User Manual
Blood Pressure Measuring Device With Stepper Motor Driven Piston Pump

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1 Introduction

This is a manual for the software from the master thesis by Pascal Schüttengruber. The software is used to operate the blood pressure measuring device. Its features are:

- A Fully automatic blood pressure measurement.

- The calibration of the pressure sensor.

- An automatic calibration of the piston pump speed.

- A Leak-proof-test.

- An all-round signal analysis of the recorded pressure signal.

- A developer mode to control every port individually.

- A help description.

The following chapters are in the order of the typical user-flow.

2 Start-screen

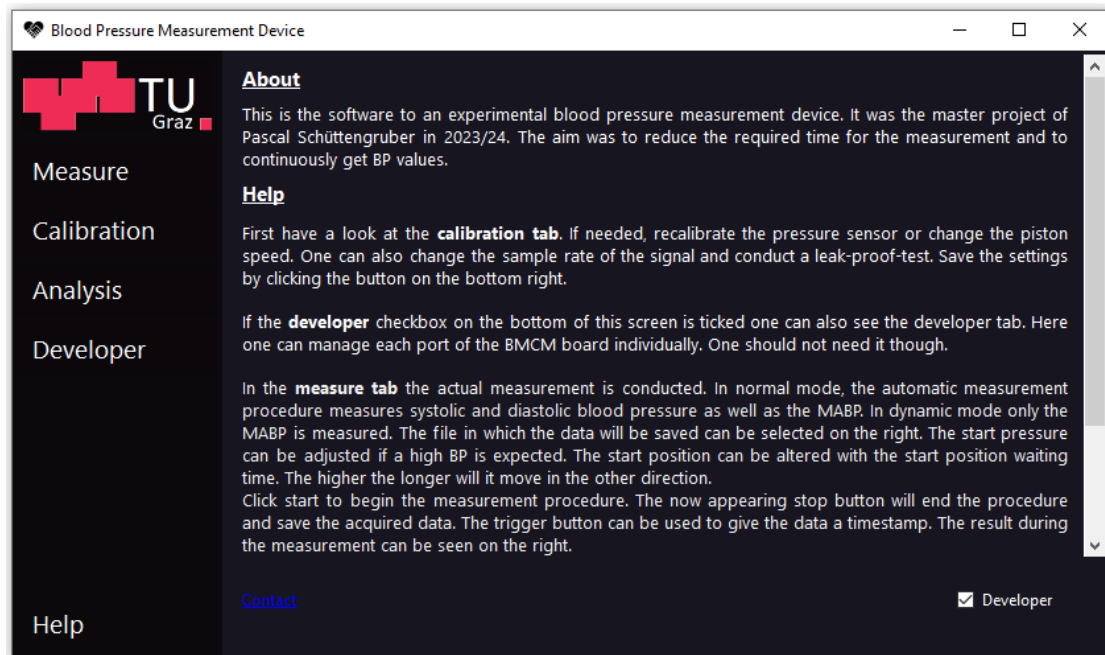When the software gets opened it should look like figure 2.1.

Figure 2.1: UI when the software is opened

On the left one can see the different tabs Measure, Calibration, Analysis, Developer and Help. On the right you should see the about and help text. If it is missing, the help.rtf file is absent. If this is the case don't worry, you are better off with this manual anyway. If the contact link is clicked, a mail form of your standard email program gets opened where the developer is the recipient. With the checkbox on the bottom right one can activate the Developer tab. If the Help tab is clicked one lands on the Start-screen again.

