2026 Volume: 02 Issue: 06 www.ijrpa.com ISSN 2456-9995 Research Article

International Journal Research Publication Analysis

Page: 01-08

DESIGN AND DEVELOPMENT OF A CAN–MODBUS COMMUNICATION GATEWAY FOR INDUSTRIAL IOT APPLICATIONS

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Article Received: 26 April 2026
Article Revised: 16 May 2026
Published on: 05 June 2026

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DOI: https://doi-doi.org/101555/ijrpa.7670

ABSTRACT

Industrial Internet of Things (IIoT) applications require efficient communication among devices operating on different industrial protocols. CAN (Controller Area Network) and Modbus are widely used communication standards in industrial automation systems. However, interoperability between these protocolsremains a challenge due to differences in message formats and communication mechanisms. This paper presents the design and development of a Multi-Protocol Communication Gateway that enables seamless communication between CAN and Modbus networks. The proposed gateway performs protocol translation, message routing, and data exchange between industrial devices and PLC-based systems. Experimental results demonstrate successful bidirectional communication, reliable protocol conversion, and improved interoperability. The developed system reduces hardware complexity, lowers implementation cost, and supports Industry 4.0 requirements.

KEYWORDS: Industrial IoT, CAN, Modbus, Communication Gateway, Protocol Translation, Industrial Automation.

INTRODUCTION

The rapid growth of Industrial Internet of Things (IIoT) Technologies has transformed the way industries monitor, control, and optimize their operations. Modern manufacturing facilities employ numerous devices such as Programmable Logic Controllers (PLCs), sensors,

actuators, Human Machine Interfaces (HMIs), and supervisory control systems. These devices often communicate using different industrial communication protocols, creating interoperability challenges. CAN(Controller Area Network)is widely used in industrial and auto motive applications because of its reliability, high noise immunity, and real-time communication capabilities. Modbus is one of the most commonly adopted industrial communication protocols used in PLCs, SCADA systems, and industrial controllers. Although both protocols are extensively used in industrial environments, interoperability between CAN-based devices and Modbus-based systems remains a challenge.

Traditional solutions require multiple protocol converters, which increase system complexity, maintenance requirements, and deployment costs. Therefore, there is a need foraunifiedcommunicationgatewaycapableoftranslatingandexchangingdatabetween CAN and Modbus networks.

The proposed Multi-Protocol Communication Gateway acts as an intermediary communicationplatformthatenablesseamlessdatatransferbetweenCANdevicesand Modbus-basedindustrialsystems.Thesystemcontributestoimprovedinteroperability, reducedhardwarerequirements,andenhancedscalabilityforIndustry4.0applications.

Literature Review

Several researchershave proposedcommunication gatewaysto improveinteroperability among industrial devices. Singh et al. developed an industrial gateway capable of protocolconversionforautomationsystems.Theirworkdemonstratedtheimportanceof integrating heterogeneous industrial networks to improve operational efficiency.

Chen and Wang proposed an IoT gateway architecture supporting multiple communicationstandardsforindustrialmonitoringapplications.Theirstudyhighlighted the significance of protocol translation and remote monitoring in Industrial IoT environments.

Other studies have focused on Modbus-based communication systems due to the widespread adoption of PLCs in industrial automation. Similarly, CAN-based communicationarchitectureshavebeenextensivelyresearchedfortheirfaulttolerance, high-speed communication, and real-time performance.

However,manyexistingsolutionssupportonlyalimitednumberofprotocolsandoften requireexpensivecommercialhardware.Theproposedworkaddressestheselimitations by

integrating CAN and Modbus communication within a single gateway architecture.

ProposedSystem

Theproposedsystemisdesignedtoestablishcommunicationbetweendevicesoperating on CAN and Modbus protocols. The gateway continuously monitors incoming communicationchannelsandprocessesdatapacketsaccordingtoprotocolrequirements.

