Finger Fracture Physical Therapy Device Report

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This project was made under the supervision of :

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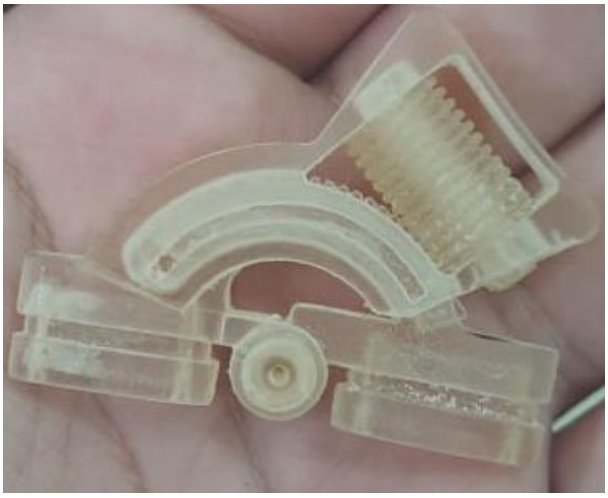


Idea :

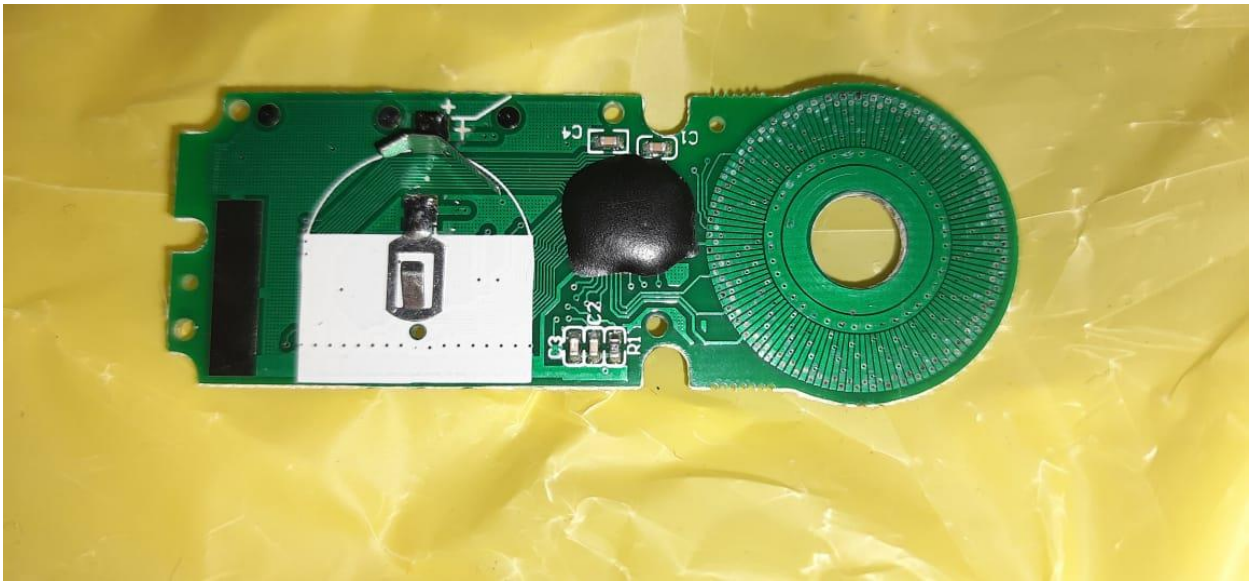
The main idea of the project was to replicate the functionality of a Digital Protractor to use it as a Physical Therapy device, by enhancing its behavior and precision in order to use it in the medical field.

Functionality:

It's used for physical therapy on figure fractures, It helps the Physical Therapist to read the angle and that helps him to treat the patient effectively.

Progress:

First was the reverse Engineering process



I was able to find out the inputs and outputs of the Digital Protractor and every sensor and component used to make it.
The main components that were inside the Digital Protractor :