3 Calibration

When using this software, one should first have a look at the calibration tab which is depicted in figure 3.1.
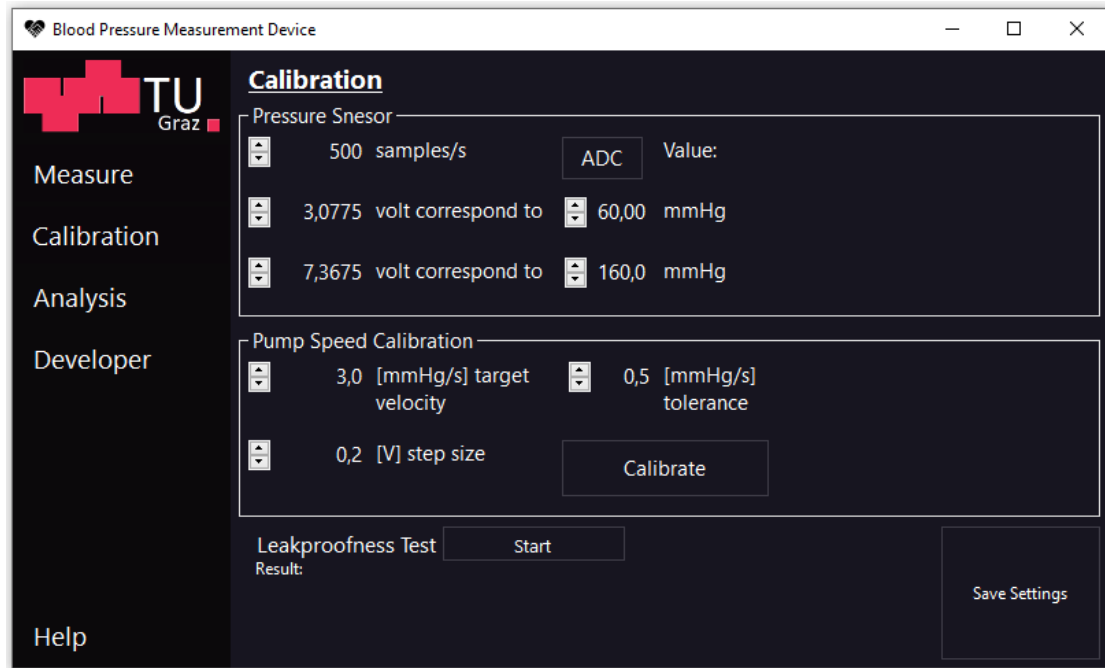

Figure 3.1: UI of the calibration tab

Here one can alter the sample rate, but 500 samples/s is recommended. The linear calibration curve of the pressure sensor can be calibrated by declaring two reference points. One can connect an external pressure measurement device to get a pressure value and use the ADC button to get the corresponding voltage of the pressure sensor. The system can be pressurized by a hand pump or one uses the developer tab.

The speed of the pump can be calibrated in the next section. With the first number selector one can choose a target inflation and deflation velocity. With the second number selector on the right one can declare the tolerance that should be achieved. The third number selector (below the first one) chooses the step size of the DAC that the algorithm uses. The calibration process is started with the corresponding button. A progress bar that appears at the bottom informs you about the status. When its finished a message box pops up that states its success of failure. If it failed, alter the values of the tolerance

and step size. Maybe your target velocity is out of the scope. The recommended range for the target velocity is about 1 to 8 mmHg/s.

A leakprooftest can also be conducted by clicking the start button. Here again a progress bar shows its status. When its finished a text beside result appears.

All settings made and as well as the calibrated speed can be saved with the save settings button on the bottom right.

4 Measure

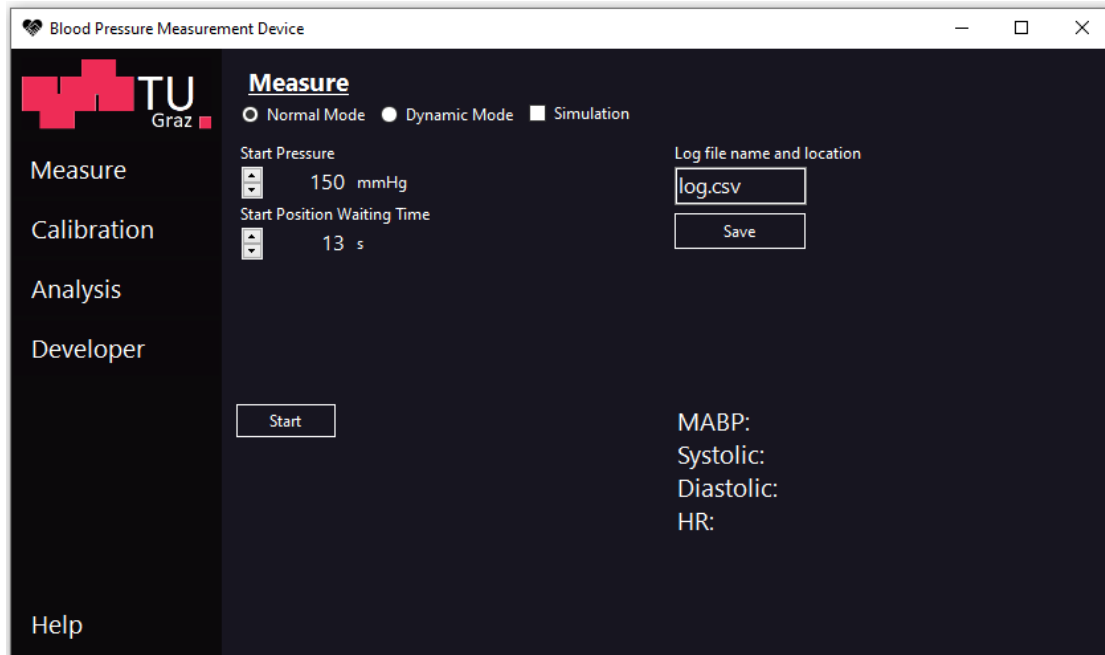In the Measure tab, which can be seen in figure 4.1, the actual measurement is conducted.

