

# Low-Cost Developing Board for PIC Microcontrollers

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**Abstract** - Microcontrollers are single-chip computers that include a minimum of microprocessors, memory and input-output module. A number of experimental-level and commercial quality development boards are available for microcontrollers, because the coding process of the microcontrollers is difficult. This paper presents a comparative description of existing microcontroller development boards and proposes a new development board for the microcontroller programming, especially for school students. Further, this study also identifies related issues and challenges of the PIC microcontrollers, and why users are not much focused on them. Finally, the paper proposes a new design of the development board for the PIC microcontrollers, which is capable to reduce some of the said issues. The proposed microcontroller development board has been tested with a PIC 16F877.

**Keywords:** *microcontroller, microprocessor, bootloader, development board, embedded system*

## I. INTRODUCTION

Nearly everyone in created just as non-industrial countries cannot think about a day without using microcontrollers. The microcontroller is an embedded computer chip that controls most of the electronic gadgets and apparatuses people use day by day, directly from washing machines to anti-lock brakes in vehicles. The microprocessor is a multipurpose, clock-driven, register-based, digital integrated circuit that accepts binary data as input, processes it as indicated by guidelines put away in its memory, and gives results (also in binary form) as output. Microcontroller is a chip enhanced to control electronic devices. ("Difference between Microprocessor and Microcontroller," n.d.) It is put away in a single integrated circuit which is

devoted to playing out a specific undertaking and execute one explicit application. It is designed circuits for embedded applications and is widely used in automatically controlled electronic devices and contains memory, processor, and programmable I/O.

There are differences between microprocessor and microcontroller. Such that microprocessor is the heart of computer system, but microcontroller is the heart of an embedded system. Microprocessor is only a processor then memory and I/O components need to be connected externally but microcontroller has a processor along with internal memory and I/O components. Microprocessor cannot use it in compact systems and microcontroller can use it in compact system. Not only that, in microprocessor cost of the entire system is high but microcontroller low cost for the entire system. ("Microprocessor - Wikipedia," n.d.) Furthermore, microprocessor has a smaller number of registers, so more operations are memory based. But microcontroller has more register hence the programs are easier to write. Microcontroller uses an internal controlling bus. As far as I think, microprocessor used for general purpose applications, but microcontroller used for application-specific systems. Utilizing these advantages, it is proposed to develop a development board for microcontrollers. ("Microcontroller," 2021)

When focusing on current methods of using development boards users, the most used method is to ask someone familiar with the development boards. The main disadvantage of this method is that they should rely on the scope of that person's knowledge and the recommendation made by one person may not be so reliable. Therefore, as it is difficult to ask many people, the Development Board proposes to make learning easier for everyone by using data

obtained from everyday users. I had to face many difficulties in finding information as there was no written evidence for PIC microcontrollers. The proposed system aims to make it easy to learn PIC microcontrollers. It also aims to create new designs using this proposed development board. To achieve the above aim the following key objectives has been identified.

- All students can study on microcontrollers.
- They can study on development boards and their strategies.
- Critically study on languages that can be used to program a microcontroller.
- Users can study on languages that can be used to design a device driver (library)
- All users study about USB communication with PIC microcontrollers.
- Not only that they can study on features and technologies that includes in existing development boards.

In the proposed system, the user will be able to easily manipulate the development board and learn about microcontrollers easily. Thus, there are facilities for innovation using this development board. The Development Board has the ability to create IoT-based designs through the Wi-Fi module it hopes to create in the future.

## II. LITERATURE REVIEW

Many computer manufacturers manufacture low-cost development boards or evaluation boards. They are very helpful for learning about the specific chip and its capabilities, trying different things with algorithm implementation and developing simple systems. They are useful for program development. The cost of these systems varies from hundreds of dollars to thousands of dollars, depending on the processor and memory configuration. The goal of this literature review is to compare most popular two development board in IT field. In here I have compared some of the most popular development boards among users. (“What is Arduino? | Arduino alternative,” n.d.) (“Raspberry Pi,” 2021) (“NodeMCU,” 2021).

Table 1: Compare the most popular existing development board  
Source: Author

	Arduino Uno	Raspberry Pi	Node MCU
<b>CPU</b>	8 bit	16 bit	32 bit
<b>Wi-Fi</b>	Shield or ESP8266	USB Dongle	Built-in
<b>Programming</b>	C++	Python/Java/C++	C++/Lua
<b>Code Distribution</b>	USB/SPI/Serial	In-situ	Serial/OTA
<b>Storage</b>	32KB flash	Depends on size of SD card	4MB
<b>I/O</b>	13 GPIO/6 ADC	17 GPIO	10 GPIO/1 ADC

After that I compared advantages and disadvantages of these existing systems.

