Development of Bluetooth Control Car Jack

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Abstract

The manual car jack is commonly available in every vehicle nowadays. Manual load lifting of a vehicle to replace punctured tire require physical efforts, thus exposing human to injuries. This study aims to investigate the reliability of motorized car jack to overcome ergonomics problems. The car jack is motorized with a maximum lifting capacity of 1 ton. The operation of the car jack is controlled remotely via Bluetooth of the Android OS application. The power source of the DC motor utilizes the 12V battery from the car itself and is connected through the adapter of the cigarette lighter in the vehicle. Another option is to use a rechargeable battery. The running DC motor is connected to a gear, operating the jack into lifting the vehicle. By using the Android application installed on the smartphone, the upward and downward movement of the jack mechanism can be controlled. This controlling method can be easily operated by any person, hence significance in reducing the risk of injuries from bending or squatting as operating a manual car jack. The project intended to be efficient in cutting down user time and effort in using car jack. Arduino and Bluetooth modules are used as the controller for the hardware.

Keywords: - car jack; dc motor; arduino; bluetooth

1. Introduction

A car jack, as a mechanical device, is used to easily lift a car, to gain access underneath the vehicle, or simply to change the tire. By changing rotational force into linear, the mechanical advantage is given to the user in lifting heavy structures which would be impossible to do without this tool (Patne et al., 2021). Changing a flat tire is a troublesome matter for sure. Variation of car jacks have been developed but conventionally manual operated. As such require physical effort on the part of the user. Elderly and handicapped users will face difficulties in operating the jack (Australian Competition and Consumer Commission, 2007). Operating the manual jack requires the user to be in a position of bending down or squatting. The prolonged period in those positions can potentially give backaches in due of time (Savadatti et al., 2016).

Innovative ideas to overcome the disadvantages of manual jack have emerged in the like of electrical-powered portable car jack. The said jack will help in removing burdensome in operating manual jack, hence decreasing the effort of tire changing and risk of injuries. It can also be advantageous if the jack is to be used on the side of a roadway or under other hazardous conditions (Lonon, 1992). The electrical-motorized jack will be power up from the car battery itself through the cigarette lighter receptacle point on the dashboard of the car (Noor et al., 2008). Other means of power can be obtained from the portable rechargeable battery or automobile mobile emergency power supply.

As for the running of the car jack, programmed apps can turn a phone into a controller. The Arduino module is used to connect to the Bluetooth module which established a wireless serial communication to a remote device (Alhayki and Vrindavanam, 2014). The said module will be use and test in the intended project.

Further research studies are needed to help keep the development study on track. Understanding the details about any innovations or development in products and technology that can be used is necessary. The following papers are studied: Sainath et al. (2014) stated the information about the basic jack along with the types of jack used in the automobile industry. Jack can be classified based on the force employed. Two common types of jack are mechanical and hydraulic based. The former will be a car jack and house jack and the latter is a bottle jack and floor jack. Hydraulic-based jack is the most efficient and reliable, user can easily lift heavy loads using a small applied force.

Kamalakkannan et al. (2016) compared motorized screw jack to manually operated screw jack. The latter required more effort to lift the load. The fabrication process is carried out on the manual-operated screw jack to a motorized screw jack. The motor worked by pressing buttons thus

become easy to operate. To overcome tiredness from the manual operation of the screw jack became the main reason for designing the motorized screw jack. Patil et al. (2016) focused on overcoming the problems faced by an automated car jack. The project proposed using the car battery to power up the electric car jack. It's easy to operate by plug and play concept. Motor polarity is changed by using switches. Required torque is applied at the screw and the gear ratio provided the torque. Noor et al. (2008) presents the development of a motorized jack that's powered up using a car battery through an internal cigarette lighter socket. To ensure adequate power is translated to lifting power, a gear ratio is used. Two relays are used as switch circuits, connecting the motor. The internally supplied car jack is tested to work as expected to a normal car jack. Khidir (2017) used electrical portable bottle car jack, connecting it with 12V D.C motor. The bottle car jack consists of a power screw that converts the rotary motion to a linear motion. The gearbox is used to increase the lifting torque of the jack. Powering the jack is through the car battery itself.

