THE INTELLIGENT HOUSE

By

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CHAPTER 1: INTRODUCTION

The Intelligent house also called the smart house or automated house is one of the advance technologies, which represent the intelligent building in smaller scale. It is under high activities of development all over the developed world, as this subject is getting more and more advanced to serve the human being, achieving auto operation, monitoring, remote control features, which serve the targets of reliability, energy saving, safety and even serve the disable people.

This research aims to study and design a Malaysian intelligent house with its sensors and its integration to the appliances as complete economic and reasonable solution, based on a survey will be conducted in Malaysia for different people of different education and income. In the same time, analyze the DTMF (dual tone multi frequency) signal generated by the normal phone for the purpose of local and remote control to the intelligent house- like switching light, air conditioner., garage gate On/Off…etc locally and remotely applying the digital wireless transmission technology, which solve the problem of wiring hassle in the already constructed houses. The study will also take into consideration the cost effectiveness, with the possibility of achieving final ready to use product.

- INTELLIGENT HOUSE DEFENTION

The intelligent house is a group of integrated modern technologies working together to achieve a certain degree of auto operation, monitoring and local & remote control, the target for those technologies is to achieve the human comfort, satisfaction and safety.

The realization of the intelligent house requires the participation of experts in different fields: building developers, designers and building automation experts should work closely with information technology, telecommunications and artificial intelligence specialists to achieve the best results serving the user who has the last say in the choosing or rejecting those technologies.

The aim of making everyday life easier and smoother, maintenance and safety, and power saving represent the background factors for the successful residential intelligence, where those factors represent the human values, which should be transferred to intelligent machines and structures. So the smart house offers a comfortable, safe, economic way of life giving a chance for the disabled people the opportunity to live among others.

The successful intelligent house meet the needs of the house owner where the huge number of equipments does not guarantee the house will be

intelligent enough to cover the requirements of human being or it may be more intelligent than the house owner need, as what happen when the whole intelligent building technologies transferred to the small scale intelligence of a house. But in general the successful intelligent house should be:

1. Modifiable to meet any new requirements.
2. Integrative to let the all systems work in one harmony.
3. Informative by giving all the data needed.
4. Secured from any hacking activities
5. User friendly to avoid feeding up.
6. Healthy and safe.
7. Productive and cost effective.
8. Very well designed based on the correct fundamental solutions.

The concept of Home Automation and Networking is to connect all of these systems and devices together on a network so that they can be controlled with a common interface and react to each other

- **HOUSE CONTROLLED ELEMENTS:**

The home elements can be divided into 5 main groups, which represent the main appliances group available in most of the residentional houses:

Lighting, Appliances and Climate Control – This will include the individual room lighting, external lights. And the air-conditioning and ventilation…etc.

Security Systems - security components like doors and windows sensors and locks, motion detector, plus video monitoring etc.

Entertainment Systems - Audio, video, theater equipment located throughout the home.

Communication Systems - Telephone, intercom, and internet.

Data Systems - Multiple PC's and other data devices.

The concept of Home Automation and Networking is to connect all of these systems and devices together on a network so that they can be controlled with a common interface and react to each other to achieve the intelligence required. As simple examples; if the house owner taking bath, watching important movie or have meeting, the phone calls should be transferred to the answering machine and other unneeded lighting should be switch off or dimmed.

In order for these devices to communicate with each other there must be a connection either via a wire or some sort of:

Communication media. Because each system has different requirements of communication speed and volume of information to be communicated, different media is necessary depending on the application used and how fast it generates or receive the data.

In general the existing media is:

Power line - The existing home's electrical wiring system already connects lights and appliances together and has outlets throughout the home. Its limitations as a network medium relate to the capacity of the wire (low speed and bandwidth). Currently it is used for Lighting and appliance networks as well as some security applications. New developments in technology are introducing communication and data to the powerline network.

Phone Lines - Most homes have several telephone outlets already in place. This wire is suitable for voice communications, data and even entertainment networking with new technologies and applications developing swiftly.

Radio Signals (Wireless) - standards and technologies are evolving wireless solutions which may include R.F. transmission or infra red…etc .to control the traditional lighting, appliance and security networks communication together with data and some entertainment systems.

Structured Wiring - New or renovated homes may install modern wiring systems to provide the capacity for current and future networks. A typical wiring system will include RG-6 (coaxial) wire for multi room entertainment systems, CAT 5 wire for data and communications as well as special wiring for speakers, home controls etc. Fiber optic cable is also being installed in some homes for future capacity.

For the purpose of appliances communication, they should talk the same language or the same **network protocol:** where there is so many protocols existing in the market now as explained in Fig.1, the important fact which have to be mentioned here is: that there is no standard protocol yet, those different protocols all working and used protocol in intelligent house technologies around the world and they differ from one to other in their performance, speed, bandwidth and cost.

