A Major Project Report

on

"SAFE AND COST-EFFECTIVE MASSAGE BAND"

Submitted in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

in

ELECTRONICS AND COMMUNICATION ENGINEERING

by

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BVRIT HYDERABAD College of Engineering for Women

(Approved by AICTE, New Delhi and Affiliated to JNTUH, Hyderabad)

Accredited by NBA and NAAC with A Grade

Bachupally, Hyderabad – 500090

2021-22

DECLARATION

We hereby declare that the work described in this report, entitled **"SAFE AND COST-EFFECTIVE MASSAGE BAND"** which is being submitted by us in partial fulfillment for the award of the degree of **Bachelor of Technology** in the department of **Electronics and Communication Engineering** at **BVRIT HYDERABAD College of Engineering for Women,** affiliated to **Jawaharlal Nehru Technological University Hyderabad**, Kukatpally, Hyderabad – 500085 is the result of original work carried out by us under the guidance of **Dr. J. Naga Vishnu Vardhan, Professor, ECE.**

This work has not been submitted for any Degree/Diploma of this or any other institute/university to the best of our knowledge and belief.

Place: Hyderabad

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Certificate

This is to certify that the mini project report, entitled **"SAFE AND COST-EFFECTIVE MASSAGE BAND"** is a record of bonafide work carried out by **Ms. K. Deekshitha (18W1HA0401), Ms. S. Tejaswini Harshitha (18WH1A0402), Ms. K. Devi Saranya (18WH1A0424), Ms. S. Harika (18WH1A0442),** in partial fulfillment for the award of the degree of **Bachelor of Technology** in the department of **Electronics and Communication Engineering** at **BVRIT HYDERABAD College of Engineering for Women,** affiliated to **Jawaharlal Nehru Technological University Hyderabad**, Kukatpally, Hyderabad – 500085.

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ABSTRACT

Every person at some point in their life might experience muscular pains. Women during menstrual cycle and elderly people experience heavy muscular pains. Adults also encounter pain during work hours or at public places. These pains can be very straining and they do not have adequate resources to manage. A good massage can calm muscles and soothe the nerves to let body pain go away. This SAFE AND COST-EFFECTIVE MASSAGE BAND is an attempt to build a device that provides relief and helps in reducing muscular pains.

With the controller of massage band, the amount of air pressure applied can be varied according to requirement. The periodical pressure applied helps in contraction and relaxation of muscles. The speed of inflation and deflation of pressure cuff can also be varied according to the user requirement. These compression sleeves have been designed to give relief from stress by improving blood circulation. The device will be controlled by mobile application and will be easy to use. It is not intrusive in any manner and is economical compared to existing solutions.

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1. Introduction

Overview on Muscular pains

Muscle aches (myalgia) are extremely common. Almost everyone has experienced discomfort in their muscles at some point. Because there's muscle tissue in nearly all parts of the body, this type of pain can be felt practically anywhere. However, there's no single cause for muscle aches and pains. While overuse or injury is common, there are other possible explanations for ongoing discomfort. Often, most instances of myalgia result from too much stress, tension, or physical activity.

Existing pain relievers

The existing solutions to relieve are too expensive and are not plausible to use without the help of another person. When there is no one to help, we have to press or hold with other hand for longer time which causes hand pain again. The existing massagers such as life long LL21 are heavy, and have frequent breakdown issues. Many other devices also face issues like heavy body, rough massage heads etc.

Proposed Solution

This device is an attempt to build a device that helps in providing relief to reduce joint and muscle pain. This device will be controlled through a mobile application which is user friendly. It has two major components pressure cuff and control unit. When experiencing pain people can just wear the cuff and plug it to the controller unit. The user can also choose the speed they would feel comfortable with and set a timer. The device inflates and deflates within the rate at which it is operating. The mapping of the speed is done on Arduino. To power this device, we have used a 5V 2A power adapter and a power bank as well. This enabled the device to be rechargeable. As this is a low-cost product, it can be made available to a large market. The massager provides a relaxing and soothing massage which relieves pain and helps in reducing joint pain and muscle pain in the hands and legs.

2. Literature Survey

- **Massage Chair:** A chair designed for massage. It is of two types, Traditional chair that helps a masseur to have an easy access to head, shoulders and back of the recipient. Other is robotic massage chair which contains electronic motors and gears to massage the recipient.

  Advantages: gives a deep relaxation, reduce blood pressure, lowers the pulse rate, increase metabolism.

  Limitations: Traditional chair requires a masseur, costly(range Rs.117,500-160,000 per piece).

  Traditional massage chair:

  Robotic massage chair:

- **Neck and Shoulder:** A massaging product solely designed for neck and shoulder, which helps in relieving the muscular pains and stiffness. These work by applying pressure to particular points of the body to relax muscles and soothe the pain. Few may also use heat to ease the pain.

Advantages: portable, loose stiff muscles, provides relief for hard-to-reach areas.

Limitations: cannot be used for more 20 minutes, Skin redness and bruising, can be used only for neck and shoulder pains.

- **Hand-held Massagers:** A portable massager which uses vibrations to warm the muscle tissues and increase blood flow to the area. These are the electric massagers which have changeable massage heads to customise the massage.

Advantages: portable, customisable massage heads, light in weight, improve skin elasticity.

Limitations: In situations like laceration or clot it can worsen the pain, possibility of receiving an electric shock.

- **Leg Foot Massager:** A machine to relieve pain with rubber kneading pads for effective massage for foot ankle and calf. It is effective in promoting blood circulation, knee pain, arthritis, varicose veins.

Advantages: Improves blood circulation, portable, helps with migraine and headaches.

Limitations: Flu-like symptoms, foot sensitivity, skin rashes around feet, chances of electric shock while using with wet feet.

- **Full-back Massager:** A massager that has soft rotating massage gel nodes that give a palm-like feeling, with right amount of vibration, there can be improvement in the blood circulation. This massager combines heat therapy with kneading and vibrations for an effective massage.

  Advantages: relieve short term pains, increase blood and lymph flow.

  Limitations: can only be used in seated position, excessive use can lead to muscle damage, inflammations and bruised tissues.