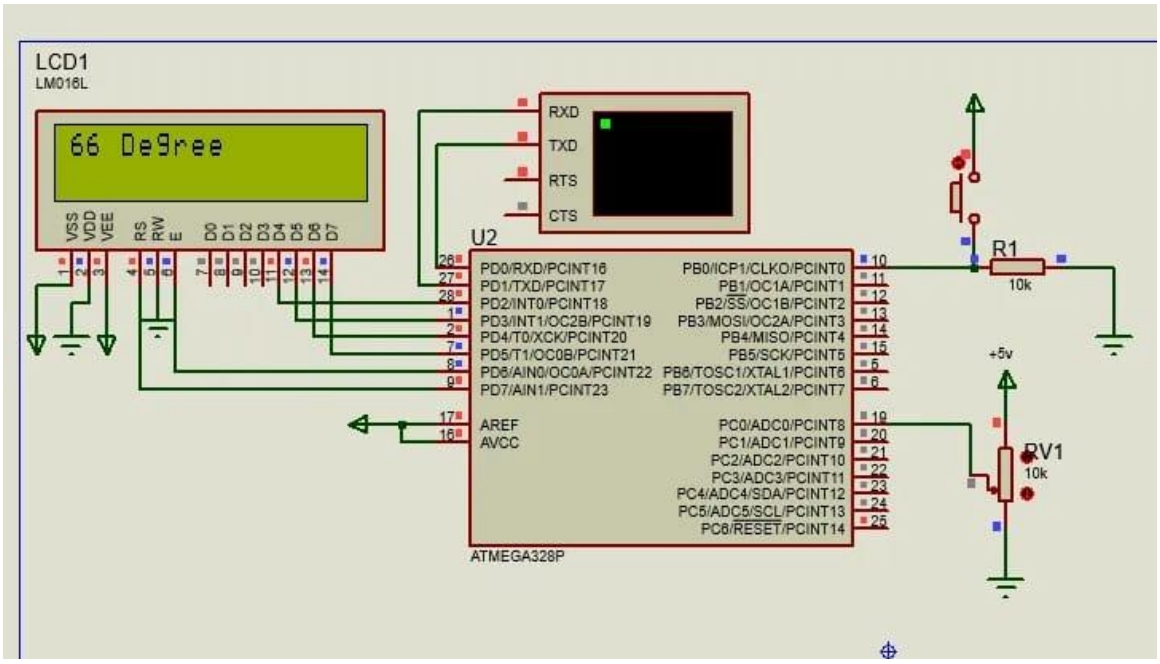
- Micro-Controller
- 5 Bit LCD screen
- Inductive Position Encoder
- Switches
- 3v Battery

The main components which I used were :

- Micro-Controller (Arduino Nano)
- 16x2 LCD character screen
- Bluetooth Module (HC-05)

- Switches
- Potentiometer
- 9v Battery

The second step was connecting the components on a simulator to know if it's doable.



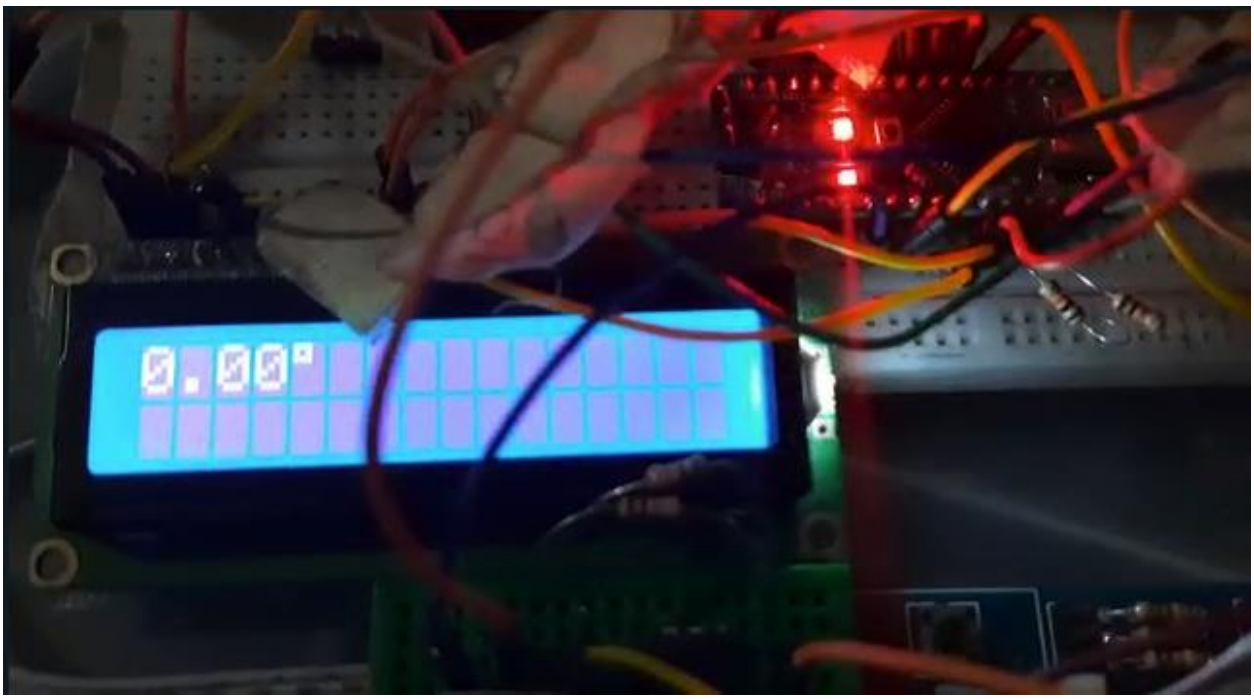
The third step was to write the code.