This mess in the market cause strong protocol competition which it is lost of time and effort.

As the devices communicate with each other, there will be a important need for this network to communicate with the outside world through the:

Residential Gateway: which allow the network to receive and transmit data to the outside world, where we can get the remote control and monitoring features and also download the entertainment and information needed to the home.

The last but probably most important element(s) of the Home Network is the:

User interface: that provides a homeowner the device to communicate with and control the network. Again ... there will probably be a series of devices to handle this job and the choices are personal as well as technical. Traditional networks use touch pads and/or remote control devices. The telephone is becoming another interface of choice allowing both manual and voice control in some instances. Of course the PC keyboard and mouse are also human interfaces that are widely popular. As technology advances, new interfaces are being developed ... for example a control screen included in the door of a refrigerator or the entrance etc.

- **GENERAL REVIEW**

Home Electronic System (HES) :

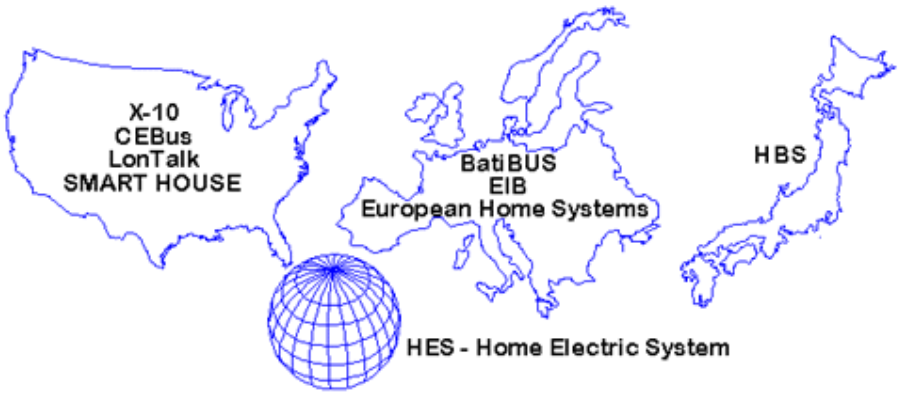

Fig.1: The Major used protocols around the world.

HES is a standard under development working group controlled by ISO (International Organization for Standardization) and IEC (International Electrotechnical Commission) of Geneva, Switzerland. The HES working group is part of the subcommittee entitled Interconnection of Information Technology Equipment, which include 20 principal member and 13 observer

from most of Europe, UK, Canada, and United States to develop the HES standard.

HES goal is to specify hardware and software to the manufacturer might offer one version of product that could operate on variety of home automation network. To achieve that, HES is specifying the following components:

1. Universal interface: which can communicate between the home appliance and any home automation network.
2. Command Language: between appliance-to-appliance communications regardless the network which carry the messages.
3. Home Gate: which links the home control network with the external service provider.

HES APPLICATION MOUDLE:

HES describe the engineering aspect of the application model device as can read, written or executed via a home automation network, where the importance of deciding the spec. and transfer it to the manufacturers to produce a product linkable to home automation network.

No major protocol includes complete application models, and the interface communication should be fully understood by the manufacturers and communication designers.

FUNCTIONAL SAFTY

The Advisory Committee of Safety (ACOS) of the IEC requested HES to develop the guidelines of safety on home automation network. Which means that all safety critical messages sent over the network must be confirmed and the device should maintain appropriate safety levels in case of network failure, thus IEC defines the functional safety as the ability of a home control system to carry out the actions necessary to achieve and maintain an appropriate level of safty both under normal conditions and in case of a fault or hazard.

HOME ELECTRONIC SYSTEM COMPONENTS

1. THE UNIVERSAL INTERFACE:

The primary goal of HES international standard is to allow the appliance to communicate with the home network. The appliance will incorporate a universal interface (UI) that includes data plug.
Each point of connection to the network will contain a network access unit (NAU) to convert the data signals and appliance messages to a particular home automation communications protocol. HES specifies the communications protocol between the UI and the NAU.

2. HES APPLICATION LANGUAGE:

The new application language for HES allow the UI to operate on all home networks, where the challenge will be to specify the UI-NAU link the minimize the interface cost without impeding network performance.

3. HOME GATE:

This is on of the important elements of the home network which translate between WAN protocol (the outside word) and the LAN protocol (home network) which should contain firewall features to prevent the home network from and undesired and unauthorized in/out messages, HES working on specifying the firewall provisions as a part of the gateway specification.

