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# DESIGN, SIMULATION AND IMPLEMENTATION OF A PIC16F877A MICROCONTROLLER BASED DIGITAL FARE METER FOR CYCLE- RICKSHAW

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**Abstract**

This research focuses on the design of a digital fare meter for rickshaw a pulled vehicle in Bangladesh. Most rickshaw fare is determined on contract basis in different cities of Bangladesh. To digitize the fare system of this rickshaw a fare meter with PIC microcontroller will be made, this is the aim of this research. In this research, a reed switch is used to count the revolution of the front wheel. From this counting we can calculate the distance travelled of the rickshaw using the formula: Perimeter = 2*pi*radius of wheel. If once we know the distance we can easily calculate the fare depends on the tradition. To display the fare and the distance a LCD display is used and two push buttons is used to on/off the device and to reset the device. PIC 16F877A microcontroller is used to interface the LCD display, push button and the reed switch. This research mainly concentrates on designing the device with minimum amount of parts to minimize cost thinking about the capability of the poor rickshaw puller. By using Flowcode software, the required simulation will be done.

***Keywords:*** Rickshaw, fare meter, PIC, Flowcode, Reed switch.

## Introduction

Cycle rickshaws (রিকশা *rickshaw*) are the most popular modes of transport in Bangladesh and are available for hire throughout the country including the capital city Dhaka, known as the "Rickshaw Capital of the World" as well as in other cities of Bangladesh. The development of transportation seems to be declined the uses of rickshaw. In real its popularity decline for long distance but it is still popular for short distance transportation. Fare system of rickshaw is very much traditional. Passenger bargain with rickshaw puller according to nonfigurative distance for decide on fare. It sometimes creates some

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annoying situation. Both sides have some grumble. This grumbling situation can be solved by digitizing the fare system. Fare meter basically is an apparatus which is basically used in a vehicle to calculate and show the fare to the passenger. It is a automated system for deciding fare deepening on some parameter. In an automated vehicle there is a motor which rpm is mainly used to decide fare. But in this project we want to make a device for a pulled vehicle. So we have to make a mechanical system for counting the rpm of the wheel. This type of digital fare management system can be made using a microcontroller. It will be very cheap if we use PIC microcontroller as the CPU of the system and seven segment displays or liquid crystal display as display. For counting distance a sensor called reed switch is used, and the output of the sensor is fed in to the MCU. The MCU then calculate the distance and fare showing in a LCD display. This paper is organized in the following ways. Section two concentrated with the basic concepts of the system design. In Section three we described the concrete idea of PIC16F877A. Design and Implementation part is described in following section. The final section deals with the conclusion and future works.

**Rickshaw: An introduction**

Rickshaw one of the principal means of transport in the urban areas of Bangladesh. With the improvement of road communication throughout the country, rickshaw has now found its way into rural areas as well (index @ en.banglapedia.org n.d.). In Bangladesh we cannot think of a city life without rickshaw as a transport for short distance journey. Rickshaw is the only low cost transport system which is environment friendly and carbon-free, but it is slower than any mechanical transport. The rickshaw has become as a part of traditional Bangladeshi culture. Long before when rickshaw was first introduced it was a two-wheeled cart, pulled by people. There were two rods attached to the sides of the cart that extend to the front. Rickshaws can have one or two riders. Only two people can ride at one time. Mostly men pull the rickshaws through the crowded streets. In Bangladesh rickshaw differs from its originality. Bangladesh has adopted three wheeled rickshaw since 1940. (Baki, 2013)In fact, the Bangladeshi rickshaws we can call bicycle rickshaw or trishaw. But publicly in Bangladesh this bicycle rickshaw is called simply as rickshaw. This vehicle looks like a combination between a rickshaw and a bicycle. Instead of pulling the vehicle, the driver pedals in this vehicle. It has three wheels with one wheel in front of the driver and two wheels on the back side supporting the passengers. It's a light three wheeled cart comprising a door less, chair like body mounted on springs with a collapsible hood. The hood consists of a frame of four bamboo strips with steel fittings and bollards over which an oil skin cover is stretched. It is made of wood, fabric, metal and plastic. It is handmade by the artists and craftsmen.