3. Block Diagram

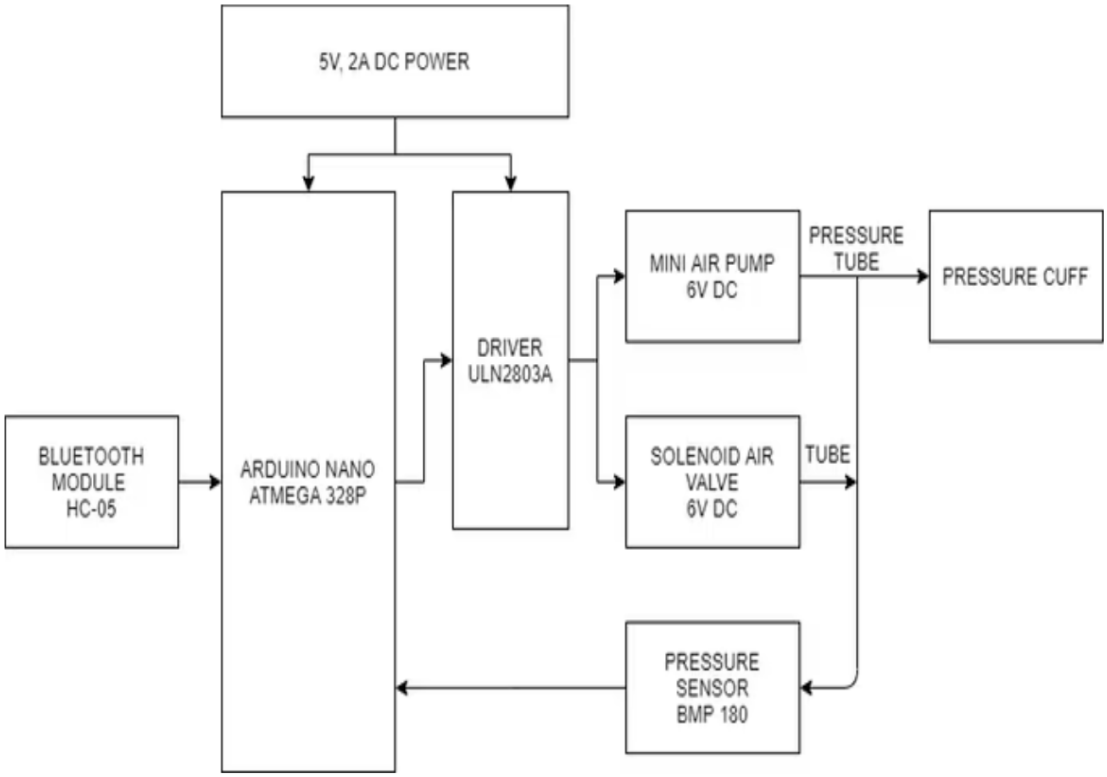

Fig.1: Block Diagram

Block Diagram description

The above figure depicts the block diagram of our proposed system. The framework used for the proposed system is the Arduino Nano ATMEGA 328P. Bluetooth module HC-05, which is used to interact with the user application on mobile phone, is connected to Arduino Nano ATMEGA 328P microcontroller board. ULN2803A driver is the Darlington transistor array that consists of eight NPN transistors. This ULN2803A is connected to both mini air pump and solenoid air valve. Both mini air pump and solenoid air valve are driven by this ULN2803A driver according to input received by the Arduino Nano board from the user application via Bluetooth module. Pressure cuff is connected to the mini air pump using pressure tube. The pressure sensor BMP 180 is connected to the pressure cuff through this tube is used to monitor the pressure that is applied using the mini air pump. For both Arduino Nano board and ULN2803A driver to function 5V, 2A DC power is to be supplied. Rechargeable batteries are used to supply the power as described previously.

4. Components List

S.No	Components	Quantity
1.	Adafruit BMP180	1
2.	Mini Air Pump Motor 6V	1
3.	Solenoid Air Valve 6V	1
4.	DC Socket Breakout Board (Female)	1
5.	Pressure Cuff	1
6.	HC-05 Bluetooth Module	1
7.	Arduino Nano R3	1
8.	Motor Driver (L293D)	1
9.	12V Adaptor	1
10.	Soldering Iron (Generic)	1
11.	Hot glue gun (Generic)	1

5. Components Description

5.1 Adafruit BMP180

This precision sensor from Bosch is the best low-cost sensing solution for measuring barometric pressure and temperature. Because pressure changes with altitude, it can also be used as an altimeter. The sensor is soldered onto a PCB with a 3.3V regulator, I2C level shifter and pull-up resistors on the I2C pins.

The BMP180 is the function compatible successor of the BMP085, a new generation of high precision digital pressure sensors for consumer applications. The ultra-low power, low voltage electronics of the BMP180 is optimized for use in mobile phones, PDAs, GPS navigation devices and outdoor equipment. With a low altitude noise of merely 0.25m at fast conversion time, the BMP180 offers superior performance. The I2C interface allows for easy system integration with a microcontroller. The BMP180 is based on piezo-resistive technology for EMC robustness, high accuracy and linearity as well as long term stability. Robert Bosch is the world market leader for pressure sensors in automotive applications. Based on the experience of over 400 million pressure sensors in the field, the BMP180 continues a new generation of micro-machined pressure sensors.

The BMP180 is designed to be connected directly to a microcontroller of a mobile device via the I2C bus. The pressure and temperature data has to be compensated by the calibration data of the E 2PROM of the BMP180.

The BMP180 consists of a piezo-resistive sensor, an analog to digital converter and a control unit with E2PROM and a serial I2C interface. The BMP180 delivers the uncompensated value of pressure and temperature. The E2PROM has stored 176 bit of individual calibration data. This is used to compensate offset, temperature dependence and other parameters of the sensor.

UP = pressure data (16 to 19 bit)

UT = temperature data (16 bit)

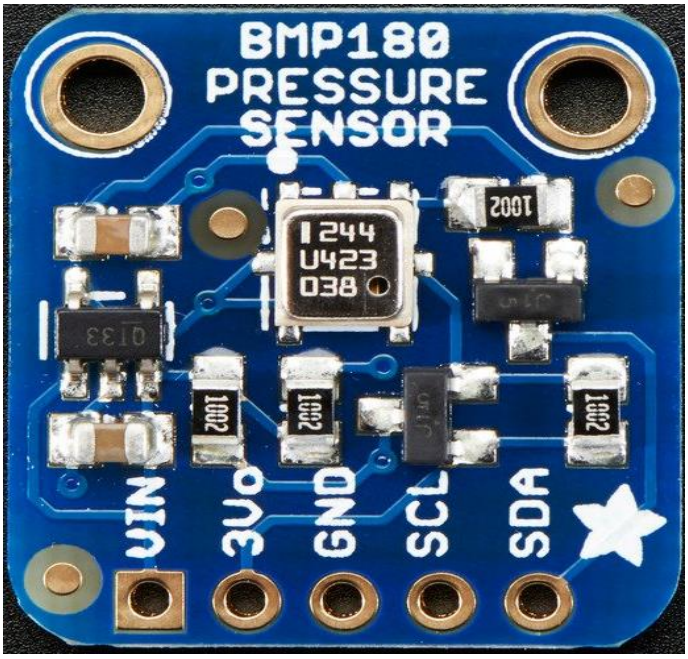

Fig.2: BMP180 Pressure Sensor

BMP180 is an atmospheric pressure sensor.

The BMP180 sensor is mainly used to measure atmospheric pressure or biometric pressure. The working principle of the air pressure sensor is very simple, it works based on the weight of air. Because the air around us has a certain weight, and this weight has a specific pressure.

BMP180 Pin Description

BMP180 is available in two different modules. One is the Five Pin module, the other is the Four Pin module. With the Five Pin module, we have an additional +3.3V pin, which is missing in the four-pin module. Apart from the fact that the operation is the same.

Pin Name	Description
VCC	Connected to +5V
GND	Connected to ground.

SDA	Serial Data pin (I2C interface)
SCL	Serial Clock pin (I2C interface)
3.3	Can power module by connecting +3.3V to this pin.

