# Design of IoT Based Smart, Portable and Low-Cost Massage Band

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## Abstract

Every person at some point in their life might experience muscular pains. Especially, women during menstrual cycle and elderly people experience heavy muscular pains. These pains can be very straining and may not have adequate resources to manage. A good massage can calm muscles and soothe the nerves to let body pain go away. Hence a portable, safe, self-operated, user-friendly cost-effective massage band is developed that provides relief and helps in reducing muscular pains. The massage band developed is integrated with an App named Smart Massager through which one can control the features like Start, Stop, Timer, Speed and Pressure. Because of this app integrated with device, it is an advantage for the user not to apply any force physically, no need to depend on others and can totally control in App. 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. Moreover, one more major feature unlike some devices available in the market which can be for certain parts in the body; this band can be used for most of the parts. It is a simple model and portable.

**Keywords**. Massage Band, Portable, Flexible.

## 1.    INTRODUCTION

Muscle aches (myalgia) are generally common. Almost, everyone experiences discomfort in their muscles some times. As muscle tissues are in nearly all parts of the body, this type of pain can be felt. However, there's no single cause for muscle aches and pains. Often, most instances of myalgia result from too much stress, tension, or physical activity. Most of the existing solutions or massage bands available in the market provides relief. But they may be 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 stress to hand.

The model developed is an attempt to build a device that helps in providing relief to reduce joint and muscle pain. The model developed will be controlled via mobile application which is user friendly where the start and stop of the device, speed, and pressure can be adjusted easily. It has two important parts like 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 suitable speed they need and can set time accordingly. The device inflates and deflates within the rate at which it is operating. Speed can be controlled using Arduino. A 5V, 2A power adapter is used to power this device. As this is of low-cost, it can be made available to a larger market. The massager provides a relaxing and soothing that relieves from pain. As the speed and pressure are set with in the normal limits, it is safe to use.

## 2. LITERATURE SURVEY

In the market, large variety of massage bands is available [1, 2]. Some of them are bulky; some of them are costlier; some are not self-operated and need support of others etc. An ancient practice of Manual massage is the one that needs the intervention of a trained physiotherapist. On the other side, automated massage is carried out using devices without or with minimal need of a trained human and the effects of automated massage is presented in [3]. Multispecialty Massage belt to improve their skeletal support of the users/patients to for the betterment and relief of pain was discussed in [4].

In paper [5], percussion massages guns that are commonly used by athletes and others for physical recovery were discussed. It is mentioned that no evidence or clinical reports are published. The effect of massage therapy on patients seeking Pain that can be addressed through a holistic approach and meta-analysis to analyze the quality of massage therapy is presented in [6].



Fig 1: Traditional Chair        Fig 2: Robotic Chair

The study of various massage bands mentioned above have their own limitations in terms of being bulky or costlier or depends on others or need to apply physical force or restricted to few parts etc. The model proposed overcomes all the mentioned

limitations and has a novelty of smaller in size (Portable), less cost, can be operated through App and not required to apply physical force, suitable for most of the parts.

**2.1 Massage Chair:** A chair designed for massage. It is of two types, Traditional chair (Fig 1) that helps a masseur to have an easy access to head, shoulders and back of the recipient but that needs a support of trainer. Other is robotic massage chair (Fig 2) which contains electronic motors and gears to massage the recipient. Though they provide a deep relaxation, reduce blood pressure, lowers the pulse rate, increase metabolism, they are very costlier and bulky in size.

**2.2 Neck and Shoulder:** It is a massaging product solely designed for neck and shoulder, which helps in relieving the muscular pains. 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. These cannot be used for cannot be used for more 20 minutes, Skin redness and bruising may cause and can be used only for neck and shoulder pains.
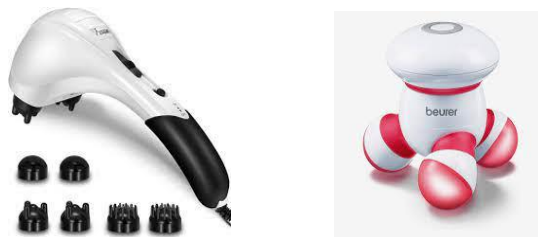


Fig 3: Neck and Shoulder Massage band



Fig 4: Hand-Held Massager

**2.3 Hand-held Massagers:** A portable hand-held massager which uses vibrations to warm the muscle tissues and increase blood flow to the area is shown in Fig 4. These are the electric massagers which have changeable massage heads to

customize the massage. It is a portable one, light in weight. But one needs to apply
more pressure.

**2.4 Leg Foot Massager:** A leg foot massager machine (Fig: 5) with rubber kneading
pads is used for effective massage for foot ankle and calf. It is effective in promoting
blood circulation. This model also has a limitation to use for only legs and is a
costlier device. Depending on foot sensitivity, skin rashes around feet, chances of
electric shock if used with wet feet may cause.