Figure 4.1: UI of the measure tab

With the radio buttons normal mode and dynamic mode one can select the operating mode of the device. In normal mode, the automatic measurement procedure measures systolic and diastolic blood pressure as well as the MABP. In dynamic mode only the MABP is measured, which will lead to more data in the same time.

The simulation checkbox is only visible when the developer checkbox is ticked at the start-screen or help-tab. When ticked it undergoes a virtual measurement procedure that tests the algorithm with pre-recorded data.

Before starting the measurement the start pressure can be altered. If the patient has high blood pressure, a higher starting pressure may be necessary. The start position waiting time is a constant that changes the starting piston position. If there are no leaks this can be very low. With a high amount of leakage a higher number is necessary to conduct the measurement.

The data will be saved in a csv file after the measurement. The log file name and location can be chosen on the top right. The file contains 3 columns. The first column

is the data, the second is the timestamp of the run and the third the direction the pump was heading.

The start button starts the measurement procedure. A trigger and a stop button will appear. The trigger button will record a timestamp in the first row of the log file when clicked. It is -1 if it was not clicked. The stop button ends the measurement, saves the data and releases the air from the system.

The parameters MABP, Systolic, Diastolic and HR are calculated during the measurement and will be displayed as text on the bottom right when they are available.

5 Analysis

After the measurements are conducted, the recorded data can be viewed in the analysis tab, which is depicted in figure 5.1.
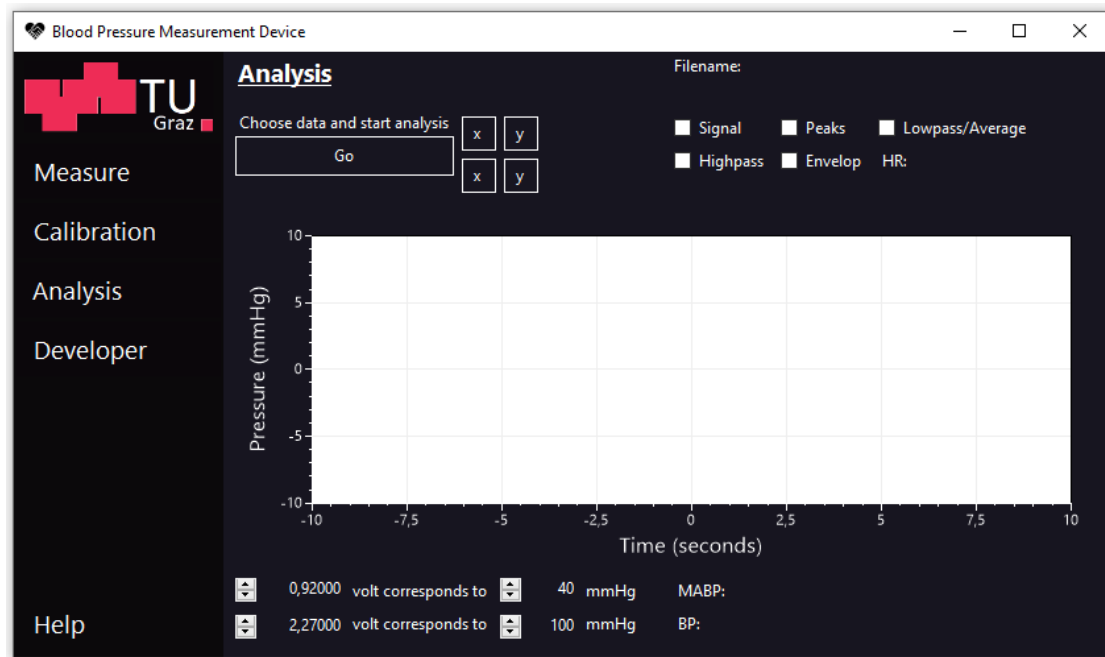