BMP180 Sensor Features

- Can measure temperature and altitude.
- Pressure range: 300 to 1100hPa
- High relative accuracy of ±0.12hPa
- Can work on low voltages
- 3.4Mhz I2C interface
- Low power consumption (3uA)
- Pressure conversion time: 5msec
- Potable size

BMP180 Sensor Specifications

- Operating voltage of BMP180: 1.3V – 3.6V
- Input voltage of BMP180MODULE: 3.3V to 5.5V
- Peak current: 1000uA
- Consumes 0.1uA standby
- Maximum voltage at SDA, SCL : VCC + 0.3V
- Operating temperature: -40ºC to +80ºC

5.2 Mini Air Pump Motor 6V-12V

Mini Air Pump with Motor is a miniature air inflator/pump. This is a 6V-12V DC motor drive air pump. This air pump (air inflator) can be used with all microcontroller units including used for Arduino, Raspberry Pi. This is used in electronic blood pressure machines for inflating purposes.

A 6V-12V DC 380mA 500mmHg Micro Air Pump has many applications such as a small blower, home aquariums pumps, gasifiers in the medical appliances and for food preservation, etc.

Micro-pumps are small and compact, and the working fluid is gaseous. As a result, we find these mainly in micro-negative pressure pumps, micro-gas circulation pumps, wrist-type electronic sphygmomanometer pumps, micro gas sampling pumps, micro-inflating pumps. Because it operates on a 6V-12V DC power supply, it is highly compact and is therefore adaptable to any application. The pressure exerted by this pump is 500mmHg and operates at max. the current of 380mA.

DC 6V-12V 380mA 500mmHg Micro Air Pump has an airflow between 1 and 2.2LPM. Also, DC 6V-12V 380mA 500mmHg Micro Air Pump does not create much noise, i.e. silent operation.

Fig.3: Mini Air Pump Motor 6V

DC 6V-12V 380mA 500mmHg Micro Air Pump uses a DC motor as the prime mover. The DC motor takes the air from the surrounding at normal pressure and

gives out high-pressure air. This high-pressure air, in turn, has uses in many applications.

DC 6V-12V 380mA 500mmHg Micro Air Pump can be operated or controlled by using a Micro-controller like Arduino, Raspberry Pi, etc.

A micro air pump is also known as a miniature inflatable pump.

Features

- Carbon brushes.
- Durable and stable.
- Long lasting.
- Inflation Time: <10 seconds (from 0 to 300 mmHg in a 1000CC closed container)
- Minimum pressure: >400 mmHg (53.33KPa)
- Hermeticity: <5mmHg (from 1000mmHg in 1000CC container min)
- Use fluid: Air
- Nozzle size: Diameter 4.1mm, mouth length 6.1mm.

Specifications

- Motor Diameter: 24.3 MM (370 motor)
- Total height: 55.6 MM (motor + pump head)
- Outlet outside diameter: 4.1 MM
- Voltage: 6 V
- Current: 0.20 A
- Operating voltage: 4.5V to 12V
- Operating current: max 430mA
- Rated power consumption: 1.5W to 2W
- Air leakage: 3.0mmHg/min
- Pressing time: 11.5S
- Maximum pressure: 400mmHg

5.3 Solenoid air valve 6V-12V

A solenoid valve is an electrically controlled valve. The valve features a solenoid, which is an electric coil with a movable ferromagnetic core (plunger) in its center. In the rest position, the plunger closes off a small orifice. An electric current through the coil creates a magnetic field. The magnetic field exerts an upwards force on the plunger opening the orifice. This is the basic principle that is used to open and close solenoid valves.

Fig.4: Solenoid Valve

A solenoid valve consists of two main components: a solenoid and a valve body (G). Figure below shows the components. A solenoid has an electromagnetically inductive coil (A) around an iron core at the center called the plunger (E). At rest, it can be normally open (NO) or normally closed (NC). In the de-energized state, a normally open valve is open and a normally closed valve is closed.

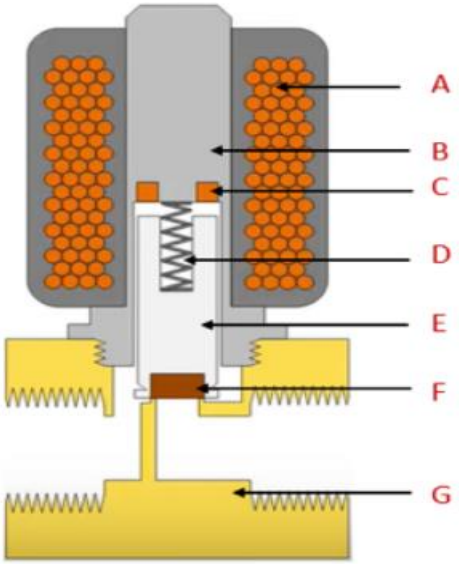

Fig.5: Components of a solenoid valve

When current flows through the solenoid, the coil is energized and creates a magnetic field. This creates a magnetic attraction with the plunger, moving it and overcoming the spring (D) force. If the valve is normally closed, the plunger is lifted so that the seal (F) opens the orifice and allows the flow of the media through the valve. If the valve is normally open, the plunger moves downward so that the seal (F) blocks the orifice and stops the flow of the media through the valve. The shading ring (C) prevents vibration and humming in AC coils.

5.4 DC Socket Breakout Board (Female)

This adapter allows you to connect a 2.5 mm barrel jack connector to bare wires. One end has 3-pin screw terminals. If you have a power supply with a barrel jack and want to plug it into a breadboard, this might be the simple solution.

DC female power jacks are commonly used in the electronic industry to connect adapters to your circuit board. The most commonly used DC female jack is a 2.1mm x 5.5 mm DC jack. Where 5.5mm is the outer diameter and 2.1mm is the internal pin size.

The DC plug (male) should match this dimension for proper matching. Most of the non-proprietary co-axial power plugs match the 2.1 x 5.5 dimensions. In most, of the DC plugs, the outer body is the negative supply and the internal is positive.

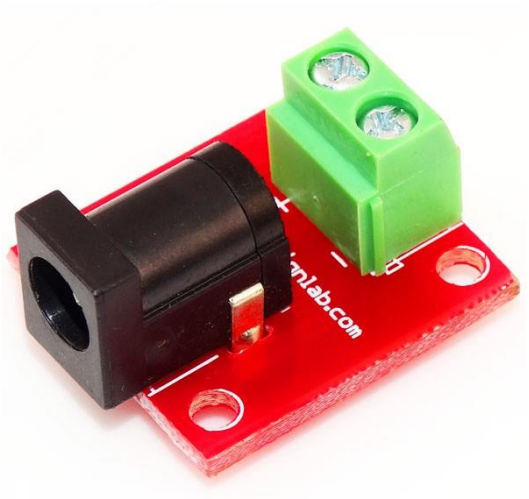

Fig.6: DC Socket Break out board (Female)

5.5 Pressure Cuff

The pressure cuff consists of a rubber inflating bulb which is connected to the cuff. When we squeeze the bulb rapidly the cuff is inflated creating the pressure necessary. The cuff has to be tightly wrapped around the area to which the pressure has to be applied. The inflating bulb has a knob which can be used to release the build up air in the cuff thus deflating the cuff.

Fig.7: Pressure Cuff

The cuff is securely kept in place using Velcro strap on. It also has a gauge to measure the pressure. It is commonly used to check the blood pressure of patients in hospitals. It is a low-cost device which is easily available in the market as it is a medical necessity.

5.6 Arduino Nano R3

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x). It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.

