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Personal Computer-less (PC-less) Microcontroller Training Kit

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Abstract. The need of microcontroller training kit is necessary for practical work of students of electrical engineering education. However, to use available training kit not only costly but also does not meet the need of laboratory requirements. An affordable and portable microcontroller kit could answer such problem. This paper explains the design and development of Personal Computer Less (PC-Less) Microcontroller Training Kit. It was developed based on Lattepanda processor and Arduino microcontroller as target. The training kit equipped with advanced input-output interfaces that adopted the concept of low cost and low power system. The preliminary usability testing proved this device can be used as a tool for microcontroller programming and industrial automation training. By adopting the concept of portability, the device could be operated in the rural area which electricity and computer infrastructure are limited. Furthermore, the training kit is suitable for student of electrical engineering student from university and vocational high school.

1. Introduction

Microcontroller learning generally uses system minimum 89S51 microcontroller type as a training tool then it is developed with AVR 8535 microcontroller. for some years [1]. Student's learning result is quite good from cognitive, affective, and psychomotor domains, yet with modular based microcontroller system student is prefer to used modular system than arranged it independently by themselves, since it is quite complicated. Modular system is considered fun and easy in microcontroller system learning and develop its application system [2]. Then it is designed and developed a modular system with Latepannda central processing unit which features more complete and large enough memory [3]. Lattepanda serves as mini-computer to set up the system, write down a memory program, input-output, serial communication and so on, while as a target (controller) uses Arduino Uno modular that embedded system by central processing unit. This microcontroller training tool's design does not use personal computer or Laptop. It is designed to control input-output system, serial communication, Bluetooth, jack audio, Wi-Fi, USB connector [4].

2. Design of PC-Less microcontroller training kit

The design model in block diagram is shown in figure 1, In general, this training tool consists of 4 process charts, there are: Input (Entry), Process (Compiler & Builder), Target Controller, and Output Interface module [5].

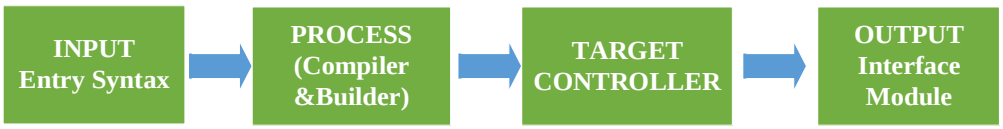

Figure 1. Block Diagram System

Microcontroller Training Kit Personal Computer Less block diagram completely shown in figure 2.

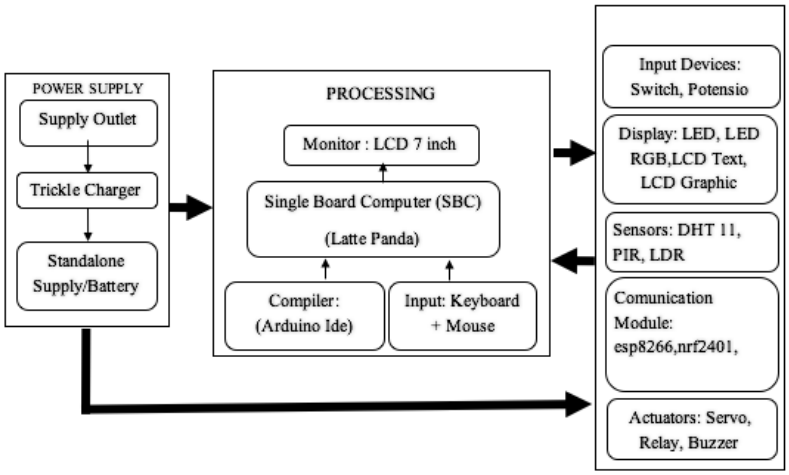

Figure 2. Block Diagram Microcontroller Training Kit Personal Computer Less

2.1. Power Supply

This section is a Direct Current (DC) power supply provider for the whole part and it is in training kit. PSU block's overall specification is as follows: Input: AC Voltage 220V, Current = 1 A, and 50-60 Hz Frequency. Output: DC Voltage 12 V, Current 1,5 A.

There is a section called Trickle Charger in PSU block, this section serves as DC power supply's source yet it also serves for Battery charging. In trickle-charger there is a controller that serves as a power supply direction's regulator, when the battery is fully charged (full Charge) then automatically the supply direction will switch DC supply directly to the circuit in Training kit, and supply to the battery is disconnected. When the voltage from AC Outlet Supply Outlet is absent/unconnected/disconnected the trickle-charger switches the DC voltage supply to the circuit work on the training kit towards the Battery, so that the power source for training kit's work comes from the Battery.

The battery on PSU block is used as backup power source if there is no power in AC Outlet Supply, therefore training kit allows to keep working about 3 hours although there is no power in AC Outlet Supply. Battery's specification: Output: Voltage 12 V, current 2400 m AH.

2.2. Processor

This block is the brain of the training kit which have many tasks i.e., starting from detects and processes learners' input in the form of data or command in training kit's operation, then forwards it to interface block. Single Board Computer (SBC) [6], as a data and command processor use Lattepanda with a Compiler installed, a software named Arduino IDE. This Software that will be used by learners to write syntax/program code in training kit's use, then it changes syntax/program code into understandable machine code by controller training kit, Arduino Mega2560. To control or communicate with interface components, the learner's inputs syntax by available wireless and navigates command by wireless mouse. In this block there is a 7 Inch LCD screen serves as display, learners can view a written program and navigate other program includes debugging and others.

