture for target wheelchair. The first one shows, controlling data communication architecture from android to wheelchair receiving unit over Bluetooth link. The button control interface and the Android sensor produce the same control information. After that separate controlling data will communicate with the device [4]. Another benefit of adding a joystick controlling interface besides Android, will give some advantages. For example, if the mobile device charges run out at the time of traveling, the joystick controlling can be fruitful. Here we will discuss only the android controller, because the joystick sends data directly to the microcontroller. The rest of the process is similar to Android. The concept of Android

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control architecture is like an Android game that we play on our Android phone.

b) Interface Anatomy

Fig.3 explains active and inactive regional view of accelerometer through the coordinate system of motion controlling interface. We know there are three axes in an accelerometer. Smartphone Accelerometer is a semiconductor IC that employs piezoelectric effect and measures the intensity of change along the x, y, and z-axes. *Yaw, pitch, and roll refer to the rotation of the device in these three axes, but the vertical acceleration that is measured by z-axis is not essential for our application. That's why z-axis has eliminated in this architecture.*

The circle of axes pictogram indicates stop region.

When the x and y-axis gravitational value is less than the threshold value, the device performs a stop operation. This value has set by measuring one-third of the gravitational force g. The app will send the stop command of the microcontroller via Bluetooth. Otherwise, the application sends front, back, right and left operation data by mobile rotation. On another side of "Button controlling interface" includes press & hold buttons for each of the commands using in motion controlling. We are using to press and hold button for our driving. So when we lift the finger from the screen button, the stop operation is done automatically.

In case of any urgent situation, SOS (Save Our Soul) dials or Emergency number dial option has included with the mobile application. If the user gets stuck in an uncertain state, he would be able to call one or more SOS numbers. In addition, he can send an SMS to a predefined cell number. This is an additional feature, it can help the user in case of any emergency when using the application for driving [5] [6]. The flow chart given below explains total transmitting unit architecture at a glance.