PROGRESS ON INTERNATIONAL STANDARD:

The progress on the international standards is low, where the current focus on standardize the protocol, which encourage the protocol competition, such competition is wasting time, resources, confusing market players and delaying the industry. (HES point of view), while the primary objectives should be stimulate consumer interest.

Siemens home phone Development:

Siemens announce that they are developing telematic systems for the mass market based on the existing "Residential Gateway" feature phones.
Under article named: **Turning a home phone into a multifunctional remote control center,** published in the Trace R&D center web site, Siemens will demonstrate the existing euroset 845 feature phone, equipped with a special upgrade for the remote control of household appliances. The home phone prototype allows you to do this from any telephone, thus becoming a "residential gateway"? A comprehensive switching center? which combines information technology and communications.
Siemens developers paid especially close attention to making the functions of this prototype easy to use. Even the installation is simple: the telephone has a serial V.24 interface which transmits the control signals by radio to modules, appliances, incoming service cables, or a PC. At the other end, this prototype connects the home telemetry equipment to the public telephone network.
using a telephone keypad. You can even determine the equipment status (on or off) from any location, the Residential Gateway allows you to forward an automatic alarm to any phone number if something out of the ordinary happens, such as a window breaking.
According to Siemens Manager Kurt Aretz, "the Residential Gateway is a prime example of how information technology and communications are merging." The standard V.24 PC interface enables a virtually unlimited number of applications to be activated or accessed from a remote location.

The house which Microsoft building:

Here is the biggest challenge announce by Microsoft, as Jay Green in his article published in the news of the academic search elite on the 22nd August 2002,
As Microsoft launched the windows XP in Oct. 2001, then the Xbox, now the Microsoft corp. willing to invade the home networking by selling routers that link PC's to game consoles, T.V. and other house hold devices, with wired and wireless connections kits. The expected cost of the wireless broadband router is 250 U.S.D, Microsoft willing to defend its place in the home networking services against intrusions by others.
Microsoft vision is not only connecting the home devices and appliances to each other but to connect to the net, downloading music, fast internet, paying bills, instant messages.
Mike Wolf an analyst with industry researcher in stat/MDR, warns the competitors should be worried.

Chapter 2: Survey

For the purpose of understanding the true need of the Malaysian citizens, a survey was conducted with the forms contains as below: and the results was expected and as brief the economic solution that cover the major important items in the house is enough to get limited control on that house or buildings and the proposed solution is using DTMF frequencies generated by the normal phone to the limited required control. Kindly refer to the below outcome.

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Subject: MALAYSIAN INTELLIGENT HOUSE SURVEY

Dear Sirs, Madams

For the purpose of better understanding the above subject, and the fulfillment of the degree of Master of Sciences, we would highly appreciate your participation in this survey.

Your cooperation and assistance is highly appreciated

Thank you

Yours truly,

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Name of the Participant:…….. ……(Not necessary)

Occupation: ……(necessary)

Imagine that you have the choice to buy an automatic system for your house, where you can control and monitor lights, Aircon, doors, security, etc... locally and remotely.

1. How much (Malaysian Ringgit) you are willing to pay for such system?

   1000 5000 10000 20000

2. Which one is preferred to you: to save around 30% of your electricity monthly bill or to enhance the security in you house so your house will be protected against intruders, fire, or water leakage?

   Save electricity Enhance security

3. Would you like to control every single light and items inside your house for RM 15,000.00 or are you satisfied with 12 main items for RM 1000?

   Every single item 12 items will be good enough

4. To control your smart house remotely, would you prefer to use a computer from an office or cyber café or would you prefer to use a telecom phone or hand phone?

   Computer is better Phone or h/p better

5. Would you like to monitor your kids, old parents remotely by Internet camera, or even monitor if there is an intruder in the house?

   Yes No

6. **General questions**: kindly tick in the proper position (based on the priority) on the systems which you would like to have it in your house, (Knowing that there will be a cost for each system):

No	System	Very Important	Important	Not so important	Not important
1	Auto and remote switching for indoor and external lighting.				
2	Auto and remote control on your air-conditioning.				
3	Smoke detectors for early fire detection.				
4	Warm your food remotely before reaching the house.				
5	Lock your main doors remotely by phone.				
6	Motion detector to detects intruders				
7	Mosquito and pets repellent system.				
8	Operate your lights by sound.				
9	Weather station inform you about temp., humidity, and wind speed.				
10	Remote warning if your house water tanks leaks.				
11	Robotic floor cleaning system.				
12	Garage door auto-opening.				

Q1: how much willing to pay	1000	5000	10000	20000
Q2: save electricity or security	Saving ele.	security		
Q3: how many item	every item	12 item		
Q4: control by computer or H/P	computer	hand phone		
Q5: remote camera monitor.	yes	no		
Q6: General questions				

No	System	Very important	Important	Not so important	Not important
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12	Garage door auto-opening.				