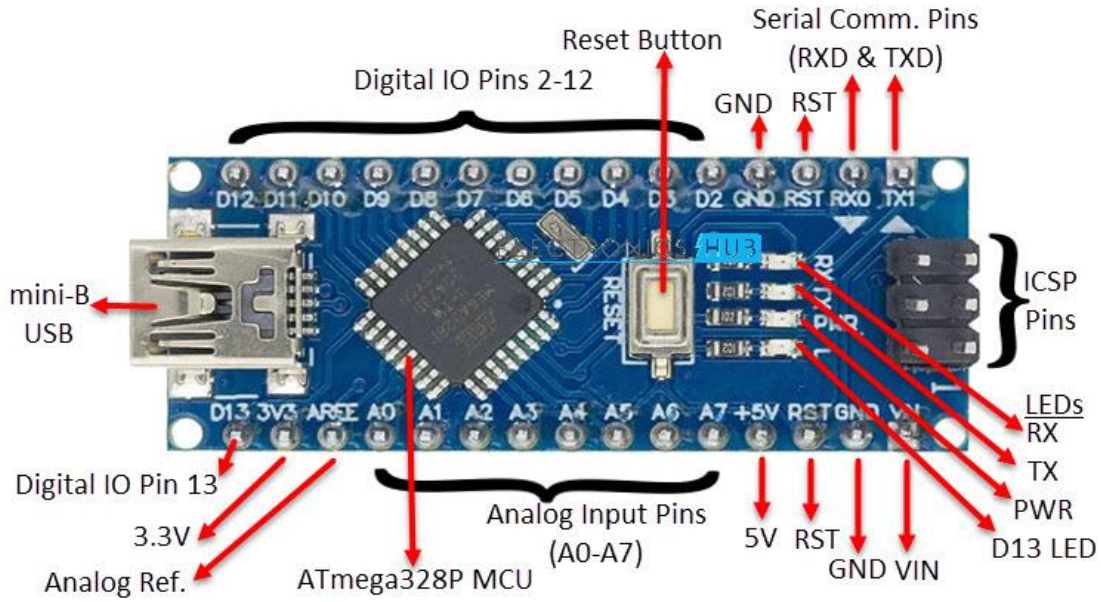

Fig.8: Arduino Nano

Power

The Arduino Nano can be powered via the Mini-B USB connection, 6-20V unregulated external power supply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source.

Memory

The ATmega328 has 32 KB, (also with 2 KB used for the bootloader. The ATmega328 has 2 KB of SRAM and 1 KB of EEPROM.

Input and Output

Each of the 14 digital pins on the Nano can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the FTDI USB-to-TTL Serial chip.

External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attach Interrupt() function for details.

PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite () function.

SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.

LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Nano has 8 analog inputs, each of which provide 10 bits of resolution (i.e., 1024 different values). By default, they measure from ground to 5 volts, though is it possible to change the upper end of their range using the analog Reference () function. Analog pins 6 and 7 cannot be used as digital pins. Additionally, some pins have specialized functionality:

I2C: A4 (SDA) and A5 (SCL). Support I2C (TWI) communication using the Wire library (documentation on the Wiring website).

There are a couple of other pins on the board:

AREF. Reference voltage for the analog inputs. Used with analog Reference ().

Reset. This is brought to LOW in-order to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

Communication

The Arduino Nano has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provide UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An FTDI

FT232RL on the board channels this serial communication over USB and the FTDI drivers (included with the Arduino software) provide a virtual com port to software on the computer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the FTDI chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A SoftwareSerial library allows for serial communication on any of the Nano's digital pins.

The ATmega328 also support I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus. To use the SPI communication, please see ATmega328 datasheet.

Specifications

Microcontroller	ATmega328
Architecture	AVR
Operating Voltage	5 V
Flash Memory	32 KB of which 2 KB used by bootloader
SRAM	2 KB
Clock Speed	16 MHz
Analog I/O Pins	8
EEPROM	1 KB
DC Current per I/O Pins	40 mA (I/O Pins)
Input Voltage	7-12 V
Digital I/O Pins	22
PWM Output	6
Power Consumption	19 mA
PCB Size	18 x 45 mm
Weight	7 g
Product Code	A000005

5.7 Motor driver (L293D)

Even the simplest robot requires a motor to rotate a wheel or perform a particular action. Since motors require more current than the microcontroller pin can typically generate, you need some type of a switch that can accept a small current, amplify it and generate a larger current, which further drives a motor. This entire process is done by what is known as a Motor Driver. With L293D Motor Driver IC, that task is made simple and has helped in a number of applications with relative ease.

L293D H-bridge driver is the most commonly used driver for Bidirectional motor driving applications. This L293D IC allows the DC motor to drive in either direction. L293D is a 16-pin IC that can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motors with a single L293D IC. Because it has two H-Bridge circuits inside. The L293D can drive small and quiet big motors as well. There are various ways of making an H-bridge motor control circuit such as using transistors, relays, and using L293D/L298. Before going into detail, first, we will see what is H-Bridge circuit.

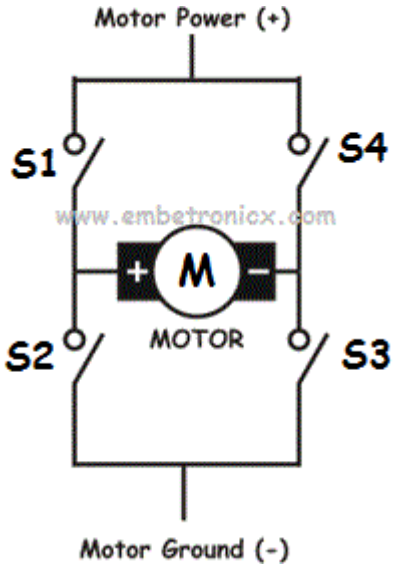

Fig.9: Motor Driver

An H bridge is an electronic circuit that allows a voltage to be applied across a load in any direction. H-bridge circuits are frequently used in robotics and many other applications to allow DC motors to run forward & backward. These motor control circuits are mostly used in different converters like DC-DC, DC-AC, AC-AC

converters, and many other types of power electronic converters. In specific, a bipolar stepper motor is always driven by a motor controller having two H-bridges.

L293D IC

L293D IC generally comes as a standard 16-pin DIP (dual-in-line package). This motor driver IC can simultaneously control two small motors in either direction; forward and reverse with just 4 microcontroller pins (if you do not use enable pins).

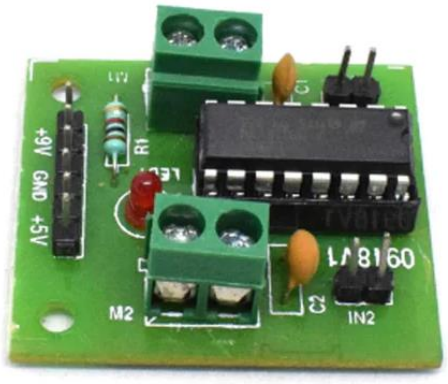

Fig.10: L293D IC

5.8 HC-05 Bluetooth module

The HC-05 is a popular module which can add two-way (full-duplex) wireless functionality to the project. This module is used to communicate between two microcontrollers like Arduino or communicate with any device with Bluetooth functionality like a Phone or Laptop. There are many android applications that are already available which makes this process a lot easier. The module communicates with the help of USART at 9600 baud rate hence it is easy to interface with any microcontroller that supports USART. The default values of the module can also be configured by using the command mode. This Bluetooth module is a wireless module that could transfer data from your computer or mobile phone to microcontroller or vice versa.