**Fig.1.** A typical pulled rickshaw of Bangladesh

**Fare meter concept**

The fare of a rickshaw is decided on the basis of travelled distance and the road condition. The main concept of fare meter is to count the distance and depending on the distance the fare is decide on. In this paper, developed system is controlled by a high speed microcontroller with embedded logic that controls the display and input sensor, as well as setting measurement conditions and performing calculations (Simic, 2014). The sensor is used to count the revolution of front wheel. The sensor sends an input signal when the sensor becomes active. With this input signal by using the distance formula the single chip microcontroller compute the distance.(Mahmud, Alam, and Jobayer, 2013) After calculating distance the MCU calculate fare considering some issues. In case of fare there is a minimum charge irrespective of the distance covered. The total charge then calculated with minimum charge plus distance multiplied by fare rate. Extra charge should be added if the road conditions are bad or the weather is bad. On this principle the fare of a rickshaw is decided. In this system the rpm of the front wheel is calculated by means of a reed switch which is mounted on the body of the rickshaw close to the front wheel. A permanent magnet will place in the wheel in such a way it will cross the reed switch every time the wheel moves around. Every time of closing of switch means a revolution of the wheel. The reed switch is connected with the digital input pin of the MCU in one side and the other side of the switch is connected to the 5 volt power supply. As the magnet crosses the reed switch it will close the switch that will be sensed by the

microcontroller By counting this revolution the microcontroller then calculate the distance using he distance formula. Then the computed distance and fare are displayed in a 16×2 character LCD. The reed switch is set in stand of the front wheel and the magnet is tied with the central spoke. This design process is more effective and feasible as it is more economical, efficient and simple.

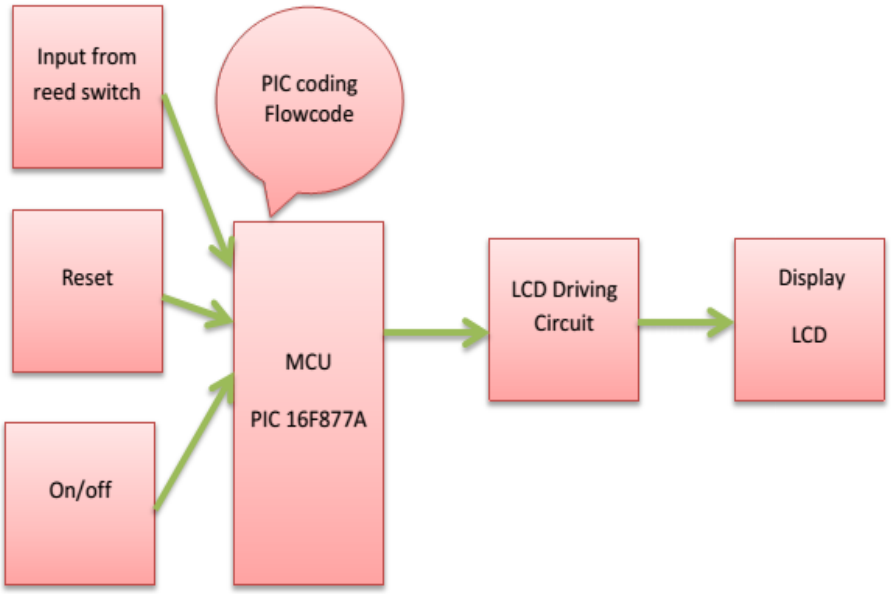


**Fig. 2.** Proposed Method for Digital fare Meter

The technique of fare meter system concentrated with some basic parts which are softly aggregated together in our proposed method. Fig. 2 represents proposed design of digital fare meter module. It includes the following modules. Basic descriptions of some modules are described in the following sections.

## Hardware design

### 1. Reed switch

A Reed Switch consists of two ferromagnetic blades (generally composed of iron and nickel) hermetically sealed in a glass capsule. The blades overlap internally in the glass capsule with a gap between them. As the magnet brought in to the proximity of the reed sensor or switch, the device activates. As the magnet removed from the proximity of the reed sensor or switch, the device activates. However the magnetic interaction in activating the reed switches.