Fig 5: Leg Foot Massager

## 3.    PROPOSED MODEL

The Block diagram of Proposed Massage band is as given below. The above Fig 6 depicts
the block diagram of the proposed system. The framework used for the proposed system is
the Arduino Nano ATMEGA 328P. HC-05 Bluetooth module 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 solenoid air and mini air pump 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 a mini air pump via 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 and rechargeable
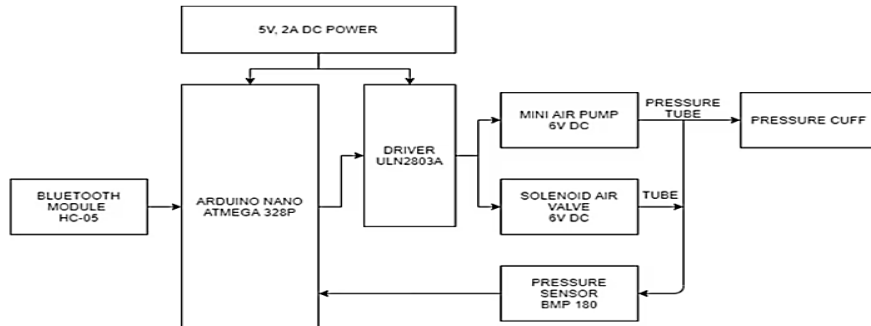batteries can also be used.
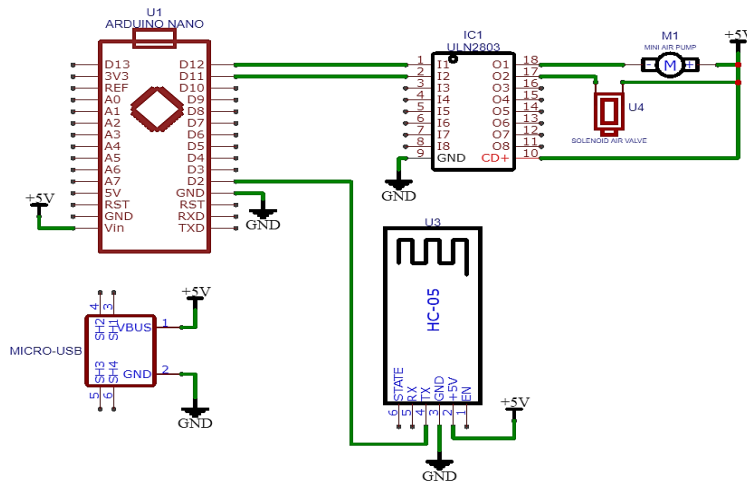
Fig: 6 Block Diagram of Proposed Model



Fig: 7 Schematic Diagram of Proposed Model

Once the device is ON, 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. Now, to record user instructions through mobile app, initially, Bluetooth connection needs to be established. Using the clock option in the app the required amount of time for massage is to be set. Next, the user can set the required pressure among three levels - Light, Medium, and Deep. This pressure value is sent to the device through Bluetooth and the desired pressure is set. The functionality of the pressure setting is illustrated from the timing diagram. The pressure value set will act as threshold. The cuff inflates pressure to that level only. Mapping of pressure value with actual value is done on the control unit. The Sequence of the operation is represented diagrammatically as below.
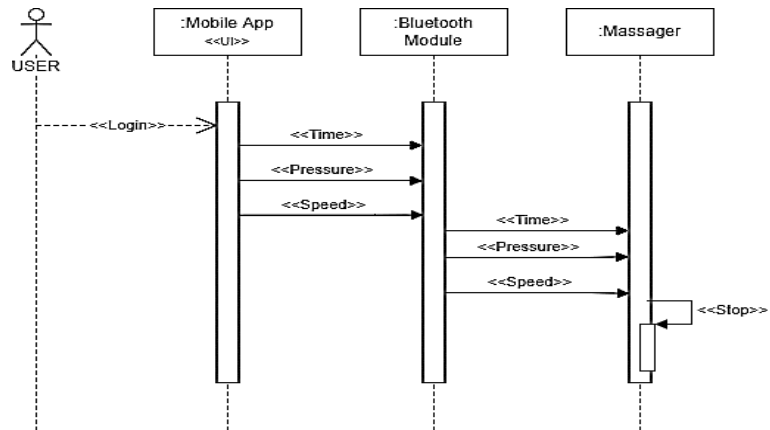
Fig. 8 Sequence diagram of the device