Table 2: Most popular development board advantages and disadvantages  
Source: Author

	Arduino	Raspberry Pi	Node MCU
Advantages	Ready to use structure	Easy to use	Low cost
	Effortless functions	Low power consumption	Integrated support for Wi-Fi network
	Large community	Great for smaller tasks	Reduced size of the board Low energy consumption
Disadvantages	Cost	Cost	Need to learn a new language and IDE
	The structure of Arduino	Limited functions	Reduced pinout
		Very slow	

	Internet connectivity	Bad for multitasking	Scarce documentation
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It is proposed to create a simple development board for microcontrollers, taking into account the advantages and disadvantages of existing development boards and the existing problems for the user. Features of the proposed Development Board for PIC microcontroller.

Table 3: Features of proposed development board  
Source: Author

<b>CPU</b>	8 bit
<b>Wi-Fi</b>	Built-in
<b>Programming</b>	C
<b>Storage</b>	14KB Flash
<b>Communication</b>	UART(1)/ SPI(1)/I2C(1)

These are the advantages and disadvantages for the proposed system. ("Advantages and Disadvantages of Using Arduino - Engineer Experiences," n.d.) ("NodeMcu and Arduino IDE which is based on the ESP-12 module," n.d.) ("Primary Advantages And Disadvantages Of Raspberry Pi | ipl.org," n.d.) (MACFOS, 2020)

Table 4: Advantages and Disadvantages of proposed system  
Source: Author

Advantages	Disadvantages
<ul style="list-style-type: none"> <li>• Low cost</li> <li>• Integrated support for Wi-Fi network</li> <li>• Low power consumption</li> <li>• Easy to use</li> <li>• Easy to learn C programming</li> <li>• Familiar with PIC microcontroller</li> </ul>	<ul style="list-style-type: none"> <li>• Build for one PIC microcontroller (PIC16F877)</li> <li>• Slightly larger in size</li> </ul>

Price comparison of existing development boards.

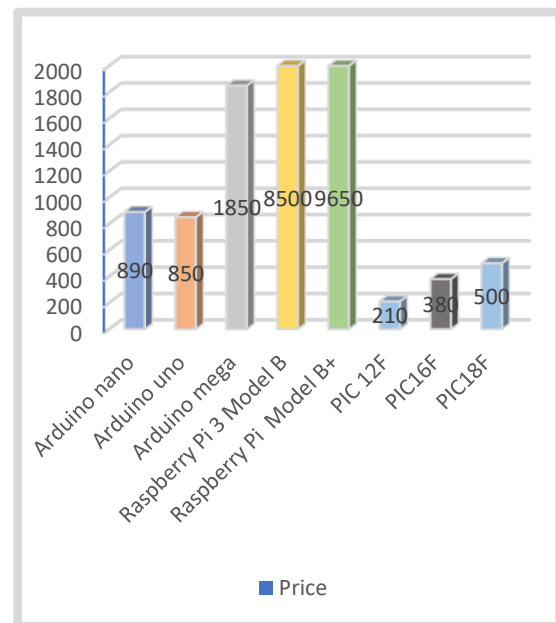


Figure 01: Prices of the development board and compare with PIC microcontroller.  
Source: Author

### III. METHODOLOGY AND DESIGN

#### O. Requirement gathering and analysis.

This study was started by identifying what are the exact problems of using PIC microcontrollers and why users are not used microcontrollers and not familiar to the microcontrollers. For that purpose, a survey was conducted using 50 users (A/L students, Undergraduate student in electronic, computing field, and graduate student in IT field). The survey kept as simple as possible to ensure that it was easy for each user to respond.

With the obtained results from this survey the research objectives were defined and then started to design the proposed system to fulfill each of them. Identified main problems of users are as follows,

- Microcontrollers are smallest and cheapest unit.
- Microcontrollers are no familiar among people.
- There are no direct communication methods for microcontrollers.
- People do not have idea about microcontrollers.
- People are no familiar about PIC programming.

- Other development more familiar among people.