Poonam and Yoginath (2017) focused on reducing human effort by using and applying automatic control of devices. Wireless technology can be operated within a 100-meter radius and plays important role in automation. For data exchange, Bluetooth technology is used. Disable and senior citizens can benefit more from automatic appliances. Cotta et al. (2016) discussed wireless communication. The most common use of wireless technology is radio-frequency. Types of wireless communication are IR wireless communication, satellite communication, broadcast and microwave radio, Bluetooth and Zigbee. Also being discussed is interfacing Bluetooth with Arduino. Wadhani et al. (2018) discussed the use of IoT (Internet of Things); a technology that can turn tasks simpler and easier. An IoT ecosystem consists of web-enabled smart devices that use embedded systems, such as processors, sensors, and communication hardware, to collect, send and act on data they acquire from their environments. The Arduino is used for interfacing the sensors. Data is uploaded on the cloud and communicate with the programmed wireless device via an electronically controlled device.

The purpose of this project is to develop a car jack that is easy to be operated, safe, and be able to lift and lower the car without much physical effort. Bluetooth technology will be integrating with microcontroller technology as the mean of controlling the jack via apps installed on the smartphone.

2. Methodology

The formal definitions of the component and automated approach of the modified jack-specific framework are provided in this section. The following functional components and its specification has been carried out on the modified jack (Babu et al., 2021). Figure 1 shows the block diagram representation of the Bluetooth car jack system.

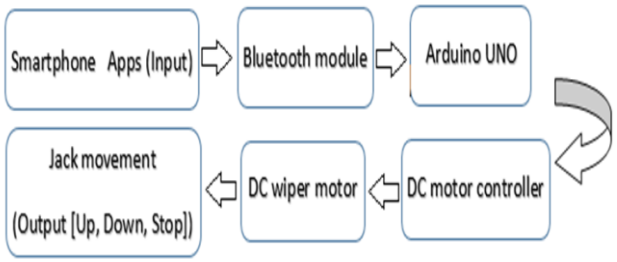

Figure 1: Block diagram representation of the Bluetooth car jack system

The operational process of the system begin with the input signal of message from the Smartphone apps is transmitted to the Bluetooth module. Received message from the module is then relied to Arduino UNO to be processed. Arduino decoded the message before channeling the intended instructions to DC motor controller. Arduino instructions is met with DC motor controller as to control the direction rotation of rotor or complete stop. DC wiper react by clockwise rotation for lifting mode of the jack and anticlockwise rotation for lowering mode. The former rotation is done with UP output, the latter with DOWN output and the STOP output will halt the rotor rotation.

2.1 Electronic Components

2.1.1 Arduino Module

It's a microcontroller considered as an open-source electronic prototyping platform for interactive operation, mainly used for portable embedded systems towards small-scale applications. The basic Arduino microcontroller is Arduino UNO; a robust microcontroller circuit chip based on the ATmega328P category. It comes with local variables, global variables, and formal parameters for programming the microcontroller to communicate with other devices. Via plug and play concept, the UNO board simply connects to the application or model through the USB connector. As for the coding, Arduino IDE software is employed for writing and then uploading the structured codes to the chipboard. It uses a USB cable to flash the code to the controller without any programming interface.

2.1.2 Bluetooth Module

HC-05 Bluetooth Module is an easy-to-use Bluetooth SPP (Serial Port Protocol) module, designed for a transparent wireless serial connection setup. Its communication is via serial communication, mostly used in electronics projects which makes an easy way to interface with a controller or PC. HC-05 Bluetooth can neither be receiving nor transmitting data. The smartphone is used as a medium to control the Arduino. To communicate with HC05 using Bluetooth, a Bluetooth terminal application is needed on the smartphone.

2.1.3 Motor Driver Module

Motor drivers act as an interface between the motors and the control circuits. The motor requires a high amount of current whereas the controller circuit works on low current signals. So the function of motor drivers is to take a low-current control signal and then turn it into a higher-current signal that can drive a motor. It not only provides a faster switching time, but it is also more efficient and no heatsink or fan is required to get continuous current at room temperature.

2.2 Mechanical Components

2.2.1 DC Wiper Motor

Wiper motors are devices in the wiper system that functions on a power supply to move the wiper blades in a smooth motion. The wiper motor rotates continuously in one direction which is converted into a back and forth motion. As it spins, a mechanism built to it rotates a worm gear, arm, and, finally, the windscreen wiper blades. A 24V bus wiper motor is chosen for heavier lifting torque.

2.2.2 Sprocket

A sprocket is a profiled wheel with teeth, that mesh with a chain, track, or other perforated or indented material. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth. Sprockets are used to transmit rotary motion between two shafts where gears are unsuitable or to impart linear motion to a track. The most common form of sprocket may be found on a bicycle.