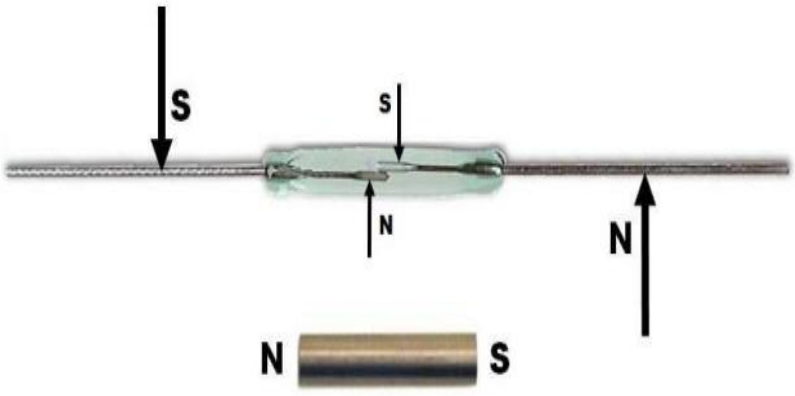


**Fig. 3.** The schematic of a reed switch

Contact is not necessarily obvious. The contact area on both blades is plated or sputtered with a very hard metal, usually Rhodium or Ruthenium. These very hard metals give rise to the potential of very long life times if the contacts are not switched with heavy loads. (Thomas, 2008).

## 2. Control unit design

This type of system can be manufactured by using logic gates. But some complexity arises during the design process. But complexity can remove by designing the system using microcontroller. Microcontroller is a chip that can be programmed to perform almost any control, sequencing, monitoring and display the function. It can be called a mini computer. Engineer's first choice for designing a automated system is microcontroller. Because of it is very cheap and available in any electronic shop. Microcontroller is designed in such a way that the chip contains input, output, memory and a processing unit. So It has great advantages. No other external components are needed for its application because all necessary peripherals are already built into it. Thus, if want to make a low budget device for saving components, cost , time, and space there is no alternative of microcontroller (Reza et al., 2010)The microcontroller is the heart of the proposed fare meter system . It constantly monitors the sensor reed switch and every time the switch activates the MCU counts it as the revolution of the front wheel. The MCU is to be programmed to calculate the distance and the fare. The LCD then display the value commanded by the MCU. For this system we use PIC 16F877A microcontroller chip because of its excellent features. Fig. 4 shows the pin configuration of the PIC 16F877A microcontroller.

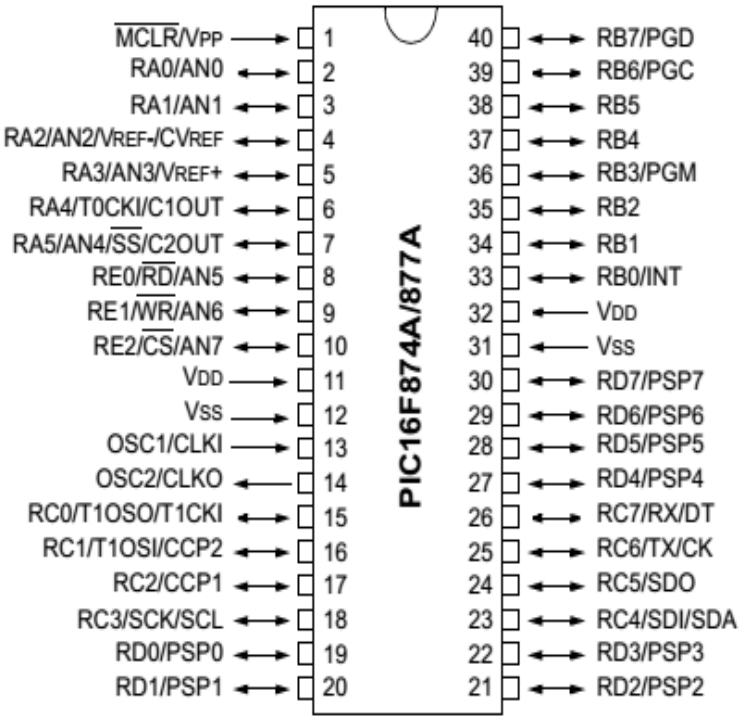


**Fig. 4.** PIC 16F877A microcontroller. (*Source:* www.microchip.com).

### 2.1 PIC 16F877A microcontroller: An introduction

PIC is the series of microcontroller ICs which was usually developed to control input output devices in a standalone expert system. PIC is a family of RISC microcontrollers made by Microchip Technology which is derived from the PIC1650 that is originally developed by General Instrument's Microelectronics Division. In an expert system PIC is the brain of the total system it acts like as the autonomic nervous system like a human being. Therefore, we propose a low cost 8-bit PIC16F77A microcontroller as a central controller of our system (Microchip, 1997).