After identifying the research problem, it was broken down into several sub questions to identify that what should be the exact objectives of the project to achieve the project aim. Following research questions were formulated with the aim of identifying areas that need to be studied in more depth to find a proper solution to the research problem. The research study clearly shows that the development board should be designed according to the needs of the user. Also, these research questions highlight the key features of the proposed development board to cover all user requirements.

- Question 01: Do you know what is a microcontroller?
- Question 02: Do you know the difference between microprocessor and microcontroller?
- Question 03: Have you ever used a development board before?
- Question 04: What development board have you used?
- Question 05: Have you used Microcontroller before?
- Question 06: Why don't you use PIC?
- Question 07: If you have used PIC before, for what purpose?
- Question 08: Do you think PIC needs a development board?
- Question 09: If so, what are the new technologies you suggest?

#### P. Proposed system design

The outline of the proposed system figure 5 defines the how the components of the system are related.

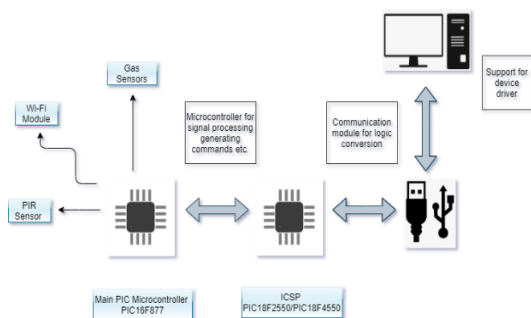


Figure 2: Proposed system architecture

Source: Author

In here to create a communication device that work with the PIC and use it to design a development board so that anyone can learn the PIC. The main reason for creating this is that the use of microcontrollers is not popular among many people and the use of microcontrollers has decreased due to the presence of a development board that can plug and play directly.

The reason why my design is an IoT based project is because its ESP8266 Wi-fi module is designated and can be used direct for an IoT based project. There is a USB port, can connect to a computer via USB and flash to the target chip. In here I use two microcontrollers (PIC18F2550 OR 4550 AND PIC16F877) because if the bootloader program is programmed into the main microcontroller, there is not enough space in the ROM That's why it is difficult to run a large program. This board can connect sensors, motors, relays etc. This board can plug and play directly. Write a driver for the board and then the driver identifies the board with the computer and transmit the data to the board. And this board compatible with MPLAB X IDE, MICKRO C pro IDE.

#### Q. Data gathering

Data gathering phase was an important and hard step which had to face many difficulties in finding the existing problems for the users. Also, there were no manuals to look at the existing development boards before the creation of this development board and to investigate the problems that arose during their creation. There were no research papers. Therefore, a google forms has been created in English medium to gather details and distributed it among service providers. Thus, had to contact each service provider personally to gather data. ("USB bootloading - Northwestern Mechatronics Wiki," n.d.)

They then proposed to create a development board that would keep a list of data and make learning more user-friendly and cost-effective, and new experiments would be needed.

#### R. Technology Adaptation

##### 1). Schematic Diagram for the Proposed System:

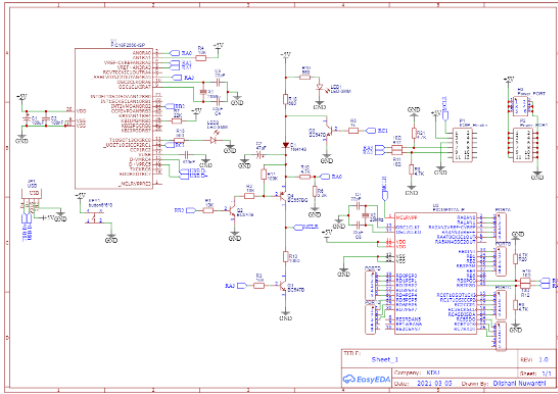


Figure 3: Schematic Diagram  
Source: Author

At the request of many users, it took several steps to create the proposed development board. This is the schematic diagram in the first step. First one is PIC18F2550 and other one is PIC16F877. PIC18F2550 is the USB support microcontroller and the PIC16F877 microcontroller does not support the USB connection. In here I used PIC16F877 microcontroller it is user-friendly, and it has a simple design. The reason for using the bootloader on power-up or reset, it is a section of program memory that runs before the main code runs. It can be used to setup the microcontroller or provide limited ability to update the main program's code. ("In-Circuit Serial Programming (ICSP) Guide," 2003).

2). PCB Design:

This is the PCB design of the schematic diagram mentioned above. In here I designed PCB in two layers. This board is powered via USB. I also hope to supply power through an adapter.

