Graphical User Interface for Electric Vehicle Charging Station

S.P.Ugale, Monali Tukaram Mandlik, D.M.Chandwadkar

Abstract: Electric vehicles are increasing day by day because of its low battery cost and good battery capacity compared to other technology. Increasing automotive growth in electric vehicles also increases the automation to use it.Graphical User Interface for electric vehicles with a full-blown touch screen will become more easy to use with the introduction of fast charging stations. The approach shown to build HMI use Texas Instruments kit and CCS software. The TM4C123GH6PM processors provide scalability it also provides different processing speeds along with the software which is compatible with hardware to build low and high end applications, and provides connectivity with various peripherals required for Electric Vehicle System Equipment HMI e.g. UART and CAN. Along with this processor touch screen display K350QVGA (Texas Instruments) is used to test the output screen

Index Terms*: *Human Machine Interface, Code Composer Studio, Texas Instruments.

I. INTRODUCTION

The market for electric vehicles (EV's) is emerging where the interest is higher than ever before (Office of Energy Efficiency & Renewable Energy, 2016) [1]. The global activity concerning EV's is increasing due to the strive of reducing greenhouse gases (NASA, 2016), as well as car batteries are getting more efficient than before The EV's on the market are today charged with a cord that is plugged into the car. The negative aspects with the cord is that it reacts badly to altering weather and air temperatures, as well as if forgetting to plug-in; the car will be powerless. As the number of EV is increasing day by day on the other hand charging demand also increases. Hence, the charging infrastructure as well as efficient Inductive Power Transfer (IPT) need to developed to meet such requirement for substantial operation of the EVs. For instance, in [2] the United States (US), and Bhutan has taken initiative to build charging stations in different regions to provide easy charging services and promote the growth of electric vehicles.

The installation of charging stations will add burden on the power grid, and the high charging loads of fast EV charging stations will degrade the distribution network and its operating parameters. The uncoordinated charging of EV's will degrade the voltage profile, peak load during EV charging and some of the harmonic distortions. Delayed Charging also provides some consequences similar to Uncontrolled Charging. In the industrial automation human-machine interaction plays an important role, the user interface is the process where interaction between humans and machines takes place [2]. The major goal of user machine interaction in human machine interface is effective operation of machine and easy control of machine and feedback/status of operations from the machine which signals the operator to make different operational decisions accordingly. In other words, The HMI gives easy way to interact with machine by using its instruction coding language and get our work done by machine. It also provides how hardware and software systems can be designed to expand the human control. Before HMI was introduced it include the Batch Interface, Command Line User Interface, and the Graphical User Interface (GUI) for industrial automation applications, which is used nowadays in HMI display panels to make user friendly system.

HMI control panels of any system includes

(1) The pushbuttons and control buttons

(2) The data handler

(3) Different LED's and light indicator.

This paper mainly focus on building graphical user interface for electric vehicle charging station. Many approaches to build GUI is discussed in later section. Final implementation is carried using Code Composer Studio IDE and hardware kit from Texas Instruments. This Graphical User Interface provides basic operation required to charge EV with different options for charging or payment to the user. Moreover this application can be further used with mobile application to book the charging slot or search for free charging station nearby etc.

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Prof. Dr. S. P. Ugale, Electronics and Telecommunication, KKWIEER, Nashik,India.

Monali T. Mandlik, Electronics and Telecommunication, KKWIEER, Nashik,India.

Prof. Dr. D. M.Chandwadkar, Electronics and Telecommunication, KKWIEER, Nashik, India.

II. LITERATURE SURVEY

A. 40V-96V DC Quick Charger for TATA EV, Mahindra Reva, everito and E2O from MassTech.

Fig. 1.HMI display screen of DC charging station of MassTech

MassTech DC charging station is mainly uses SETQCY series for fast charging of electric vehicle.IP54 standard is used to design the product and install with waterproof and dustproof. This DC fast charging station has charging interface, human-machine interface, system communications, billing and other parts, modular design, installation is easy, simple operation and maintenance, and the charger with the use of electric vehicles outdoor DC fast charge ideal choice. [9].

