eRickshaw: The Auto Rickshaw with Electric Motor

An Alternative to Gas-Powered and Pulled Rickshaws.

Introduction and Challenge

Electric rickshaws are becoming more popular in Asian cities because of their low fuel cost and environmental friendliness compared to internal combustion rickshaws.
Electric rickshaws are mostly manufactured in India and China.
The eRickshaw is a project by Robert Bosch Engineering and Business Solutions Ltd., a 100 percent owned subsidiary of Robert Bosch GmbH, offering end-to-end engineering, IT and business solutions. It is the largest Bosch software development center outside Germany.

Approach

Bosch Connected Devices and Solutions GmbH (BCDS) is committed to driving the Internet of Things (IoT) forward on a global scale. BCDS provides innovative approaches to sensor devices, data transfer, the cloud, and integration with other services. In 2016, BCDS introduced the Cross Domain Development Kit (XDK), an integrated software and hardware platform for embedded solutions. The XDK contains multiple microelectromechanical systems (MEMS) sensors from Bosch Sensortec and Akustica, both fully owned subsidiaries of Robert Bosch GmbH, who specialize in MEMS sensors and microphone solutions, bringing digital awareness to new customer products. With the XDK, BCDS supports IoT concepts by simplifying IoT prototyping, assisting users to develop their own new product ideas as quickly as possible.

Use Case
Low-cost sensors are needed to implement road safety features, such as Electronic Stability Control (ESC) and traction control of the wheels (TCS) for the eRickshaw vehicles. An accelerometer measures the acceleration of the vehicle. A gyroscope sensor controls tilt and roll-over. A real-time operating system (RTOS) has to read input from the vehicle such as throttle setting, brakes, and steering angle to further control the wheel hub motors of the eRickshaw. This prototype from Bosch uses the XDK to cover these requirements. It serves as a main control unit and supports rapid application software development through real-time debugging.

> "Since the time given for rapid prototype development was limited, we decided on an in-house Bosch product with ready-to-use software. The XDK really fits in with our eRickshaw application. All the required sensors are part of the product. The XDK speeds up our whole development process up to the building of prototypes and their commercial exploitation," he explained.
> **Developer Kai Clemens Liebich, Automotive Electronics (AE), a division of Robert Bosch Engineering and Business Solutions Ltd.**

Since the eRickshaw runs on a 48V battery, a DC-DC converter is used to power the XDK. The developers used the accelerometer and gyroscope readings to define the stability of the vehicle, which is necessary for integrating ESC and TCS features and an antilock braking system (ABS). All of these systems are implemented through torque vectoring. The XDK is the main control unit, and fetches the data from the sensors. It calculates a real-time vehicle model based on a Kalman filter, and executes the algorithms for all the driver assistance systems.

The data from the accelerometer and gyroscope are also read to control through the Controller Area Network (CAN bus). For this purpose, the XDK is connected to the vehicle CAN bus via an external CAN controller, and communicates with the electronic control units (ECUs) of all three hub motors.

The XDK is used as a Vehicle Control Unit in the eRickshaw to control the components of the bodywork electronics and its functions. No further microcontroller is needed, because the application software is embedded on the microcontroller unit.

The Role of Bosch Connected Devices and Solutions
The booming IoT industry, with all its networking and control solutions, is in the focus of BCDS's activities. With the XDK, BCDS provides an answer to many questions that arise around innovative IoT applications. All major sensors are already included in this all-in-one kit, and further sensors can be connected with an included add-on board.

This modular concept also applies to the software. Every buyer of the XDK can download the XDK Workbench free of charge. This includes typical applications and a community with forums and tutorials. The software modules that are available here can be applied immediately or modified by professional users.

BCDS additionally acts as a cooperation partner for the series production of IoT projects developed using the XDK. As an innovative company, Bosch Connected Devices and Solutions can draw on extensive sensors and software solutions experience. By combining our expertise with partners from different business entities, including Bosch Sensortec and Akustica, we enable new value propositions and new ways to create value.

Solutions and Benefits
This use case demonstrates how the XDK, with its on-board accelerometer and gyroscope sensors, is a possible solution to integrate vehicle input data and road safety features into the eRickshaw. It shows the XDK's potential for quick software development for any vehicle prototype. As a smart energy device that communicates via Bluetooth, the XDK enables smart mobility for the eRickshaw at low cost, offering great scope for IoT enhancement and establishment.

Conclusion
Electric rickshaws will be widely accepted as an alternative to conventional auto rickshaws. If introduced in a systematic manner, battery-run rickshaws could provide a low-emission complement to an existing and popular vehicle that is already on the road. With its fast acceleration and steering wheel angles of up to +/- 90 degrees, the eRickshaw is also a very flexible and swift means of transport.

The various sensors included in the XDK, such as the accelerometer and gyroscope, show a way for the eRickshaw to be equipped with safety systems such as ABS, TCS and ESC so that it becomes a safer means of transport. The XDK is also attractive because it provides readily available base software for this application.

The eRickshaw is just one example of how this Bosch-internal product can serve as a prototype accelerator for the IoT. In principle, the XDK can fulfill this function in all sensor-based IoT applications.

About Bosch Connected Devices and Solutions
Bosch Connected Devices and Solutions GmbH is based in Reutlingen, Germany and is a 100% owned subsidiary of Robert Bosch GmbH. As an innovative company, it serves the new market for the Internet of Things. We offer compact electronic devices, comprehensive software and end-to-end solutions in many fields of application. Our main businesses are in the areas of Connected Mobility and Industry 4.0 and Logistics. We improve everyday life, increase comfort, security and productivity.

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