Figure 5.1: UI of the analysis tab

Click the Go button and choose the data you want to observe. First the recorded signal is shown. Now you can look how the signal looks during the different stages of the data analysis. Untick the signal checkbox and tick some other checkbox. One can tick multiple and compare, but the first checkbox ticked defines the range of the y axis. The range of the axis can be altered with the mouse wheel or the x and y buttons beside the go button.

The pressure calibration on the bottom left is only needed when the data got recorded as text file and when it contains voltage values. Because then one needs to know how the sensor war calibrated.

MABP and BP on the bottom right show the calculated parameters.

6 Developer

This tab should only be needed by the user, if one wants to inflate the system for the pressure sensor calibration. A screenshot of it is shown in figure 6.1.
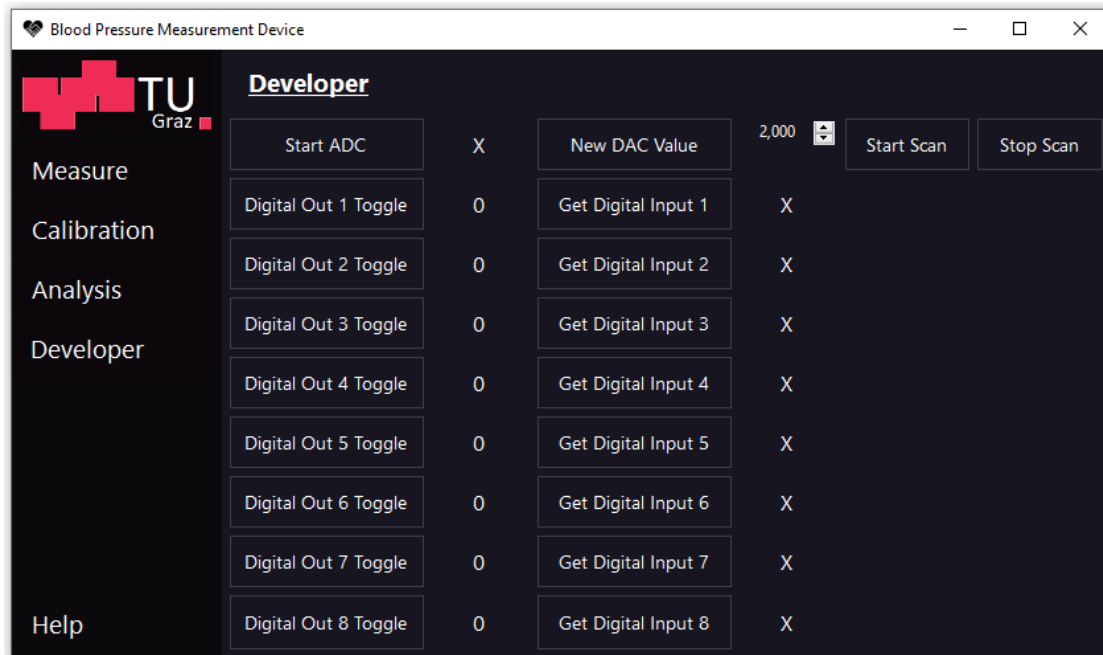

Figure 6.1: UI of the developer tab

With this tab on can control every single port of the bmcm board. Start ADC gets one value of the ADC 1. Digital Out N Toggle inverts the state of output N. The number beside the button shows its actual state. Get Digital Input N reads the digital input N and displays true or false on the field beside it. New DAC Value puts the number chosen by the number selector beside it as new output voltage on the DAC port. Start Scan starts a measurement procedure manually. Every first value of each run gets displayed below. Stop Scan stops the procedure and saves the recoreded values to a text file.

6.1 Port Description

DO1 and 2 are used for the limit switches, do not touch them. DO3 controls the test valve, DO5 the emergency valve. DO4 activates the membrane pump. DO6 toggles the direction of the stepper motor. DO7 enables the stepper motor. DO8 is not connected.

The digital inputs are not connected in version 1 as well because the input resistances were too high. The analog inputs were used instead to record the state of the limit-switches.