B. GT-PQ 45K 450 -12 by Electway

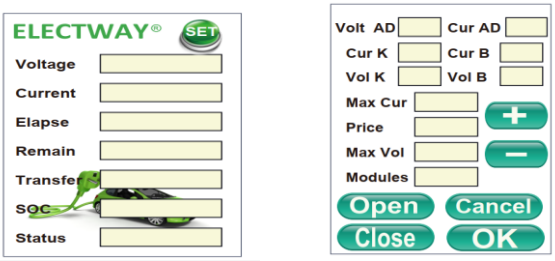


Fig. 2.HMI display screen of DC charging station of Electway

DC charger comply with the CHAdeMO technology to charge EV.different protocols are used to communicate between off board conductive charger and battery management system to meet the CHAdeMO 0.9 version. The charger may communicate with battery management system (BMS) of the electric car, it may complete charging according to the message of the BMS.

C. EVlink quick charging stations from Schneider electric

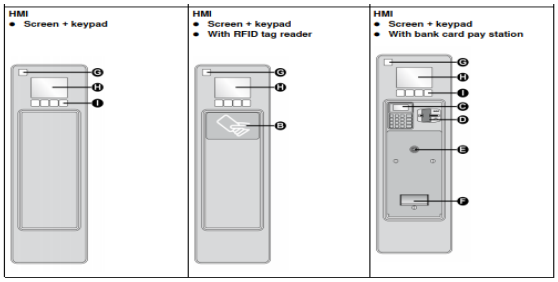


Fig. 3.HMI display screen of Schneider Electric DC charging station

The above fig. shows the EVlink quick charging stations with 50 kW charging power. This charging station allows vehicles compatible with this version to recharge the EV in less than 20 minutes. Following are the features of EVlink quick charging station [10].

1. Simple graphics interaction between user and charging station to indicate remaining charging time.
2. Management of charging process.
3. Inbuilt locking of socket during charging
4. Stop push button during emergency.
5. Data transmission is carried through wired or wireless media. Data includes charging data, charging start or stop.
6. Special provision for payment of charging through bank card.

D. Comparison of Phi Hong EV DC Chargers

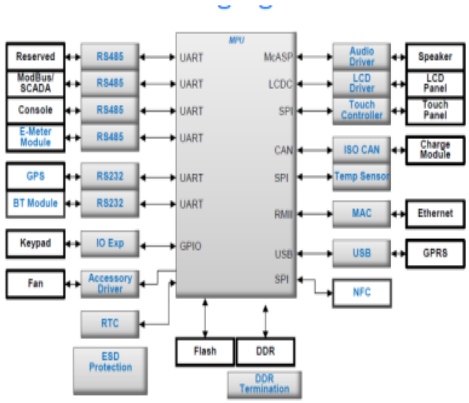
	20kW / 40kW	60kW / 80kW / 100kW / 120kW (single gun)	60kW / 80kW / 100kW / 120kW (dual gun)	60kW Integrated type DC Charger-Dual guns	60kW / 80kW / 120kW Integrated type DC Charger-Four guns	15kW Wall-mounted DC Charger
Display	7" HMI or 10.4" TFT-LCD touch panel	7" HMI or 10.4" TFT-LCD touch panel	7" HMI or 10.4" TFT-LCD touch panel	7" HMI or 10" TFT-LCD touch panel	7" HMI or 10" TFT-LCD touch panel	7" HMI or 10" TFT-LCD touch panel
Push buttons	Start, Stop, Emergency Stop	Start, Stop, Emergency Stop	Start, Stop, Emergency Stop	Emergency Stop	Emergency Stop	Emergency Stop
User authentication	RFID system	RFID system	RFID system	RFID	RFID	RFID
External com.	Ethernet	Ethernet	Ethernet	Equipped with Ethernet, Wifi. Optional: 2G / 3G / 4G	Equipped with Ethernet, Wifi. Optional: 2G / 3G / 4G	100M Ethernet inlet, 3G / 4G / Wifi