2.3 Construction and Implementation

The construction involves two parts namely, the control circuit and the mechanism. The construction is done with a local welder based on the design of the model. DC wiper motor was weld with metal support to the point of the jack. The jack was then mounted on a metal casing and welded to it. Progress of fabrication and assembly of model is done simultaneously with the progress of coding assembly language for the microcontroller to the control circuit. The coding on Arduino UNO went through Arduino IDE software. After the coding, the required App was made using Blynk; a platform with iOS and Android apps to control Arduino, Raspberry Pi, and the likes over the Internet. It's a digital dashboard of a graphic interface build by simply dragging and dropping widgets. Arduino was then patched up to the Apps. To control the motors wirelessly, the HC-05 Bluetooth module was connected to Arduino (Shashwat and Bhosle, 2017).

Figure 2 showcase the construction model as described in the paper. The model is assembled and tested for synchronisation evaluation of hardware and software. Functional jack mechanism is then mounted in the metal casing as shown in Figure 3.

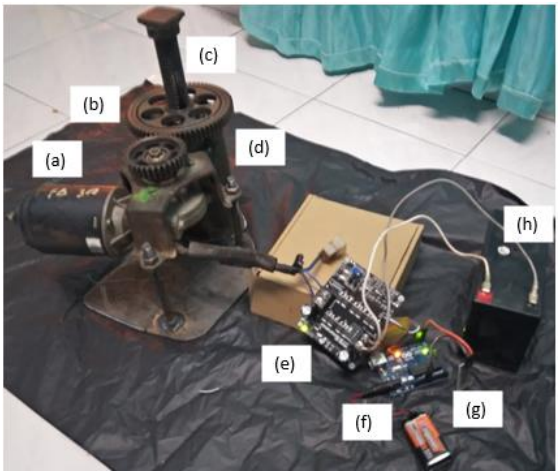

Figure 2: Hardware and software testing via smartphone. (a) DC wiper motor (b) Sprocket (c) Modified iron shaft (d) Iron cylinder with bearing (e) Motor driver module (f) Arduino module (g) Bluetooth module (h) DC battery

Figure 3: Car-jack in the metal casing

The electronic schematic circuit shown in Figure 4 consist of modules for Arduino, Bluetooth, motor driver and power supply of DC battery. As the brain of the system, the Arduino module is connected to Bluetooth module as to receive and process the signal. Connection is establish between Arduino and Motor driver module for transmittion of the processed signal. The motor driver control the movement of the wiper motor based on it. The power source for the Arduino and Motor driver comes from DC battery. The ON-OFF switch control the activation of entire modules.

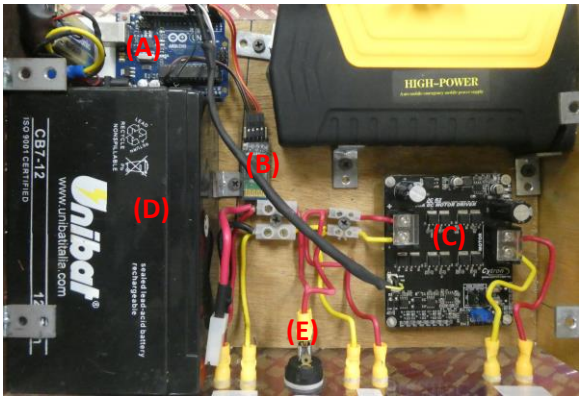

Figure 4: Electronic schematic circuit of the Bluetooth car jack system. (A) Arduino module (B) Bluetooth module (C) motor driver module (D) DC battery (E) ON-OFF switch

As for the Blynk app development, only three command button were created for simplicity of user, arranged in a row at the center of the smartphone screen. Pressing the UP button will activate lifting mode, DOWN for lowering mode and STOP for halt mode. When activated, the corresponding button will be light out. The interface of the app is shown in Figure 5.

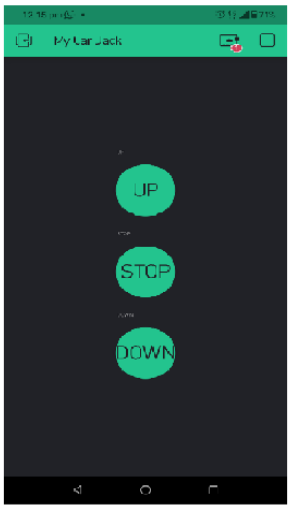

Figure 5: Blynk apps interface on the smartphone

2.3.1 Multi-purpose Container

The motor of the jack was intended to be power up by supplied car battery through a cigarette lighter receptacle on the dashboard. As a precaution for malfunction of the cigarette lighter receptacle, the jack can also be put in motion by jumpstart technique over the car battery using jumper cables. Another option is by connecting the jack with a portable rechargeable battery. The intention for the establishment of the multi-purpose container are: i) to position: Arduino module, Motor Driver module, Bluetooth module, 12V portable rechargeable battery, automobile mobile emergency power supply. ii) to store: jumper cables, connecting cables, USB cables, cigarette lighter receptacle connector, emergency lamp, portable impact drill, compact tire air compressor, lug wrench. Figure 6 show the multi-purpose container accommodating the modules and tools as mentioned in the intended construction.