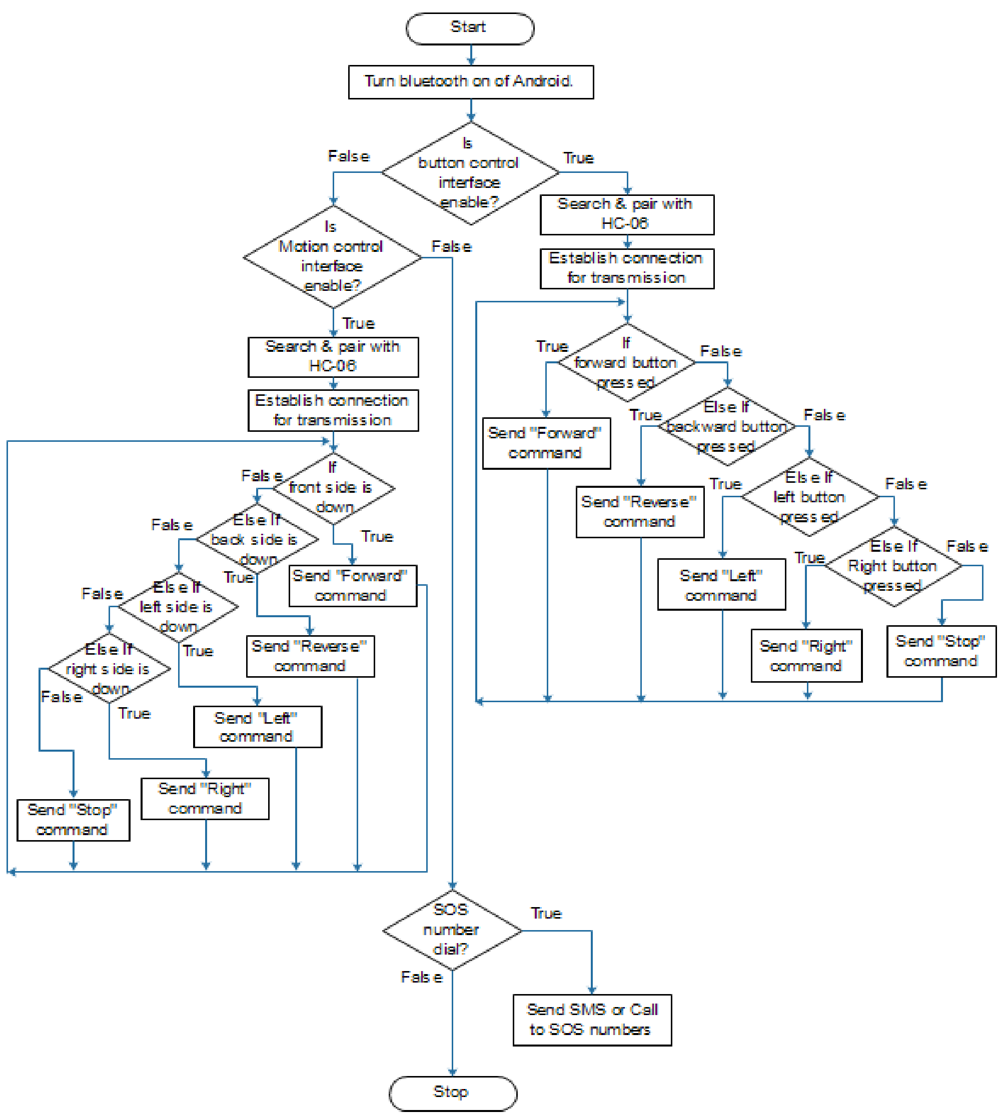

Fig. 2: Transmitting app Flow chart.

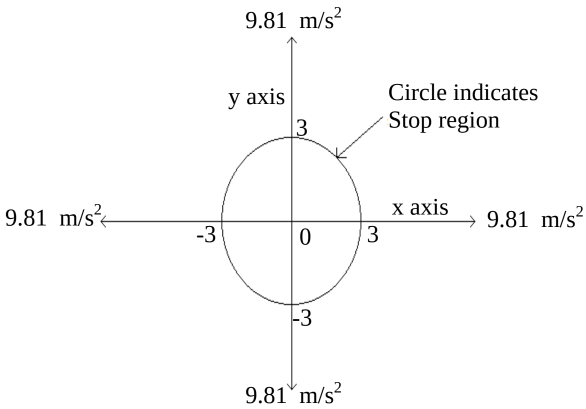

Fig. 3: Coordinate system for motion controlled interface.

III. Receiving Unit Architecture

a) *System Block Diagram*

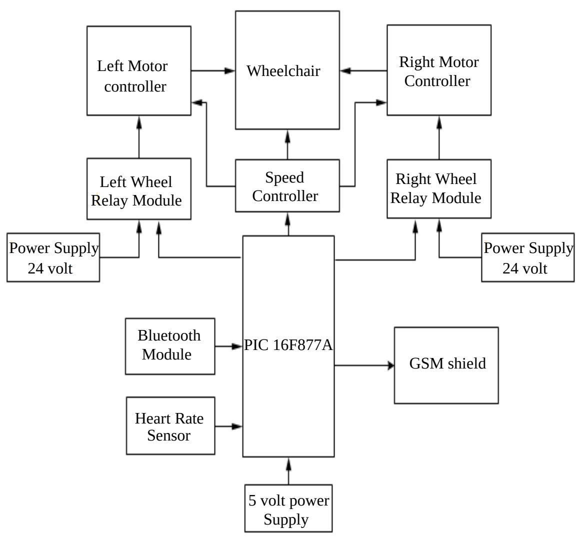

Fig. 4: Block Diagram of Receiving unit.