	20kW / 40kW	60kW / 80kW / 100kW / 120kW (single gun)	60kW / 80kW / 100kW / 120kW (dual gun)	60kW Integrated type DC Charger-Dual guns	60kW / 80kW / 120kW Integrated type DC Charger-Four guns	15kW Wall-mounted DC Charger
Internal communication	CAN,RS485	CAN,RS485	CAN,RS485	CAN,RS485	CAN,RS485	CAN,RS485
Message					Charging procedure and status Warning and alarming	Charging procedure and status Warning and alarming

E. Comparison of different Touch Technology

	Capacitive touch	Resistive Touch	IR touch	Surface Acoustic Wave touch
I/P method	Finger, gloved	Finger,gloved,pen	Finger,gloved,pen	Finger, gloved
Multitouch	Yes	Limited	Yes	No
Surface Hardness	>9H	<3H	>9H	>9H
Size Recommended	6.4"to 32"	6.4",8.4",10.4",12.1"	8"to150"	Good for all sizes
Cost	High	Low	Moderate	Moderate
Touch Controller	High	Low	Moderate	Moderate
Durability	High	Low	High	Low

III. BLOCK DIAGRAM OF HMI PANEL



- ARM Cortex-M4 micro-controllers is the central processor to carry out different operations and provides top performance as well as integration with different hardware with rich communication features. Many inbuilt modules which provides rich HMI application is included in TI Tiva C-series cortex M4 controller [6].this controller has Ethernet controller facility.
- HMI board includes 7 TFT LCD with Capacitive/Resistive Touch Panel.it can have parallel interface of 16 bit or extended upto 24bit. Features of display screen include 7" size with 262k colors, resolution of 800X480, this controller has inbuilt LCD interface controller which reduces design complexity.
- In HMI communication protocol is important for real time application hence Ethernet can be used for such purpose. It allows you to connect and communicate with one or multiple HMI or between HMI and any PLC's present on the field.
- To save the HMI data USB Host or USB OTG can be used to store data in Pen drive or any hard drive. This board has two USB port with 480Mbps speed.one is USB 2.0 and other USB OTG 2.0.it supports different types of data transfer.

IV. HARDWARE SOFTWARE OVERVIEW

A. Tiva TM4C129XL Launchpad

The Tiva C Series Evaluation Board TM4C129GXL has ARM Cortex M4 as the main Controller.it is low cost platform for various applications. The Tiva Launchpad includes TM4C123GH6PMmicrocontroller,USBinterface(2.0),motio n control PWM module.it also includes user buttons and LED(RGB) that can be programmed according to the custom application. The Evaluation board has two stackable headers (40pin booster pack connector) that is used to interface the different Booster pack directly. There is no need of any external wire interface for such booster pack and other peripherals. Debug USB port on right side of board is used for program debugging.USB micro connector is used to connect board with the system.

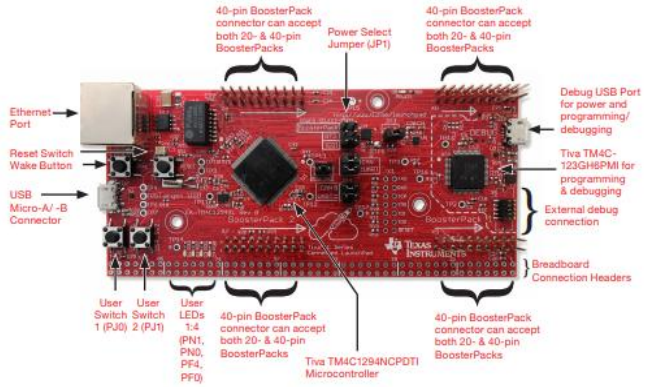


Fig. 4.TIVA Evaluation board

B. Touch Screen Display

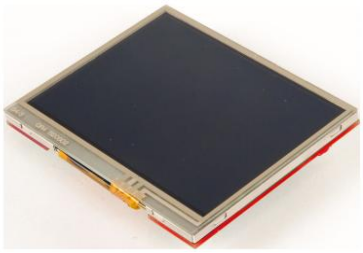


Fig. 5. BOOSTXL-K350QVG-S1 Boosterpack

The K350QVGA display is a booster pack from TEXAS Instruments which can be directly used with any Launchpad or evaluation board.it is easy to use and easy to plug in module. This module can be directly used with microcontroller to develop applications which needs touch screen color display for displaying output parameters.it has resistive touch screen. The basic features of this display is listed below, includes,