### 2.2 PIC 16F877A internal architecture

The PIC 16F877A is a mid-range family of the PIC micro® microcontroller series. The program memory contains 1K words, which translates to 1024 instructions, since each 14-bit program memory word is the same width as each device instruction. The data memory (RAM) contains 68 bytes. Data EEPROM is 64 bytes. There are also 13 I/O pins that are user-configured on a pin-to-pin basis. Some pins are multiplexed with other device functions. (Microchip, 1997)

### 2.3 Memory Organization and other features

PIC16F87A microcontroller has two memory blocks available for use which are program memory and data memory. The program memory has 1024 memory locations with 14 bits width. Flash memory can be used to store the instructions. Flash memory can be updated for several amounts of times. So the large amount of program instructions and data can be rewritten in Flash memory. This is a non-volatile type of memory so the content of the memory will not be lost even after the power is switched off. Data memory contains the data address and programs state etc. it has been partitioned into special purpose and general purpose registers. The numeric values like integer and floating point values are stored in the data register. It can work as accumulator of the memory.

## 3. Display design

Liquid Crystal Display an acronym of LCD, revolutionized the present display technology with its versatility and weightlessness compared with the other technology. Modern digital equipment's is embedded with LCD for display. Now a day there is no alternative of it. A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. The LCD is used as a display for showcasing fare in BDT and distance in kilometre. There are various shape and size of LCD available depending on the configuration. A 16x2 LCD character display is very elementary module and is very frequently used in various systems. LCD is preferable to the user over seven segments and other display even in a small system. LCD can be used to display special character, small animations and even custom character. LCDs are cost effective; can be programmed easily.(Max, 2012) A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. There are two register available in a LCD named data and c0mmand register. Command instructions are needed to display character in LCD which is stored in the command register. A command is basically an instruction given to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the ASCII value of the character to be displayed on the LCD. For this system we use LCD-016M002B.it has the following features.

- 5 x 8 dots with cursor
- Built-in controller (KS 0066 or Equivalent)
- + 5V power supply (Also available for + 3V)
- 1/16 duty cycle
- B/L to be driven by pin 1, pin 2 or pin 15, pin 16 or A.K (LED)
- N.V. optional for + 3V power supply(Max 2012)

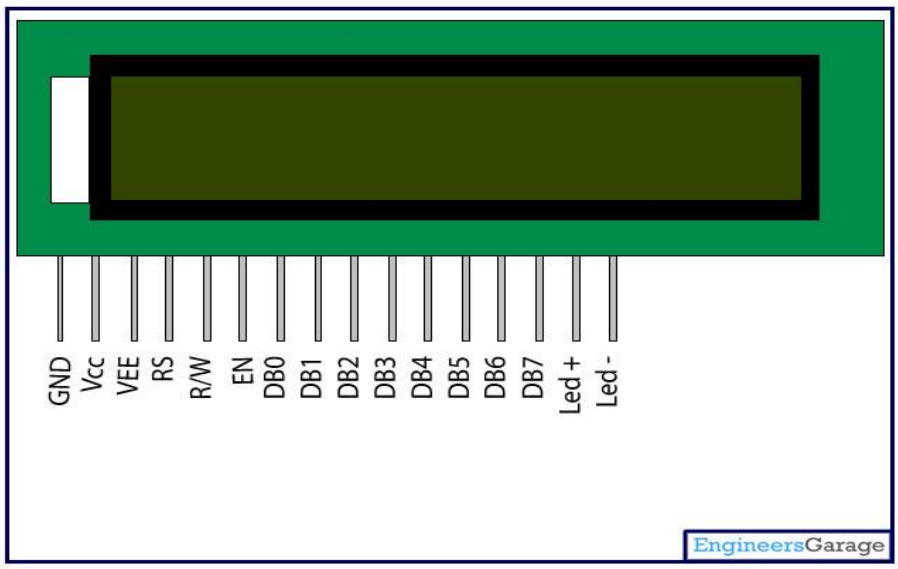


**Fig. 5. LCD-016M002B** character display. (*Source:* www.engineersgarage.com).

### 4. Others

We use a simple reed switch which is used for switching a +5V power supply. In our proposed system a permanent magnet is used to on off the reed switch which should be with the moving wheel.During the experiment we scotch to bind it on the wheel in such away so that it can control the reed switch. Since the main components of the system are on the brake section so we need a long wire from the reed switch.