Speed can also be controlled through APP among three levels like Low, Medium, and Fast that correspond to inflate and deflate of pressure cuff. The pressure cuff inflates and deflates according to speed value. The value that sent from the APP to Arduino would be 0, 1, and 2 respectively. The mapping of the speed is done using Arduino. The below Fig: 9 depict the waveforms for various speeds
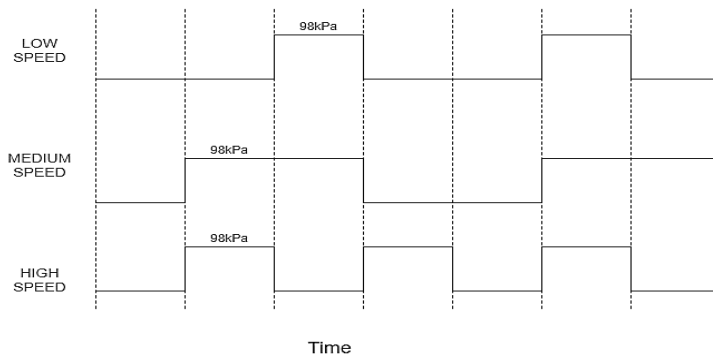


Fig: 9 Waveform of speed values

The below Fig's 10 & 11 shows the user module of the APP where the time can be set, speed and pressure can be controlled and device can be start and stop.
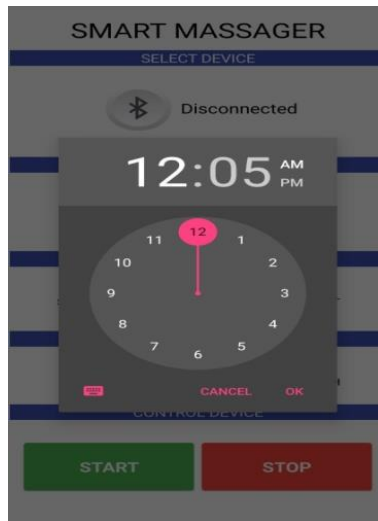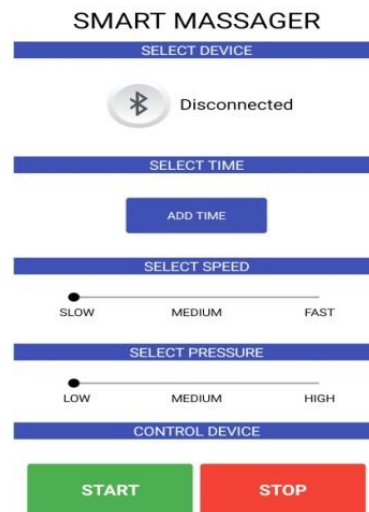
Fig: 10 Time Setter in APP          Fig: 11 Speed and Pressure controls, Stop – Start buttons

Once all the pressure, time and speed values are selected, then click on the START button to initiate the process. In this model, an Arduino Nano microcontroller board that has Atmega328P is used and programmed using Arduino IDE. For driving the solenoid air valve and the mini air pump, an L293D driver module is used. This module needs 5V input and need upto 500mA on every output pin. The Arduino gives control signals to the driver according to the configurations set in the app. For establishing communication, Bluetooth module is used.

A solenoid air valve is driven by L294D and controlled by Nano acts like a gateway. When activated it doesn't let the air out and therefore increases pressure within the cuff, making it inflate. BMP180 pressure sensor was used. Because of I2C interface, it was easily interfaced with Arduino using the four pins (+3.3V, GND, SCL, SDA). The sensor module was kept inside a box with a nozzle for connecting the tube and sealed on 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.

A Mobile App was developed using Kodular.in that allows creating Android apps easily with a blocks-type editor and requires no coding skills. It is a free online tool for the development of mobile apps. It mainly provides an online drag-and-drop Android app creator, by which everyone can create any kind of app.

Fig: 12 Prototype of Proposed Massage Band   Fig: 13 Applying at different Parts in a body

As the Pressure cuff is flexible, a single band can be accommodated for massaging at different parts in a body like Hand, leg, shoulder, back, neck etc. where it not possible with most of the existing models and totally can be controlled by a App without need of applying any physical force.

## 4.    CONCLUSION

Massaging has many benefits like reducing stress, relieving body pains, helps with insomnia problems etc. Massage bands are really popular due to the many benefits they provide. But many massage bands that are available now in the market have their own limitations as discussed.

The Safe and cost-effective massage band is an attempt to overcome all these limitations. This device is portable and has some technological touch to automate the process which is programmed using Arduino. The device consists of pressure cuff which inflates and deflates to create pressure. This pressure can be easily controlled with the mobile application developed using Kodular.in 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 also be powered by rechargeable batteries which make it safe from any electrical shocks.

In future, 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. Analytics can also be included to predict the most comfortable pressure for each and every one and appropriate pressure for a certain kind of muscular pain can also be recommended.

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