Key Features:-

1. Kentec TFT LCD (part number: K350QVG-V2-F)
2. Display Size of 3.5-inch QVGA
3. Resolution of 320×240
4. Communication (SPI)
5. Resistive Touch Screen (4 wire)
6. White LED backlight with driver circuit
7. It is compatible for use with 20/40 pin launch pads

C. Code Composer Studio Ide

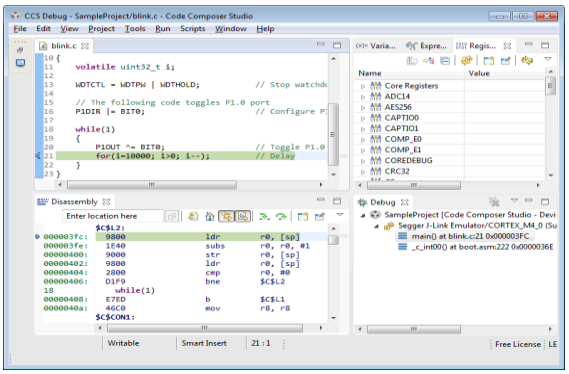


Fig. 6.CCS IDE Window

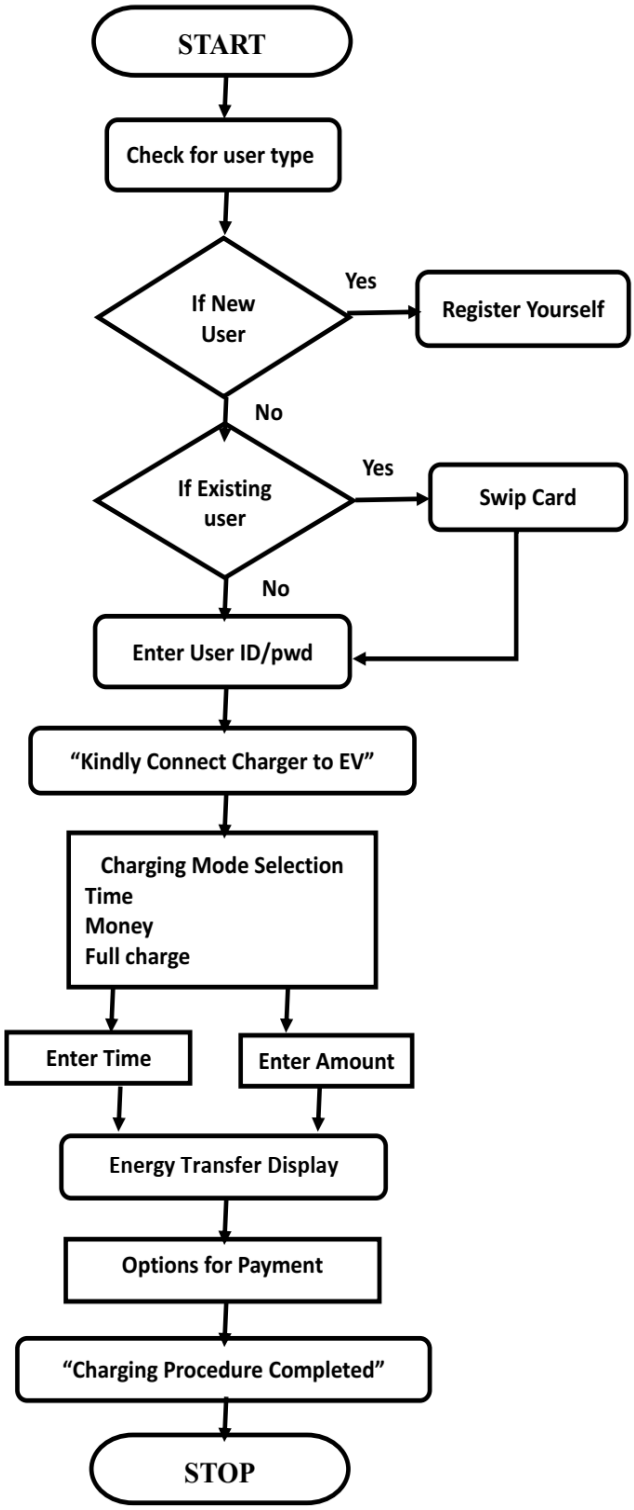
- TI's Microcontroller and Embedded Processors supports Code Composer Studio as IDE.
- Various embedded applications can be developed and debug using different tools of Code Composer Studio. Tools of CCS includes an optimizing C/C++ compiler, source code editor, project build environment, profiler, debugger and many other features.
- This IDE provides good step by step user interface starting from program building to debug interface. This feature allows user to get easier and faster start to build any application.
- Code Composer Studio has two advantages of Eclipse software and debug capabilities of embedded to have rich development environment for developers.