digitalAngleInterrupt

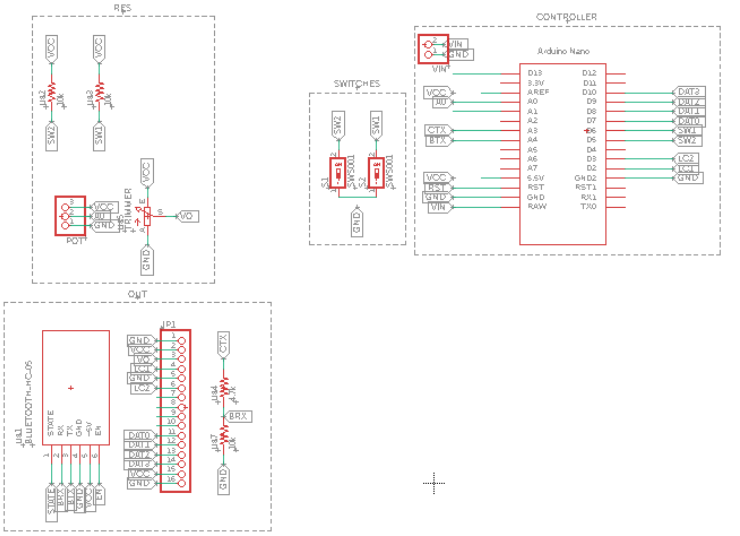
```
#include <LiquidCrystal.h>
#include <SoftwareSerial.h>
#include <Oversampling.h>

#define Adc            10    //res. of adc
#define oversampling   14   //no. of bits obtained through the oversampling process
#define Averaging      50  //no. of consecutive oversampled readings performed inside 'adc.read()' before returining the averaged value.

#if      oversampling    == 16
#define   Max   65472.0
#endif
#if      oversampling    == 14
#define   Max   16368.0
#endif
#if    oversampling    == 10
#define   Max   1023.0
#endif

// Bit math Macros
#define TOG_BIT(VAR,BIT)  VAR ^=  (1 << (BIT))
#define GET_BIT(VAR,BIT)  ((VAR >> BIT) & 1  )
#define SET_BIT(VAR,BIT)  VAR |=  (1 << (BIT))
#define CLR_BIT(VAR,BIT)  VAR &= ~(1 << (BIT))

// define lcd 16 x 2pins
#define d4 7
#define d5 8
```

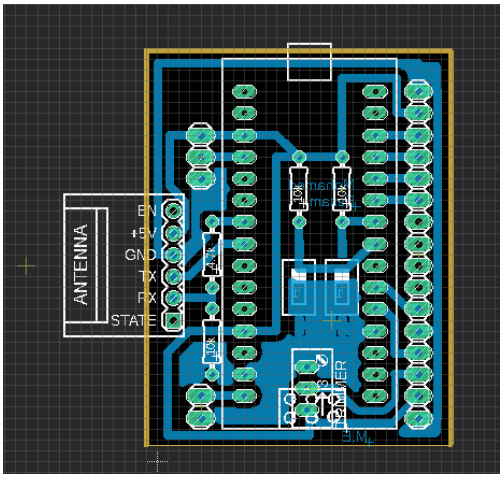
In order to use a low budget potentiometer, I've increased the precision of the readings in the SW code by using the oversampling and decimation method, it's known that the ATMega328p has 10 bit resolution embedded inside. By using the above mentioned technique the resolution became 14 bits, and that gave an error range of +/- 0.02 degree.

The fourth step was connecting all the components on a bread board to test the connections.