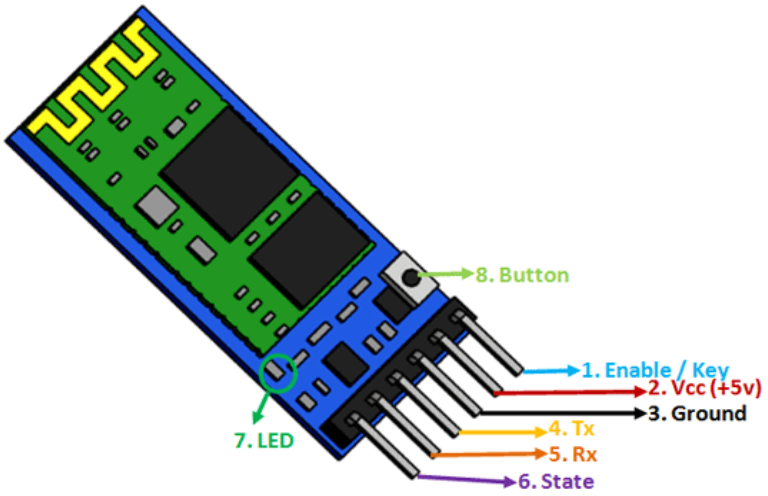

Fig.11: Bluetooth module

The HC-05 has two operating modes, one is the Data mode in which it can send and receive data from other Bluetooth devices and the other is the AT Command mode where the default device settings can be changed. We can operate the device in either of these two modes by using the key pin as explained in the pin description. It is very easy to pair the HC-05 module with microcontrollers because it operates using the Serial Port Protocol (SPP). Simply power the module with+5V and connect the Rx pin of the module to the Tx of MCU and Tx pin of module to Rx of MCU as shown in the figure below.

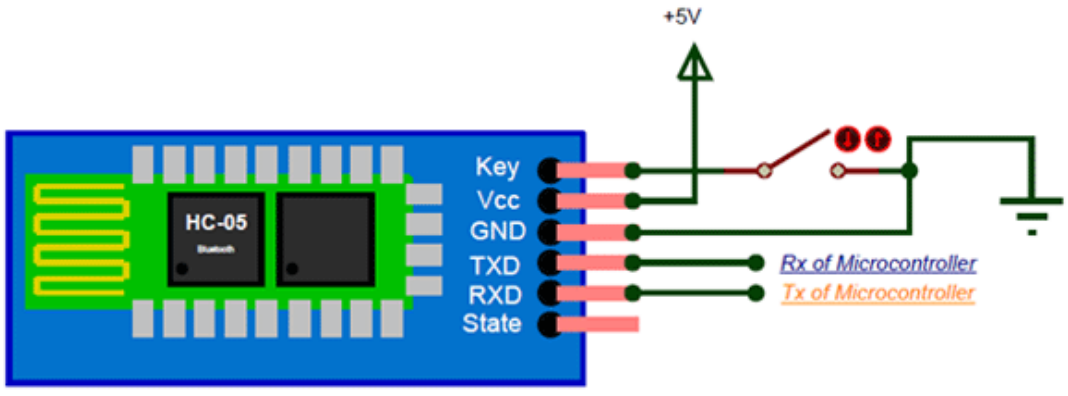

Fig. 12: Working of a Bluetooth module

Pinout Configuration

Pin Number	Pin Name	Description
1	Enable / Key	This pin is used to toggle between Data Mode (set low) and AT command mode (set high). By default it is in Data mode
2	Vcc	Powers the module. Connect to +5V Supply voltage
3	Ground	Ground pin of module, connect to system ground.
4	TX – Transmitter	Transmits Serial Data. Everything received via Bluetooth will be given out by this pin as serial data.
5	RX – Receiver	Receive Serial Data. Every serial data given to this pin will be broadcasted via Bluetooth
6	State	The state pin is connected to on board LED, it can be used as a feedback to check if Bluetooth is working properly.
7	LED	Indicates the status of Module • Blink once in 2 sec: Module has entered Command Mode • Repeated Blinking: Waiting for connection in Data Mode • Blink twice in 1 sec: Connection successful in Data Mode
8	Button	Used to control the Key/Enable pin to toggle between Data and command Mode

Fig. 13: Pinout Configuration of HC-05 Bluetooth module

HC-05 Default Settings

Default Bluetooth Name: “HC-05”

Default Password: 1234 or 0000

Default Communication: Slave

Default Mode: Data Mode

Data Mode Baud Rate: 9600, 8, N, 1

Command Mode Baud Rate: 38400, 8, N, 1

Default firmware: LINVOR

5.9 12V Adaptor

An AC adapter, AC/DC adapter, or AC/DC converter is a type of external power supply, often enclosed in a case similar to an AC plug. Other common names include wall wart, power brick, wall charger, and power adapter. Adapters for battery-powered equipment may be described as chargers or rechargers (see also battery charger). AC adapters are used with electrical devices that require power but do not contain internal components to derive the required voltage and power from mains power. The internal circuitry of an external power supply is very similar to the design that would be used for a built-in or internal supply.

External power supplies are used both with equipment with no other source of power and with battery-powered equipment, where the supply, when plugged in, can sometimes charge the battery in addition to powering the equipment.

Use of an external power supply allows portability of equipment powered either by mains or battery without the added bulk of internal power components, and makes it unnecessary to produce equipment for use only with a specified power source; the same device can be powered from 120 VAC or 230 VAC mains, vehicle or aircraft battery by using a different adapter. Another advantage of these designs can be increased safety; since the hazardous 120 or 240 volt mains power is transformed to

a lower, safer voltage at the wall outlet and the appliance that is handled by the user is powered by this lower voltage.

Fig.14: 12V Adaptor

5.10 Soldering iron (generic)

Solder is melted by using heat from an iron connected to a temperature controller. It is heated up to temperatures beyond its melting point at around 600 degrees fahrenheit which then causes it to melt, which then cools creating the soldered joint.As well as creating strong electrical joints solder can also be removed using a desoldering tool.Solder is a metal alloy used to create strong permanent bonds; such as copper joining in circuit boards and copper pipe joints. It can also be supplied in two different types and diameters, lead and lead free and also can be between .032" and .062". Inside the solder core is the flux, a material used to strengthen and improve its mechanical properties.Filler metals used in soldering were once lead based (lead solder), however, owing to regulations, lead-based solders are increasingly replaced with lead free solders, which may consist of antimony, bismuth, brass, copper, indium, tin or silver.

Occasionally at the site of the joint, there are impurities such as oil, dirt or oxidation, the flux helps prevent oxidation and can sometimes chemically clean the metal. The flux used is rosin flux which helps the mechanical strength and electrical contact of electrical joints. Sometimes it is also possible to apply a 'wetting agent' to reduce the surface tension.

Fig.15: Soldering Iron

5.12 Hot glue gun

For arts and crafts and quick, easy patch-ups, nothing beats a hot glue gun. Unlike other adhesives, hot glue goes on smoothly, dries fast, and holds firm when applied to all sorts of different surfaces. While its hold is not the strongest, it can be used to bond a greater diversity of materials than almost any other glue.Because of its thick, gel-like consistency, hot glue works better for sticking thin, easily damaged surfaces together than more liquid adhesives like paste and even superglue. Watery glues can be difficult to apply, require longer to take effect and have a higher chance of damaging sensitive materials than hot glue. Hot glue is also versatile, and will often hold together temperamental objects that don't take well to other types of adhesives. Just make sure any delicate parts are aligned before application.

