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Sudan University of Science and Technology
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Development of Smart Microcontroller by Using Zigbee Wireless Technology

تطوير متحكم ذكى باستخدام تقنية الذبذبة النحلية اللاسلكية

A thesis submitted as partial fulfillment for the degree of M.Sc. in Electronics engineering (Computer).

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الايه

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" اللَّهُ نُورُ السَّمَاوَاتِ وَالْأَرْضِ مَثَلُ نُورِهِ كَمِشْكَاةٍ فِيهَا مِصْبَاحٌ الْمِصْبَاحُ فِي زُجَاجَةٍ الزُّجَاجَةُ كَأَنَّهَا كَوْكَبٌ دُرِّيٌّ يُوقَدُ مِن شَجَرَةٍ مُّبَارَكَةٍ زَيْتُونِةٍ لَّا شَرْقِيَّةٍ وَلَا غَرْبِيَّةٍ يَكَادُ زَيْتُهَا يُضِيءُ وَلَوْ لَمْ تَمْسَسْهُ نَارٌ نُّورٌ عَلَى نُورٍ يَهْدِي اللَّهُ لِنُورِهِ مَن يَشَاء وَيَضْرِبُ اللَّهُ الْأَمْثَالَ لِلنَّاسِ وَاللَّهُ بِكُلِّ شَيْءٍ عَلِيمٌ"

صدق الله العظيم

سورة النور

الايه 35

Dedication

To
my
family
this
work
is
dedicated.

Hisham Abdelrahim
August 2010

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Very exceptional thanks to ALLAH for all his precious and valuable gifts including giving me the chance to do this thesis; I would like to thank him for his unlimited generosity and mercy.

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Abstract

The adoption of wireless communications based on Low-Rate Wireless Personal Area Network ZigBee technology (designed to control and monitoring in real time) in civil and industrial applications has increased rapidly in recent times. Due to several reasons include, low cost, low power consumption, ease of use and installation. In this thesis the establishment of a practical system for monitoring and remote controlling of temperature of power transformer using ZigBee wireless technology has been accomplished, the system will initially measure the temperature, and then sent these values to the centralized computer to calculate the required response to activate or de-activate the cooling fans of the power transformer. The system was established and designed by using a computer work station with graphic interface to control the phases of operation and communication; moreover, ZigBee wireless chips were used, in one side these chips have been connected to computer work station and on the other side it has been connected to microcontroller. Temperature sensors and light emitting diodes have been used to represent inputs and outputs of microcontroller. After installation and completion of all installation and programming works the system has worked successfully.

المستخلص

اعتماد تقنية الاتصالات اللاسلكية قصيرة المدى المبنية على تقنية الذبذبة النحلية (المصممة للتحكم و المراقبة فى الزمن الحقيقى) فى التطبيقات المدنية و الصناعية قد ذادت بوتيرة سريعة فى الاونة الاخيرة, لاسباب عدة منها التكلفة الاقل و قلة استهلاك الطاقة وسهولة الاستخدام و التركيب. فى هذا البحث تم انشاء نظام عملى للمراقبة و التحكم عن بعد فى درجة حرارة زيت محول قدرة باستخدام تقنية الذبذبة النحلية اللاسلكية, يقوم النظام فى البداية بقياس درجة الحرارة, بعد ذلك يتم ارسال هذه القيم لبرنامج فى حاسوب مركزى, ليقوم الحاسوب بحساب الاستجابة المطلوبة لفصل اوتشغيل مراوح التبريد لمحول القدرة. تم انشاء النظام وتصميمه باستخدام حاسوب مركزى ذو واجهة بينية للتحكم فى مراحل التشغيل و الاتصال, تم ايضا استعمال شرائح اتصال لاسلكى تعمل بتقنية الذبذبة النحلية, اوصلت هذه الشرائح بكل من الحاسوب المركزى من جهة والمتحكم الدقيق من جهة اخرى, تم اضافة محسسات حرارة كمداخل للمتحكم الدقيق. ودايودات ضوئية كمخاج وذلك لتمثيل الاستجابة للتغيير فى درجة الحرارة. بعد تجهيز واكمال جميع اعمال التوصيل و البرمجة تم تشغيل النظام و قد عمل بنجاح.

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List of abbreviations

Acronym	Stand for
AIB	Application Support Layer Information Base
AES	Advanced Encryption Standard

AF	Application Framework
APDU	Application Support Sublayer Protocol Data Unit
APL	Application Layer
APS	Application Support Sublayer
APS-IB	Application Support Sublayer-Information Base
APSDE	Application Support Sublayer Data Entity
APSDE-SAP	APSDE-Service Access Point
APSME	Application Support Sublayer Management Entity
APSME-SAP	APSME-Service Access Point
ASDU	APS Service Data Unit
CAP	Contention Access Period
CCA	Clear Channel Assessment
CFP	Contention-Free Period
CSMA-CA	Carrier Sense Multiple Access with Collision Avoidance
DSSS	Direct Sequence Spread Spectrum
ED	Energy Detection
FFD	Full-Function Device
GTS	Guaranteed Time Slot
LR-WPAN	Low-Rate Wireless Personal Area Network
MAC	Medium Access Control
MANET	Mobile Ad hoc Network
MFR	MAC Footer
MHR	MAC Header
MLME	MAC Layer Management Entity
MLME-SAP	MAC Layer Management Entity Service Access Point
MPDU	MAC Protocol Data Unit
MSDU	MAC Service Data Unit
NLDE	Network Layer Data Entity
NLDE-SAP	Network Layer Data Entity Service Access Point
NLME	Network Layer Management Entity
NLME-SAP	Network Layer Management Entity Service Access Point
NPDU	Network Layer Protocol Data Unit
NSDU	Network Service Data Unit
NWK	Network Layer
PAN	Personal Area Network
PC	Personal Computer
PD	PHY Data
PD-SAP	PHY Data Service Access Point
PHR	PHY Header
PHY	Physical Layer
PIB	PAN Information Base
PLME	Physical Layer Management Entity
PLME-SAP	Physical Layer Management Entity Service Access Point
PSDU	PHY Service Data Unit

PPDU	PHY Protocol Data Unit
QOS	Quality of Service
RF	Radio Frequency
RFD	Reduced Function Device
SAP	Services Access Point
SSP	Security Services Provider
WLAN	Wireless Local Area Network
ZDO	ZigBee Device Object