## Software design

### 1. Flowcode

Flowcode is a Microsoft Windows-based development environment which is used for programming embedded devices such as PIC, AVR (including Arduino) and ARM using flowcharts instead of a textual programming language. It is commercially developed by Matrix TSL. It is currently in its seventh revision. Flowcode uses high level programming language dedicated to simplifying complex functionality such as Bluetooth, zigbee, RFID, Mobile Phones Communications, and USB etc. by using premade dedicated component libraries of functions. For speeding up software development Flowcode is therefore ideal environment. It saves time and allowing those with little programming experience to get started and help with projects. Flowcode is flowchart based and

components are simply dragged onto a chart before the program is compiled. Flowcode allows designer to design a complex PIC based control systems by simply drawing a flow chart of desired program. It is a matter of minutes even without any textual programming skills. Flowcode is built on a C compiler - C2C. This is a general purpose 8/16 bit compiler designed specifically for microcontroller devices. Flowcode generates a C code file from the flow chart created in Flowcode. This C-code is automatically compiled into assembler code by the C2C compiler and then ultimately translated into a Hex machine code file using Microchip's MPASM assembler. A PIC programmer can then be used to download the resulting Hex files into the target PIC's program memory. The programmer used is a powerful programmer for the PIC series of microcontrollers. Major parts of this programmer are Serial Port, Power Supply and Firmware microcontroller. Serial data is sent and received from 9 pin connector and converted to/from TTL logic/RS232 signal levels by MAX232 chip. A Male to Female serial port cable, connects to the 9 pin connector of hardware and the other side connects to the back of computer. If training and development boards are used then this whole operation of compiling assembling and downloading is carried out with one button, providing a totally seamless PICmicro development tool.

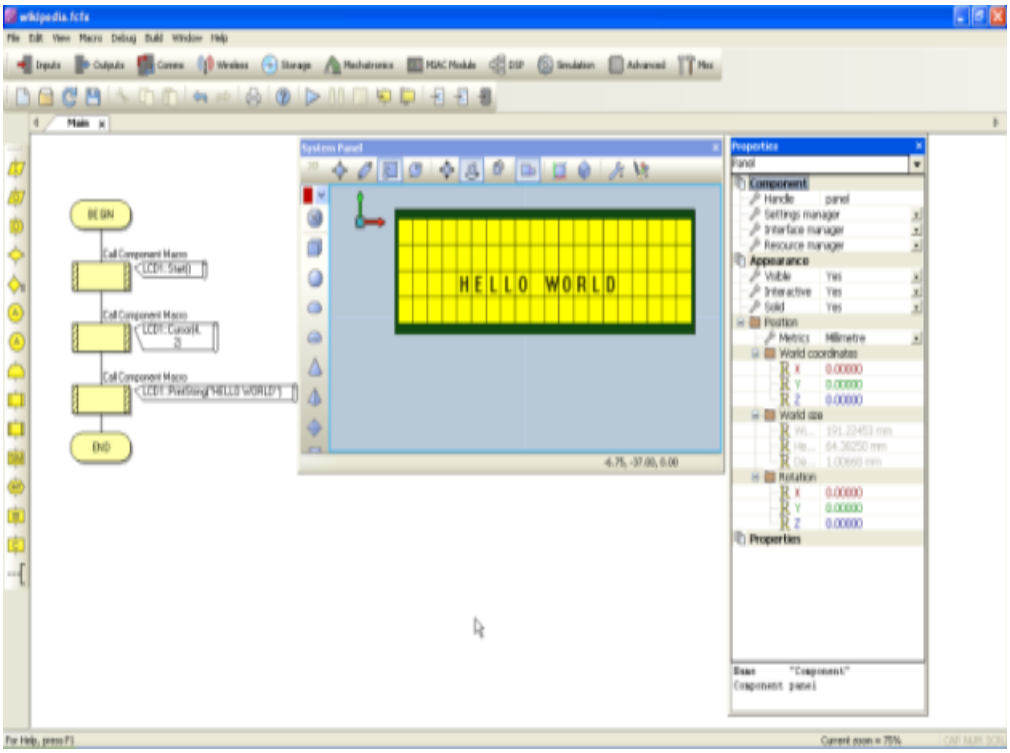


**Fig. 6.** Flowcode 5 environment running on DOS.

## 2. Flowchart for fare meter in Flowcode-5

**Step 1:**
- Launch **Flowcode** and start a new program

◊**Step 2:**
- Add two pushbuttons one is representing the reed switch and other is used to reset and a **LCD** component.