Fig.16: Hot glue gun

6. Software Requirements

6.1 Kodular.io

Kodular allows you to create Android apps easily with a blocks-type editor. No coding skills required. With the Material Design UI, your apps will stand out. Kodular is a free online suite for mobile apps development. It mainly provides an online drag-and-drop Android app creator, on which everyone can create any kind of app without programming a single line of code.

Kodular is an online suite which primarily provides an online web application that allows the development of apps without knowing how to code. Kodular Creator is an MIT App Inventor distribution, meaning it is built on App Inventor open source project; although it offers big improvements over App Inventor. However, Kodular Creator is not an open source project and the source code is hosted privately on GitHub, but other repositories related with the Suite are available.

The biggest noticeable difference at first glance of this App Inventor distribution is that it has more components, more granular control on the app, and functionality absent in the App Inventor open source project. The suite also provides an online app store as an alternative to the Google Play Store and an extensions IDE for advanced users to code new components for Kodular Creator. In order to provide control over all these services, Kodular also provides Kodular Account, a system to control all services from a single place.

Kodular was founded the 6 July 2017 by Conor Shipp, Diego Barreiro, Mika, Pavitra Golchha, Sander Jochems, Sivagiri Visakan and Vishwas Adiga. The first public beta became available on the next month. At that time, Kodular features were nearly the same ones as MIT App Inventor ones, and the interface was not changed a lot. Kodular was presented at Galicia Maker Faire on September 2017, which was awarded the Makers of Merit prize. In addition, it was invited to InnovAmes where the platform was introduced to the public.

However, on February, Kodular was turned off to the public due to a massive increase on requests. During that time, Kodular became a company in the Netherlands, and it was presented on Galiciencia 2017 where it was widely covered by the press. The 22nd

June 2018 Kodular Creator became online again, which brought lots of new components and features to the platform. Also, the Kodular Store was released, with Kodular Extensions IDE and Kodular Account.

On January 2019 Kodular Creator reached 100,000 active users, and a total of 700,000 unique users per day in apps made with its platform. Half a year later, on August 2019, these number increased up to 200,000 active users in the platform and more than 1,500,000 unique daily users in apps. This makes Kodular Creator one of the largest Android development platforms, having more than 500,000 apps hosted in the platform.

The word Kodular comes from joining two words: Kode + Modular. The word Kode comes from derivating Code by replacing the C with a K (this was intended as users at Kodular does not use normal Code, they use pseudo-code). Kodular also provides different services, which are called Modules, like the App Store and the Extensions IDE.Also, it is being said that Kodular in Estonian means "the core", which the purpose of being the core of introduction to coding.

Kodular Creator (formerly known as Makeroid) is the main web app and the core of all services. It is built primarily for newcomers to computer programming to create software applications for the Android operating system (OS). It has a user graphical interface, similar to Scratch, MIT App Inventor, and its distributions. Only by dragging and dropping a few components, and joining some blocks as in Scratch the app is made. It runs on Google App Engine, using several Google Cloud services.

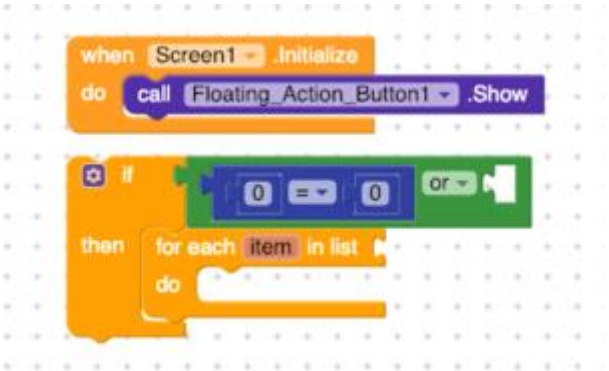

Fig. 17: Programming in Kodular

There is a Project's Dashboard with cards containing each app details. On the creator area, there are two pages: Designer and Blocks. On the Designer there is a top panel with dropdowns and four main sections: Palette, Mock, Components and Properties. On the Palette section there is a list of all available components to drop on phone's Mock to design the app. All components can be viewed as a list with its parent in the Components panel, and on Properties section users can change visual properties of those components. On the Blocks page there is a Blockly panel which is used to join blocks to code the app.

Kodular Extensions IDE is an online IDE for advanced users to create extensions (new components) for the Creator. Using Java, it adds the possibility to code new components to add more features to Kodular Creator.

6.2Arduino IDE

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

Writing sketches

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

 Verify button.

Verify Checks your code for errors compiling it.

 Upload button.

Upload Compiles your code and uploads it to the configured board. See uploading below for details.

 New file.

New Creates a new sketch.

 Open file.

Open Presents a menu of all the sketches in your sketchbook. Clicking one will open it within the current window overwriting its content.

 Save file.

Save Saves your sketch.

 Serial Monitor button.

Serial Monitor Opens the serial monitor.

Tools

- *Auto Format* This formats your code nicely i.e., indents it so that opening and closing curly braces line up, and that the statements inside curly braces are indented more.
- *Archive Sketch* Archives a copy of the current sketch in .zip format. The archive is placed in the same directory as the sketch.
- *Fix Encoding & Reload* Fixes possible discrepancies between the editor char map encoding and other operating systems char maps.
- *Serial Monitor* Opens the serial monitor window and initiates the exchange of data with any connected board on the currently selected Port. This usually resets the board, if the board supports Reset over serial port opening.
- *Board* Select the board that is to be used
- *Port* This menu contains all the serial devices (real or virtual) on your machine. It should automatically refresh every time on opening the top-level tools menu.
- *Programmer* For selecting a hardware programmer when programming a board or chip and not using the onboard USB-serial connection.

7. Working

Once we plug in the 12V adaptor and ON the power supply, the mini air pump starts pumping the air with the help of the motor inside, when motor rotates the piston inside pumps the air outside and this air will be filled inside the pressure cuff through the pipe connected between pressure cuff and the mini air pump.