Thesystemconsistsoftwocommunicationinterfaces:

- CANInterface
- ModbusInterface

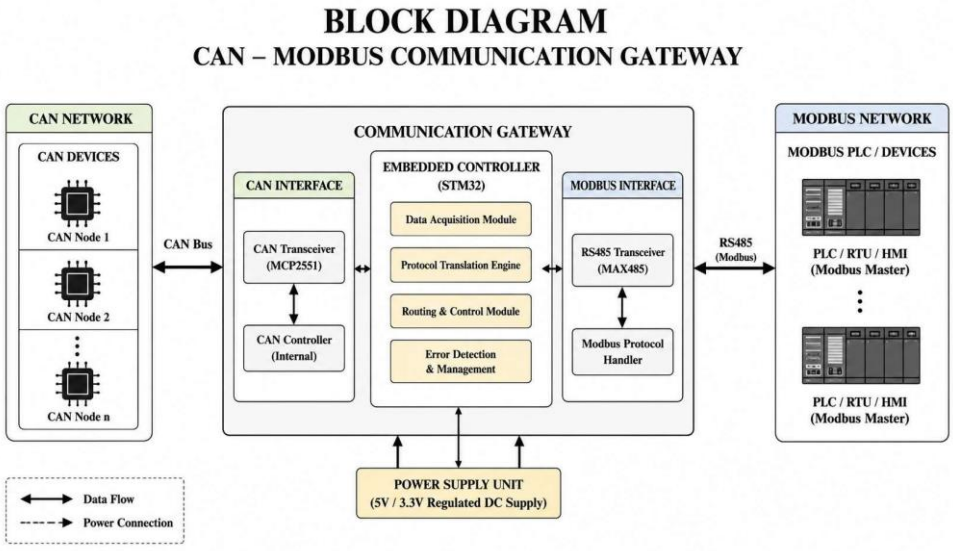
Aprotocoltranslationengineservesasthecentralprocessingunitofthegateway.When a data packet is received from a source network, the gateway identifies the communicationprotocolanddecodesthereceivedmessage.Thedecodedinformationis then translated into the required destination protocol format.

Forexample:

- Datafrom aCANdevicecanbetranslatedintoModbusformatforPLC communication.
- Datafrom aModbusPLCcanbeconvertedintoCANmessagesforcommunication with CAN-based industrial devices.

Thegatewayensuresaccurateprotocolconversionwhilemaintainingcommunication reliability and minimizing latency.

Block Diagram



Working Principle

Theoperationalflowoftheproposedgatewaycanbesummarizedasfollows:

1. Initializeallcommunicationinterfaces.
2. Continuouslymonitorincomingcommunicationchannels.
3. Detectthesourcecommunicationprotocol.
4. Receiveanddecodeincomingdatapackets.
5. Validatepacketintegrityanderrorconditions.
6. Convertdataintotherequireddestinationprotocolformat.
7. Routetheconvertedmessagetothetargetcommunicationinterface.
8. Monitortransmissionstatusandcommunicationperformance.
9. Repeattheprocessforsubsequentpackets.

Thisapproachenablesseamlesscommunicationbetweenheterogeneousindustrial devices and networks.

RESULTS AND DISCUSSION

Thedevelopedgatewaywasevaluatedunderdifferentcommunicationscenarios involving CAN devices and Modbus-based PLC systems.

The experimental results demonstrated successful protocol translation between all supported communication standards. Data packets transmitted from CAN devices were accuratelyconvertedintoModbusmessagesandsuccessfullyreceivedbyPLCsystems. Similarly, information generated by Modbus PLC systems was reliably translated into CAN messages and transmitted to CAN-based devices.

Thesystemexhibitedhighcommunicationreliabilityandstableoperationduringtesting. The use of a unified gateway significantly reduced hardware requirements compared to conventional solutions that rely on multiple dedicated protocol converters.

Theresultsconfirmthattheproposedgatewaycaneffectivelysupport IndustrialIoT applications requiring communication among heterogeneous industrial networks.