V. EXPERIMENTAL SETUP

Fig. 7.Experimental Setup for Implementation

The above fig. shows the experimental setup for this application project. The touch screen display from Texas Instruments is used to show results.TM4C123GH6M Launchpad is used to interface this display. Coding is to be done using code composer IDE which provides a better solution for Texas kit to be easily interfaced and use for any application

VI. FLOW OF SYSTEM



VII. RESULTS

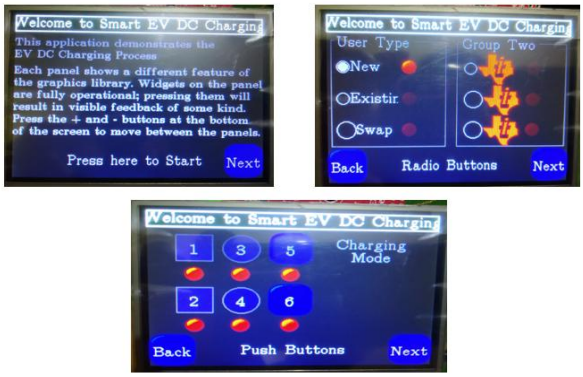


Fig. 8.Display screen output on K350QVGA touch screen

The above fig.shows some of the output screen display that will be used at electric vehicle charging station. Code composer studio is used for coding and designing of graphical user window.

VIII. CONCLUSION

This paper introduced the building of human machine interface using Texas controller and code composer studio and also selection of HMI screen based on different selection criteria from different manufactures. The literature activities showed that resistive touch is best for this application hence K350QVGA touch screen is used to test the display output. Code composer studio provides a good interface with Texas instruments kit and booster pack which makes the design more simple and easy to use.

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AUTHORS PROFILE

Prof. Dr. Sunita P. Ugale is working as an Associate Professor in E&TC department of K.K.W.I.E.E.R, Nashik, Maharashtra since last 20 years. She pursued Bachelor of Electronics Engineering from the K.K.W.I.E.E.R Nashik. She has completed her Masters of Technology from DOEACC, Aurangabad and her Ph. D. from S.V. National Institute of Technology, Surat.
Her special fields of interest include Fiber Optics Communication, Optical Sensors and VLSI technology. She has published more than 50 papers in various National and International Journals and conferences. She is working as a reviewer for various international journals and conferences.Dr. Patil has published 3 books titled "Electrical Circuits & Machines" February 2005 by Central Techno Publication, Nagpur, Fiber Optical Communication: Systems and Components",1st ed., Wiley India,(2012) and Fiber Optical Communication: Systems and Components", Precise text book for AKU, Wiley India,(2014). She bagged "Lady Engineer Award" from Institution of Engineers' (India) - Nashik in 2008.She has worked as Board of Studies member of Electronics Engineering for Pune University. She has received research grant from Department of science and technology of India, DHI New Delhi and BCUD.

Monali T. Mandlik is a Student of Masters of Engineering (VLSI and Embedded System) at K.K.W.I.E.E.R Nashik, India.

Dr. Dinesh M. Chandwadkar is a Professor and head of E & TC Department at K. K. Wagh Institute of Engineering Education & Research, Nashik, India. Signal Processing, Power Electronics, Mechatronics, and Automotive Electronics etc. is his major area of interest. He has published many research papers in reputed Journals. He is working as Board of Studies member of Electronics and Telecommunication Engineering for Pune University. He is working on a research project " Technology Pilot for DC charging of EV Bus", funded by, DHI New Delhi.