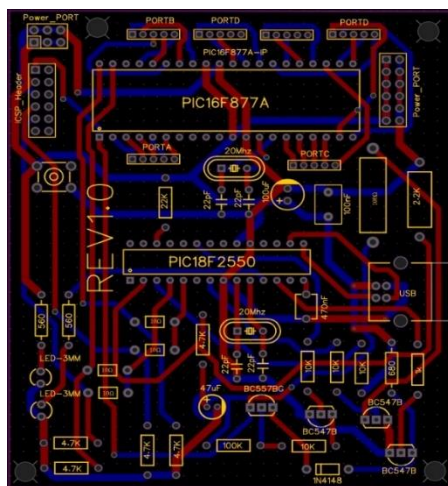


Figure 4 :PCB Design 1 for the proposed system

IV. DISCUSSION

The world has not yet properly developed a development board for learning microcontrollers. Also, the microcontroller is not popular because the language used for programming is not close. Moreover, development boards such as Arduino are so close to man that they are more inclined to create using them.

This paper has reviewed on existing developing boards, Arduino, Raspberry Pi, and NodeMCU, in electronic fields. However, these developing boards are more suitable for the related work for create a developing board for PIC. According to my survey, many people are asking for a development board for microcontrollers as well. Many of them are undergraduate students. The survey revealed that the new development board for the microcontroller, which is expected to be designed according to existing development boards, is designed to use new technologies and make it easier to learn and use for a variety of tasks.

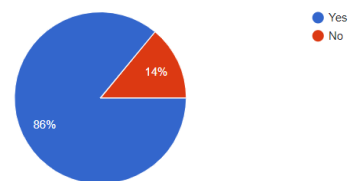


Figure 5: Number of people who have previously used one development board or more  
Source: Author

Figure 6 shows the number of user development boards currently in use. Even now there are people who do not use any development board.

Figure 7 shows the development boards that the user is currently using. It seems that many people there prefer to use Arduino.

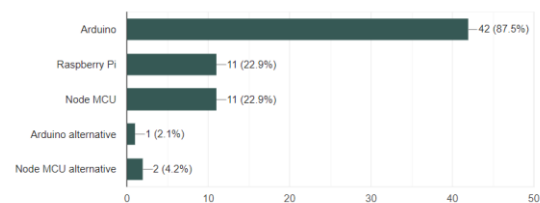


Figure 6: Development boards that users have used so far  
Source: Author

Reasons why PICs are not used by users today as shown by Figure 8. Here are the problems and difficulties faced by the user in using the PIC



Figure 7: Functions that users have used PIC before  
Source: Author

As this figure 9 shows, many people say that PIC needs a good development board. Therefore, it is important to create a development board using the latest technologies so that the user can learn more about microcontrollers and use them more closely.

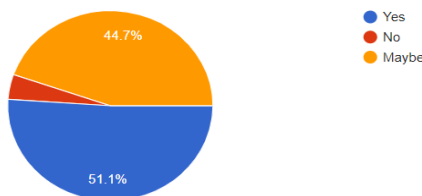


Figure 8: Number of users proposed development board for PIC  
Source: Author

Therefore, it is important to create a development panel using the latest technologies so that the user can learn more about microcontrollers and use them more closely.

Today we can see some PIC-related development boards but most of them are having compatibility issues with software and hardware. The proposed system to design a development board with fewer compatibility issues, to do that best practice is to admire the Arduino boards.

However, the idea was to make it as friendly as an Arduino board, and to make it as close as possible to the language used, and to bring it to the masses as an entry level platform. Proposed to have a universal dev board where you can use PICs IO pins from the board pins itself.

## V. CONCLUSION AND FUTURE WORKS

Creating development boards using novel technologies has become very popular in the world today. Many development boards created using such technologies are still used by people

in IT field. They are used by people for different projects with different technological capabilities. This research study identified the technologies and flaws in the existing development boards and selected the problem of lack of microcontroller popularity, lack of dedicated development boards and low usage. The paper is proposed a lower cost microcontroller development board to provide a closer understanding of PIC and to learn the PIC programming to humans using IoT technologies. A development board for microcontrollers was proposed to make it easy for every user to learn and use. It is also proposed to write a separate device driver for this development board. The limitations of this project are to focus only on the needs of the microcontrollers of school children and university students. This project can be developed for industry-wide projects around the world and for innovative designs using new technologies that are directly used in IoT. Also, this development board can be upgraded to make it more tempting for everyone to write a device driver.

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