2.3. Display

This section contains interface component that consists of input: Push Button, Potensio Meter Single, and Display's component: consist of 16-character text LCD, Double Row, LCD Graphic Nokia 5110, LED and RGB LED. Furthermore, sensor component that consists of temperature and humidity sensor (DHT 11), PIR sensor (Passive Infra-Red) and Light Dependent Resistor (LDR) sensor serves as light sensor. This microcontroller training kit is equipped with wireless communication module, there are Bluetooth module, Wi-Fi Module (Esp 8266) and wireless communication module uses 2,4 Ghz frequency (NRF2401), and the last in Interface block is equipped with actuator component such as Motor Servo 1800, Relay 220V 2 A, and Buzzer Active 5V.

3. Usability Testing PC-Less microcontroller training kit

Starting from input process that involves keyboard and mouse, those devices are used as interface between learners and training kit, learners will input syntax program in the form of C++ for Arduino Uno use keyboard, then navigate the command pointer by mouse, which in each input step is displayed on HMI, a 10-inch LCD Display.

The next process is compiling and building, which focusses on training kit “brain”/core in the form of Single Board Computer (SBC) or LattePanda. The SBC is set in such way and equipped with software installed that serves as input-syntax compiler and builder. First SBC will arrange an input syntax program by learners, then translate into Assembly, until this stage SBC acts as Compiler, then syntax Assembly is converted into code in the form of hexadecimal or binary code understood by the Machine in the form of Integrated Circuit (IC) on the target (Arduino).

Next process is downloading, at this stage there is a data transfer from SBC to Arduino in the target, SBC sends machine code that is the result of building syntax process, to IC ATMEGA 2560 in Arduino through USB on SBC as a transmitter through USB Port in Arduino as Receiver. Arduino Uno is a controller that can be determined its performance based on input syntax program, in this Training kit Arduino is on target part, a machine-code form program (*.hex) that is downloaded to Arduino. There is a pin in Arduino that serves as communication and control channel that is connected to the device in Interface part. In this interface, there are several modular interface devices, including: LCD 16 x2, Buzzer, Servo 180°, DHT11, Relay 1, ultrasonic, LED, Potentiometer, Bluetooth, RTC DS 3231, ESP 8266, NRF 24l01, LCD Graphic Nokia 5110, PIR, Infrared Receiver, LED RGB and LDR.

The Arduino interconnection with one of the modules in interfacing is arranged through Dipswitch observation, which every interfacing module has a Dipswitch to communicate with Arduino, the learners must activate communication path by turning Dipswitch on (TURN ON) if they want the Arduino to make contact with one of the interfacing modules in Training Kit. Microcontroller Training Kit Personal Computer Less Physical can see in figure 3.

Figure 3. Microcontroller Training Kit Personal Computer Less Physical Form Picture

Interfacing module will show its performance (working) after obtain the right machine code (*hex) derives from syntax program input by learners and has been processed by compiler and builder on SBC. For example, if the learners want to move interfacing module's motor stepper in training kit, he/she should input / create the right syntax program, then perform a code program compiling and building uses software sketch installed on SBC then download a program from SBC to Arduino, then activate the right dipswitch to open communication path between Arduino and interfacing module that is motor stepper module interfacing, by activating dipswitch in that motor stepper module interfacing.

Microcontroller Training Kit Personal Computer Less Hardware's Specification:

1.	Dimension L x W x H	:30 x 30 x10 cm
2.	Display	: TFT LCD 7 inch
3.	Core	: SBC LattePanda
4.	Controller	: Arduino
5.	PCB	: Fiber
6.	Input Device	: Mouse & Keyboard (Wireless)
7.	Power Consumption	: AC 220V ,10 W
8.	Power Backup	: Battery 12V, 1,5 A
9.	Interfacing Module	: LCD16 x 2; Active Buzzer; Motor Servo 180°; Temperature & Humidity Sensor (DHT11); Relay; Bluetooth; Wireless Module NRF 24l01; Wireless Module ESP 8266; LCD Graphic Nokia 5110; PIR Sensor; Infrared Receiver; LED; LED RGB; and LDR

4. Conclusion and Future Work

PC-Less microcontroller kit is an affordable training kit intended to be used for university and vocational high school especially for the school located in rural area. Using Lattepanda, adopted the portability of SBS, the device allows the learners to practice microcontroller programming anywhere with the concept of low-cost and low-power.

The future work of this research is to measure the effectiveness of practical work of microcontroller programming using the device. PC-Less microcontroller kit would be implemented in the course of industrial automation practical work; hence the evaluation will involve some students of electrical engineering education who take this course.

References

[1] Y Somantri and I Fushsilat 2017 Low Cost Advanced Integrated Microcontroller Training Kit *IOP conference Series Materials Science and Engineering* **180** 1 012107

[2] Li Y 2007 Teaching embedded systems using a modular-approach microcontroller training kit *World Transactions on Engineering and Technology Education UICEE* **6** 1

[3] Sheng X, Yin J, and Shang J 2011 An energy-saving control strategy on central air-conditioning system *Electricity* **22** 4 62-66

[4] Yanping Z 2011 Research and practice of course design on microcomputer principle and interface technology *Procedia Engineering* **15** 11 4211-4215

[5] Edi R, Faisal and Fajar 2014 *RaspberryPi, Mikrokontroler Mungil Serba Bisa* (Yogyakarta: Andi Ofset)

[6] http :// www dfrobot. Co. *LattePanda window 10 mini PC (2G/32GB). A Powerful Window.*