Result Table

Parameter **ObservedResult** CAN Communication Successful Modbus Communication Successful CANtoModbusConversionSuccessful ModbustoCANConversionSuccessful Communication

ReliabilityHigh

ComparisonofExistingSystems

Parameter	ExistingSystems	ProposedGateway
NumberofProtocolsSupported	1	2(CANandModbus)
ProtocolTranslation	Limited	FullSupport
PLCIntegration	Partial	Complete
Real-TimeCommunication	Moderate	High
Scalability	Medium	High
Cost	High	Low
Industry4.0Compatibility	Partial	High

System Architecture

The proposed Multi-Protocol Communication Gateway is designed to facilitate communication between CAN and Modbus networks. The architecture consists of CAN andModbuscommunicationinterfacesconnectedtoacentralprotocoltranslationengine. The gateway continuously monitors communication channels, processes incoming messages, performs protocol conversion, and routes translated data to the destination network.

The CAN interface is responsible for receiving and transmitting CAN frames from industrial devices and machine controllers. The Modbus interface provides communication with PLCs, HMIs, and industrial monitoring systemsthroughRS485 communication.

Theprotocoltranslationengineservesasthecorecomponentofthesystem.Itinterprets incoming messages, validates packet structures, extracts data fields, and converts them into the required destination protocol format. A routing module determines the destination network and forwards the translated data accordingly.

Thearchitectureprovidesinteroperabilityamongheterogeneo industrial networks while maintaining communication reliability and scalability.

Hardware Components

Embedded Controller

The embedded controller acts as the central processing unit of the gateway. It manages protocoltranslation,dataprocessing,routingdecisions,andcommunicationmanagement.

CANTransceiver Module

TheCANtransceiverenablescommunicationwithCAN-basedindustrialdevices.It converts

controller-level signals into CAN bus signals and vice versa.

RS485CommunicationInterface

The RS485 communication interface provides support for Modbus communication. It enableslong-distancecommunicationandallowscommunicationwithPLCs,RTUs,and industrial monitoring devices.

Power Supply Unit

Thepowersupplyunitprovidesregulatedvoltagetoallsystemcomponents.Stable power delivery is essential for reliable operation of communication modules and processing units.

Experimental Results

TestScenario1:CANtoModbusCommunication

Data generated by CAN devices was successfully translated into Modbus messages and receivedbythePLCsystem.Thecommunicationprocessdemonstratedreliableprotocol conversion and stable operation.

TestScenario2:ModbustoCANCommunication

DatafromModbus-enabledPLCsystemswassuccessfullyconvertedintoCANframes and transmitted to CAN-based devices. The gateway maintained accuratedata transfer and low communication delay.

The experimental evaluation demonstrated successful bidirectional communication betweenCANandModbusnetworkswithhighreliabilityandminimalpacketloss.

Advantages

- SupportscommunicationbetweenCANandModbusnetworks.
- Reducestheneedformultipleprotocolconverters.
- Improvesinteroperabilityamongindustrialdevices.
- EnablesefficientdataexchangebetweenPLCsandCAN-basedsystems.
- Reducesinstallationandmaintenancecosts.
- Providesascalableplatformforfutureprotocolintegration.
- SupportsIndustry4.0andIndustrialIoTapplications.

Applications

- IndustrialAutomationSystems
- SmartManufacturing
- PLCMonitoringandControlling
- ProcessControlSystems
- FactoryAutomation
- Industry4.0Deployments

FutureScope

Future enhancements may include integration of wireless communication technologies such as Zigbee, LoRa, and MQTT. Additional industrial protocols such as OPC UA, Ethernet/IP,andProfinetcanalsobeincorporatedtoimproveinteroperabilityandsupport advanced Industry 4.0 applications.

Cloud-basedmonitoringsystemscanbeincorporatedtosupportremoteaccessanddata analytics. Artificial Intelligence and Machine Learning algorithmscanbeimplemented for predictive maintenance and fault detection.

CONCLUSION

This paper presented the design and development of a Multi-Protocol Communication Gateway for integrating CAN and Modbus communication networks. The gateway enablesseamlesscommunicationamongheterogeneousindustrialdevicesbyperforming protocol translation and data routing. Experimental evaluation demonstrated reliable communicationandsuccessfulinteroperabilitybetweenCANdevicesandModbusPLC systems.

Theproposedsolutionreduceshardwarecomplexity,lowersimplementationcosts,and supportsIndustry4.0requirements.Thegatewayoffersascalableandflexibleplatform for future industrial automation and Industrial IoT applications.

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