Figure 6: Multi-purpose container

3. Operation Result

To operate the car jack, attach it first to Multi-purpose Container using the connecting cables, as showcase on Figure 7. The operation of the jack begins by switching ON the supply to the modules, located on the Multi-purpose Container. Communication is established between the Bluetooth module and the programmed Blynk apps installed on the smartphone. The jack then can be powered by using the car battery itself or by a rechargeable battery in the container. It can be explained by the three types of operation modes:

Mode 1: Using cigarette lighter power plug cable, connect the jack to the cigarette lighter receptacle. The jack is ready to be used. Mode 2: Using car jumper cables, connect the jack to the car battery. The jack is ready to be used. Mode 3: If the cigarette lighter receptacle malfunction, the car battery is weak, or interrupted wireless communication, connect the jack to the rechargeable battery stored in the container. The jack is ready to be used. This mode can be used as Emergency mode because it can be manually

controlled by an up and down switch located on the jack casing.

As demonstrate in Figure 8, actual lift testing with a Proton Wira was successfully completed. The mechanism of the jack started with the signal passed to the motor from the Arduino module through the Motor Driver module. The driver acts as an intermediary between the controller and the motor. It interprets the signal from the controller and provides the correct power level to be forwarded to the motor, to obtain the desired movement. Their main function is to receive an electrical input and convert it into mechanical movement. By touching the "UP" button on the app, the jacking mechanism will move upwards, and vice versa for the "DOWN" button. The mechanism will stop in motion if the user touches the "STOP" button.

Table 1: Lifting time by car models

Car Model	Weight	Lifting Time
Proton Wira	980 kg	1.5 to 2 minutes
Perodua Myvi	960 kg	1.5 to 2 minutes
Perodua Kancil	650 kg	Below 1.5 minutes

Table 1 shows the testing result of lifting time for 3 different car models. Three types of car models have been tested which are Proton Wira, Proton Myvi and Perodua Kancil. The results shows that the car jack tend to achieve minimum lifting time of below 1.5 minutes for Perodua Kancil followed by Perodua Myvi and Proton Wira with maximum lifting time of 1.5 to 2 minutes. Estimation of lifting times taken were considered depending on the condition of battery power and car weight.

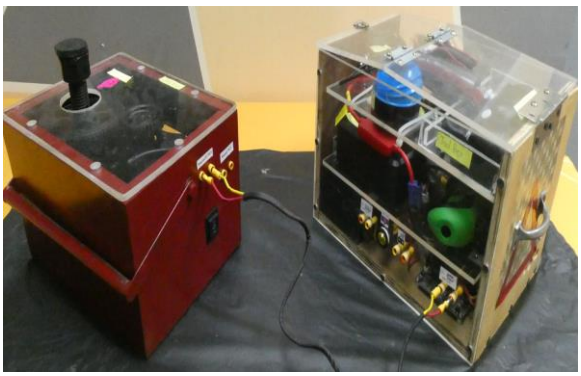

Figure 7: Car-jack connecting to multi-purpose Container

Figure 8: Car-jack doing actual lift testing

5. Conclusion

The existing car jack principle was modified by using an electric motor as the lifting mechanism of the jack. The 12V car battery or portable rechargeable battery is used as the power source for the motor. As the rotor rotates, torque is generated thus eliminate human endeavo**r** in jacking the car. Project robustness, uncomplicated to operate, and reliability in raising and lowering the level is the focus of this project. The proposed electric circuit consists of a Bluetooth module, Arduino module, and Motor Driver module. The interface between the smartphone and circuit is achieved through the Bluetooth module and that between Jack and the electronic circuit is through the Motor Driver module. Controlling the jack movement is automated by a push of a button via an installed Android app on the smartphone. Manual jack operation via switch is also available as a precaution for the weak car battery or interrupted wireless communication. The rechargeable battery will be used to power the motor if the said situation occurs. Torque from the jack mechanism is tested and able to lift a car weight around 1000 kg. Risk of injuries or getting backaches is reduced when using the motorized jack. Further research should be carried out in designing the jack applicable to lift vehicles weighing over 1000 kg. Reducing the weight of the project and the need for a separate container for storing modules are the aspects that can be improved.

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