The above figure shows whole receiving system block diagram of our wheelchair, the brain of the receiving system is PIC16F877A Microcontroller, which performs forward, reverse, 360 degrees left turn, 360 degree right turn and break commands. There is some extra facility for the emergency. That is real-time patient monitoring.

b) *Patient Monitoring Circuitry*

The heart rate sensor performs real-time patient monitoring by counting the number of beats in the heart. This process is terming as smart monitoring. As it varies from man to man, it is possible to set the value manually. By default, we have selected the lower threshold as 60 and the upper threshold value as 90. This standard for an adult is very normal. When the heart rate is more or less than threshold, it waits for 5 seconds, and then again observes the condition of the user. If the sensor finds such an unusual situation, SMS (short message service) is sent to emergency SMS numbers through GSM circuits. To complete this purpose, we can use any heart rate sensor, or it can be made manually [7].

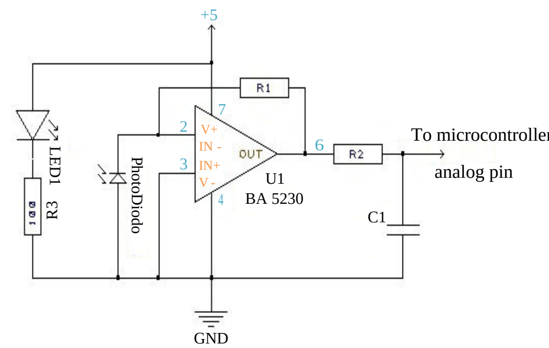

Fig. 5: Heartbeat monitoring circuit.

Where,

Feedback R1 = 1MΩ

Low-Pass filter R2 = 100Ω, C1 = 4 μF

c) *Hardware implementation*

The hardware implementation has done in both mechanical & electronics parts. Those three control box shown in Fig.6 consist of electronics parts. That includes Microcontroller, assembly of Relay, Bluetooth module, GSM (Global System for Mobile Communication) module circuitry. After receiving commands, microcontroller initiates ports to operate the Relay.

Fig.7 shows assembly of the system. Where mechanical parts of the wheelchair include 24 volts, 250 watts, 150 rpm DC gear Motor and four pcs 12 volts batteries [8]. The connection between motor and batteries has established by motor controller and relay circuit. That helps in *forward & reverse direction rotation*. For turning in a shortage amount of space, the rotation of the wheel in both forward and reverse direction is more significant. Moreover, the speed controller circuit provides variations in speed manually according to user's desire by a suitable potentiometer. Different speed variations can be possible in future using PWM (Pulse Width Modulation).

Fig. 6: Control box and Battery assembly.

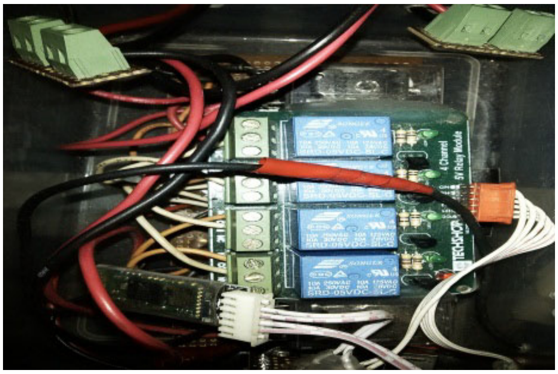

Fig.7: Relay and HC-05 Bluetooth circuit assembly.

Fig. 8: Android controlled smart wheelchair for disabilities.

IV. Conclusion

The system has considered and designed to make lives better for the disabled society. For this, the prototype and the whole system have implemented considering sufferings of the people, who are dependent on the wheelchair for their mobility. Various people with disabilities have tested the prototype for 15 days. Various changes in the system have done according to their wishes. Wheelchair operating application has designed and developed in an easier way so that the general people of our country can easily drive this wheelchair. Fig.8 shows the finally developed system. The aim of our research is to design, and improvement of a modern low-cost android controlled smart wheelchair for disabled people with higher flexibility and better assistance.

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