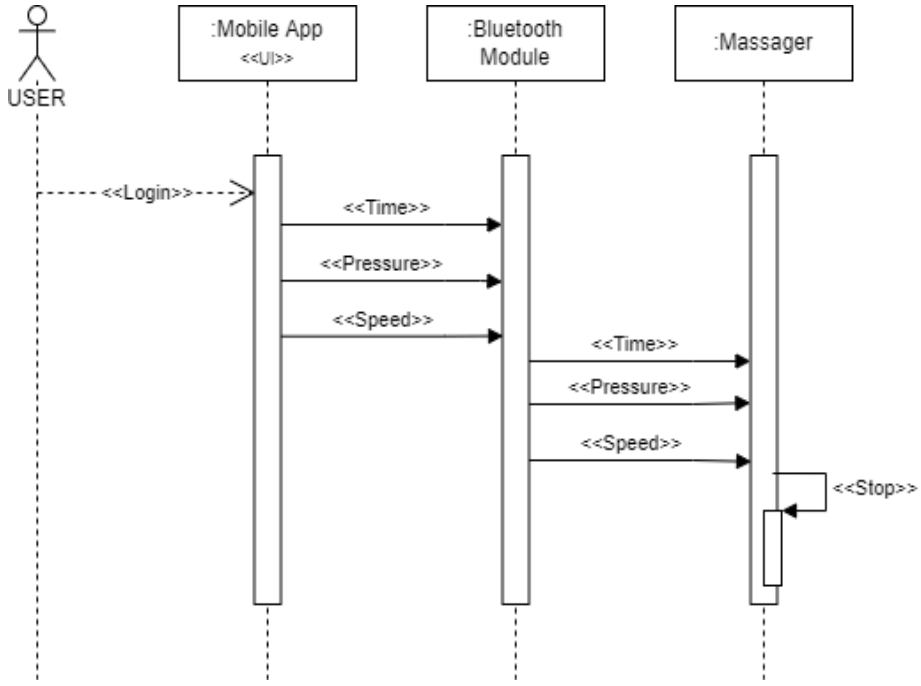

Fig.18: Sequence diagram of the device

Now in order to record user instructions through the mobile app, firstly Bluetooth connection needs to be established, then there is a clock option in the mobile app to set the required amount of time for massage for a user, it also allows the user to set the required pressure by using a scroll bar. They can choose between Light, Medium, and Deep pressure modes. The corresponding pressure value is sent to the device through Bluetooth and the required pressure is set. The timing diagram illustrates the functionality of the pressure setting. The pressure value (Light-0, Medium-1, Deep-3) set acts as a threshold and the pressure cuff inflates to that pressure level only. The mapping of the pressure value and the actual pressure level is done on the control unit.

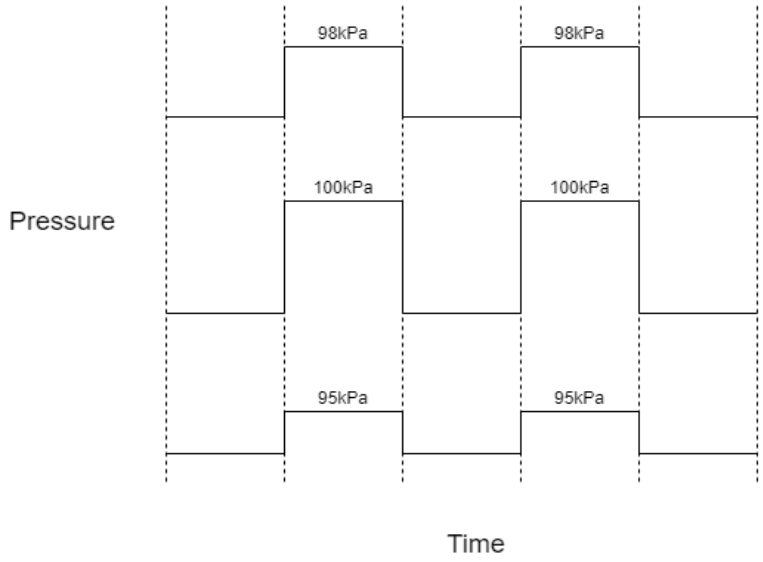

Fig.19: Waveform of Pressure values

Speed can be also set on the App, the user can choose between Low, Medium, and Fast speeds which correspond to the time the pressure cuff has to inflate and deflate. When the setting is Low speed, the pressure cuff inflates and deflates at a slow rate. When set to Fast speed the pressure cuff inflates and deflates at a fast rate. The value that will be sent from the app to Arduino for Low, Medium, and Fast Speed settings would be 0, 1, and 2 respectively. The mapping of the speed would be done on Arduino.

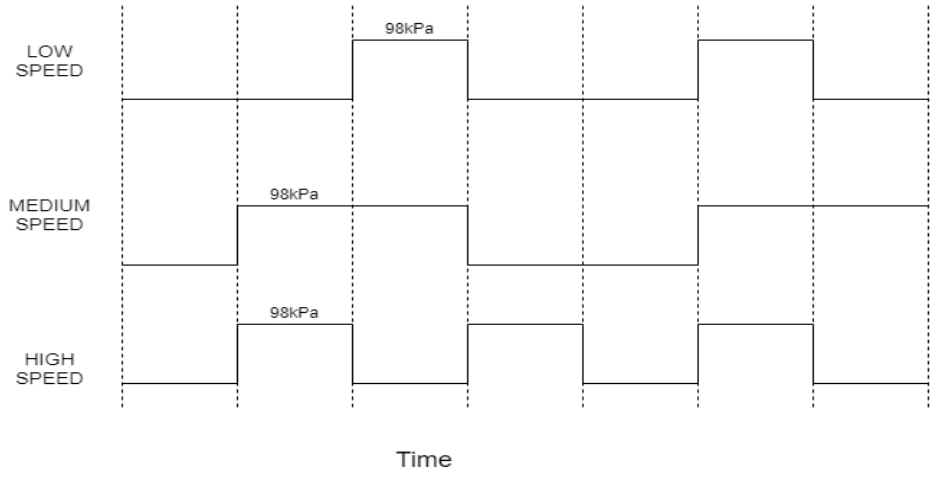

Fig.20: Waveform of speed values

Once all the pressure, time and speed values are selected, then click on the START button to initiate the process. We have used the Arduino Nano microcontroller board which has an Atmega328P microcontroller and Arduino IDE for programming in this project. For driving the solenoid air valve and the mini air pump, we have used an

L293D driver module. This module can take 5V input and can handle up to 500mA on every output pin. For powering the device, we have used a power bank , and we can connect to a direct power supply with a 5V 2A power adapter. The Arduino shall give control signals to the driver according to the configurations made on the app. Bluetooth module HC-05 is used for communication with the phone.

A solenoid air valve which is also driven by L294D and controlled by Nano acts like a gateway and when activated doesn't let the air out therefore increasing pressure within the cuff and making it inflate. For monitoring pressure, the BMP180 sensor was used. Since this has an I2C interface, it was easily interfaced with Arduino using the four pins (+3.3V, GND, SCL, SDA). The sensor module was put inside a 3D printed housing with a nozzle for connecting the tube and sealed from all sides to obtain consistent pressure readings.The process ends once the selected time is completed, or we can also end the process by clicking the STOP button.