- Connect the **LCD** to **PORTB.**

-Connect 1st push button with 0th pin of **PORTA.**

-Connect 2nd push button with 1th pin of **PORTA.**

◊**Step 3:**
- Initialize the push button component for running the loop.

◊**Step 4:**

- Initialize two float variable for storing value of fare and distance in the loop

◊**Step 5:**
-Initialize the loop for calculating distance and fare.

◊**Step 6:**
- Initialize the LCD component

◊**Step 7:**
- Set the **LCD cursor** to column **two** and row **zero**

- Display the Distance in KM

◊**Step 8:**
- Set the **LCD cursor** to column **two** and row **one**

- Display the Fare in BDT.

◊**Step 9:**
- Repeat loop while the 2nd Push button state is high.

◊**Step 10:**
- Stop loop and reset value of variable to zero while the 1st Push button state is high.

## Testing

The physical realization of this work was carried out to achieve the conceived idea. Here the work will be seen not just on paper but also as a finished hardware. After carrying out all the paper design and analysis, the hardware was implemented and tested to ensure it's working ability and was finally constructed to meet desired specification.

## Result and Discussion

The design result was achieved as the LCD displayed fare and distance in two lines. One major problem was encountered during simulation. When execution time of Flowcode remain as usual the loop continuing without high state of 1st push button. But the problem can be solved by introducing a time delay of 1 second for push button state become high. The other problem is, when the vehicle moves in unusual manner like moves in an inclined road the revolution per minute become very high. The switching speed of the reed switch cannot synchronize with the revolution of the wheel. So cases like this the real count of revolution does not match with the count in the microcontroller. So sometimes give the wrong values. This problem can be solved by using a faster switch.

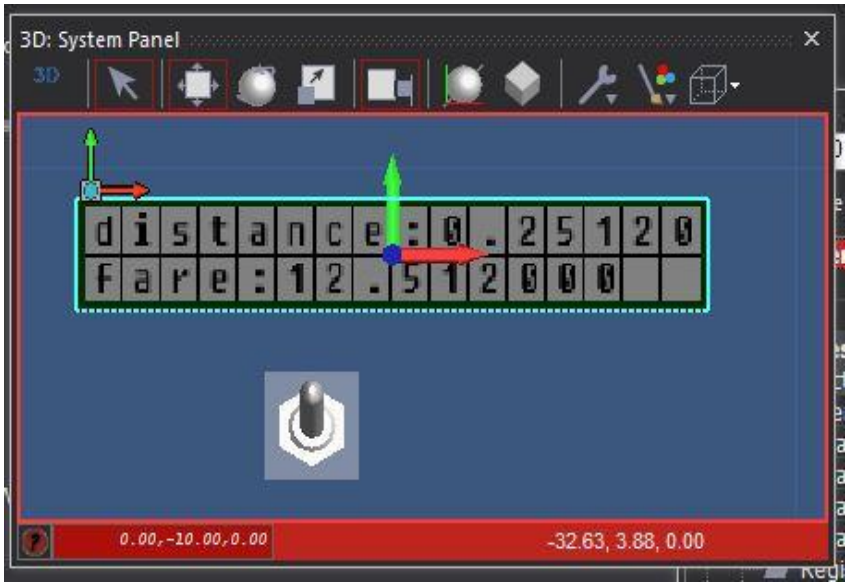


**Fig. 7.** Simulated result of proposed system.

## Conclusion

A step-by-step approach in designing a fare meter has shown that the system performance is quite reliable and accurate (Pradeep 2013). This work is a full-fledged real-time system. By developing this system many aspects of creating real-time system can be short out. No other system of similar style and scale exists in the knowledge of the system developer. When a instrument is designed trade-offs always exists. Fare meter has successfully designed and implemented for rickshaw. It definitely helps to save cost and time as compared to the conventional method (Shahidi, et al., 2013). There is a

switching speed issue in the proposed system. This issue is marked as very important task in future work. More detailed investigation and estimation of possible solution are necessary to ensure more accurate operation. Realized system concept can be used in a wide variety of commercial applications, so far but most of the method has some shortness in practice. Our intension of this research work was to establish a flexible, economical and easy configurable system for our poor rickshaw puller. We have been used a low cost PIC 16F877A microcontroller in this system which is the key point to reduce the cost. We have successfully simulated the system in Flowcode and therefore implemented in lab. This could have a substantial benefit from this research work for poor rickshaw puller.

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