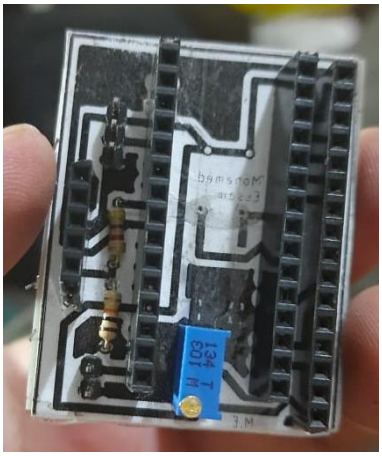


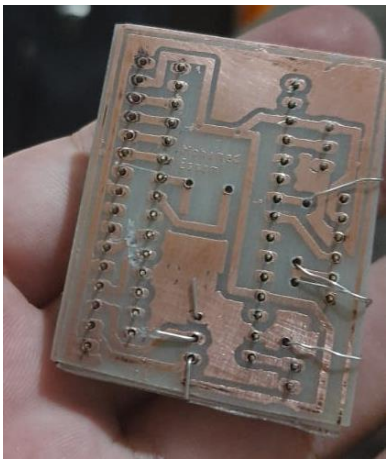
The fifth step was the PCB design



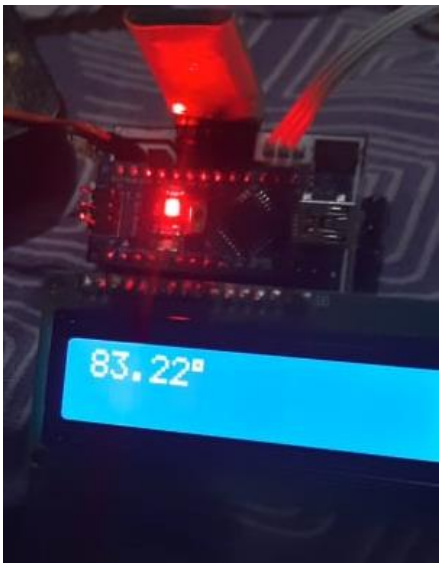


The Last step was to fabricate the PCB and connect all the components on it to make it compact.

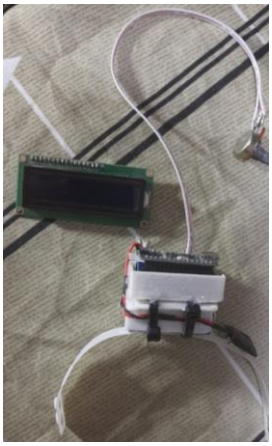




The final Product was a fully functioning PCB as shown in the figure below :



And by adding 3d printed parts the project became as shown:



Features :

The project has many features, such as :

The precision that was mentioned before.

It sends the reading to an LCD and through Bluetooth module into any Bluetooth serial terminal Application on the mobile phone.

It has a switch that can Hold the reading.

Also another switch that toggles between the reading in degree with fraction and the reading in degrees and minutes.

It has a low cost Potentiometer.

It has a small sized PCB that can be put on the hand like a wrist-band.

Future Improvements:

- Using ATMEGA328p Controller's Chip instead of the full Nano Platform
- Using a smaller sized Bluetooth-Module
- Using a 4 digit LCD instead of 16x2 LCD to make it smaller
- Using a better quality Potentiometer
- Using a rechargeable small sized LI-PO Battery

Notes:

The Potentiometer used is a low quality one, that's why the Angle may be shifted by 2 to 5 degrees from the real angle depending on the potentiometer, and that can be fixed in the code using the mapping function and by getting a better-quality Potentiometer.

Bill of Materials (BOM)

Component	Price	Quantity	Total Price	Link
Arduino Nano	175	1	175	https://makerselectronics.com/product/arduino-nano
16x2 LCD	50	1	50	https://makerselectronics.com/product/16x2-character-lcd
Bluetooth Module	160	1	160	https://makerselectronics.com/product/bluetooth-module-hc-05

PCB	6	1	6	https://makerselectronics.com/product/pcb-board-fiber
Trimmer	3.5	1	3.5	https://makerselectronics.com/product/multi-turn-pot-20k
Pot	3	1	3	https://makerselectronics.com/product/pot-1m
Switches	1	2	2	https://makerselectronics.com/product/push-button-3x6x5-0mm
Resistors	0.1	4	0.4	https://makerselectronics.com/product/resistor-1-2ohm-1-2w
9v Battery 6F22	15	1	15	https://makerselectronics.com/product/camelion-battery-9v-6f22
Battery Cap	1.5	1	1.5	https://makerselectronics.com/product/battery-9v-cap
Pin header female	3	2	6	https://makerselectronics.com/product/pin-headers-female-40-pins
Pin header male	2	1	2	https://makerselectronics.com/product/pin-headers-male-40-pins
Data Cable 3 pin	5.5	1	5.5	https://makerselectronics.com/product/data-cable-jst-3-pin-30cm
19 grams of filament PLA+	--	--	--	

Project Total Cost : 429.9 EGP