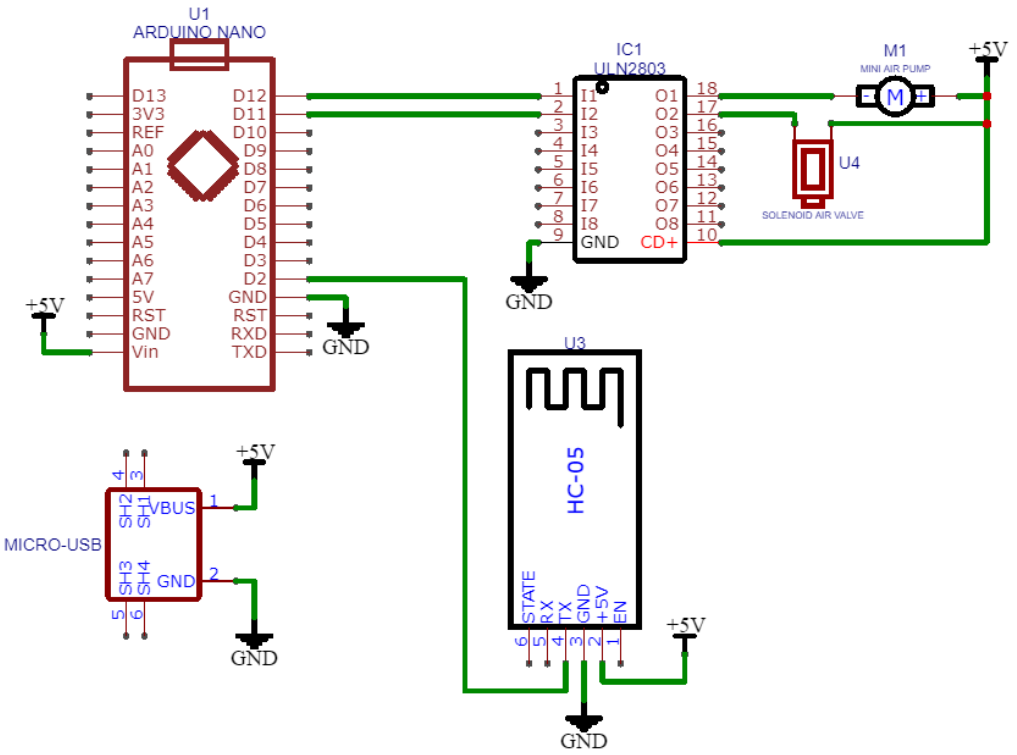

Fig.21: Schematic Diagram

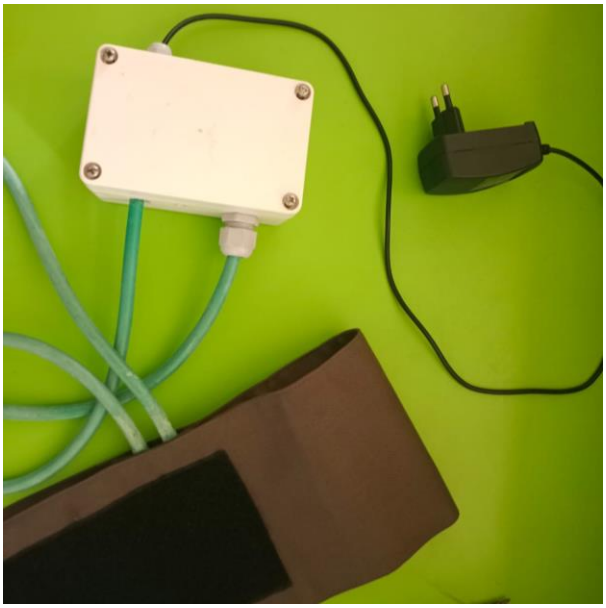

Fig.22: Prototype model of SAFE AND COST-EFFECTIVE MASSAGE BAND

8. Advantages

1. Portable Device - This device is easy to carry due to its light weight. And can also be used anywhere near power sockets.
2. Cost effective – This massage band developed is cost effective compared to the pricey products available.
3. Pressure can be adjusted as per requirement – The pressure applied through the pressure cuff can be controlled and adjusted with the help of Bluetooth connected mobile application as per the requirement of the user.
4. Improves blood circulation – This periodic inflation and deflation of pressure cuff not only reduces the pain and soothes the muscles but also improves the blood circulation.

9. Limitations

1. Bluetooth connection should be established to use the massager.
2. It is a wired device so needs to accommodate near to power supply plugs

10.Futurescope

This device was developed to overcome the limitations of existing massage bands. But for the introduction of this product in the market better features can be added. For example, voice alerts can be included for better feedback. Voice alerts can help enhance the customer satisfaction. This can also be achieved by making the mobile app more interactive and livelier.

Analytics can also be included to predict the most comfortable pressure for each and everyone. We can also provide some analytics in which the appropriate pressure for a certain kind of muscular pain is also recommended. A proper ABS enclosure can be made for the device to make it more visually pleasing and comfortable to carry around. This enclosure can be designed in such a way that it is easy to carry and can fit in a purse for the ease of portability. Currently the device does not include battery. So, a battery can be added and a proper case for the batteries can also be designed.

11.Conclusion

Massaging has many benefits like reducing stress, relieving body pains, helps with insomnia problems etc. Massage bands are very popular due to the many benefits they provide. Many massage bands are available now in the market some are bulky, some are costly and some have fewer features though handy and cost effective.

The Safe and cost-effective massage band was developed to overcome all these limitations. This device is portable, user friendly technological touch to automate the process like pressure and speed adjustment, time duration. The device consists of pressure cuff which inflates and deflates to create pressure. This pressure can be easily controlled with the mobile application according to the preference of the user. A pressure sensor is used to measure the exact pressure to feed to the Arduino. It has a blue tooth module to enable wireless operation. The device can be powered by rechargeable batteries or using adapter

12. References

1. Electronic Massage Devices Market - Global Industry Analysis, Size, Share, Growth, Trends and Forecast 2019-2027

2. Best Massagers, "Medically reviewed by Jenneh Rishe, RN - Written by Suzy Davenport " on September 29, 2021

Code:

```
#include <Wire.h> //Wire.h library required for I2C interfacing
#include <Adafruit_BMP085.h> //Adafruit library for interfacing BMP180
#include <ArduinoJson.h>
String incomingData = ""; //Create empty string called incomingData
long pressure_default = 95000; //Default Pressure set in Pascals
int time_def = 0; //flag to control status
long speed_default_on = 6000; //Inflate time
long speed_default_off = 2000; //Deflate time
int time_rec = 0; //Parse and extract time data
int pressure_rec = 0;  //Parse and extract pressure data
int speed_rec = 0;  //Parse and extract speed data
long previousMillis = 0;        // will store last time LED was updated
long interval = 0;
const int solenoid1 = 12; //Pin 11 for connecting solenoid Air valve via ULN2803A driver
const int solenoid2 = 11; //Pin 11 for connecting solenoid Air valve via ULN2803A driver
void setup() {
  Serial.begin(9600);
  pinMode(solenoid1, OUTPUT);
  pinMode(solenoid2, OUTPUT);
}
void loop() {
  if (Serial.available() > 0) { //When Serial data is avaiable on serial port enter this loop
    incomingData = Serial.readString(); // read the incoming byte:
    Serial.println(incomingData); //Print on serial moniotr(For debugging purpose)
    StaticJsonDocument<200> doc; // 200 is memory capacity in bytes
    DeserializationError error = deserializeJson(doc, incomingData);
    time_rec = doc["Time"]; //Parse and extract time data
    pressure_rec = doc["Pressure"];  //Parse and extract pressure data
    speed_rec = doc["Speed"];  //Parse and extract speed data
    //Print on serial monitor for debugging
```

```
    //Serial.print(time_rec);
    //Serial.print(pressure_rec);
    //Serial.print(speed_rec);
    interval = time_rec * 60000; // interval in minutes
    time_def = 1; //Flag that will be checked in each loop and is set when valid data is receieved
    Serial.println("activated");
  }
  unsigned long currentMillis = millis();
  if (currentMillis - previousMillis > interval) {
    previousMillis = currentMillis;
    time_def = 0;
    interval = 0;
    Serial.println("deactivated");
  }
  if (time_def > 0)
  {
    digitalWrite(solenoid1, LOW);
    digitalWrite(solenoid2, LOW);
    delay(2000);
    digitalWrite(solenoid1, HIGH);
    digitalWrite(solenoid2, LOW);
    delay(5000);
  }
}
```