Development

- **RESEARCH Problems:**

1. **The 24 hours connection to the Internet and the cost related to this arrangement and the busy telephone line equipped.**
2. **The 24 hours connection to a booted computer and the power consumed by the computer and the problem of computer hanging will disable the whole internal and external control.**
3. **The high cost of network and gateway …etc.**
4. **The two different protocols between the internet and house protocol**
5. **The need for a computer in the remote area, which make it unhandy tool for control.**

The proposed Solution:

1. Using the DTMF frequency generated by the normal phone or hand phone as a common language with the outside world with no hassle or much problem as the house will talk the same language with outside world.
2. As the researcher will try to implement a module of control through the phone using DTMF signals generated by the phone it self, it highly expected that there will be a problems to solve and considered as listed hereinafter:

    - The solution should cover reasonable no of equipment.
    - The ability to switch on and off remotely and locally.
    - The ability to provide the status of the appliances as per the requirements.
    - Avoiding the hassle of wiring by wireless control will advantage.
    - No side effect on the public network.
    - Covering the need of disable people will be advantage.
    - Reporting about any emergency will be essential for security reasons.

In fact it was found after deciding the target of this research that semeins already develop(as a manufacturer and market producer) the idea of this research by developing the normal phone with a certain technology to be the residential gateway (in different words using the DTMF as communication language with outside world as it is detailed in the latest news in the review of previous studies, however since

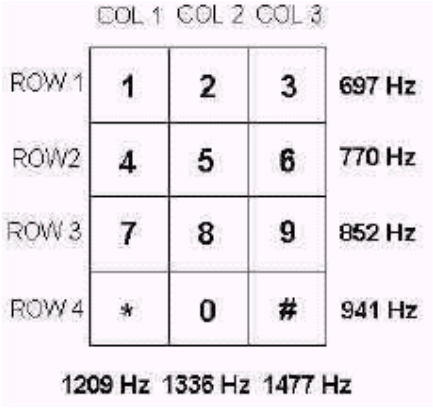
this technology is unknown to the researchers, I found there will be no conflict to continue in the direction which I start in the beginning.

After detail study to the hardware, datasheet, previous works, It was found that the solution as it is in the block diagram-Fig.2 will cover that requirements and prove the theory.

The above Development advantages

1. There is no need for network
2. There is no need for computer
3. There is no need for gateway for the purpose of remote control
4. Cost effective
5. Simple battery backup enough to keep the system running
6. Remote control facility
7. Easy to control from any hand phone or normal DTMF phone from any place in the world.
8. (On) confirmation as per the international requirements.
9. Serve the disable people through the wireless facility.
10. Cover the security doors and windows sensors.
11. Not effected by any interference.
12. In the future development can provide message to the hand phone as: (your house door broken) or (your mother need help) or even linked to the computer for further development.

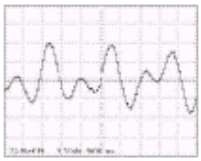
As the researcher will try to implement a module of control through the phone using DTMF signals generated by the phone itself, it highly expected that there will be problems to solve.



Sample of the frequencies generated by the telephone Keypad

Key	Row Frequency (Hz)	Column Frequency (Hz)
0	1336	941
1	1209	697
2	1336	697
3	1477	697
4	1209	770
5	1336	770
6	1477	770
7	1209	852
8	1336	852
9	1477	852

Table of the frequencies generated by the telephone Keypad



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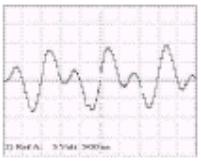

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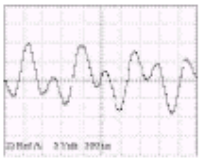

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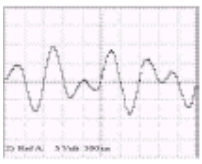

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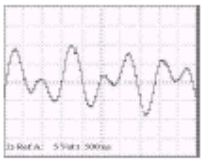

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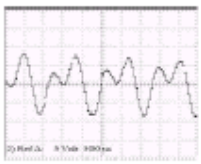

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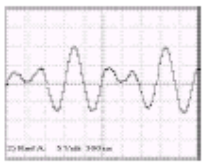

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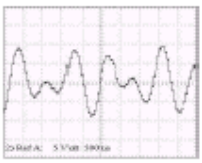

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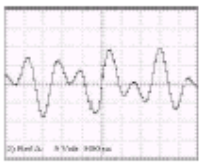

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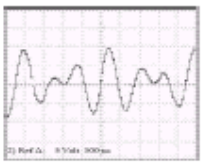

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Graphics of the frequencies generated by the telephone Keypad

Chapter 4 : Methodology

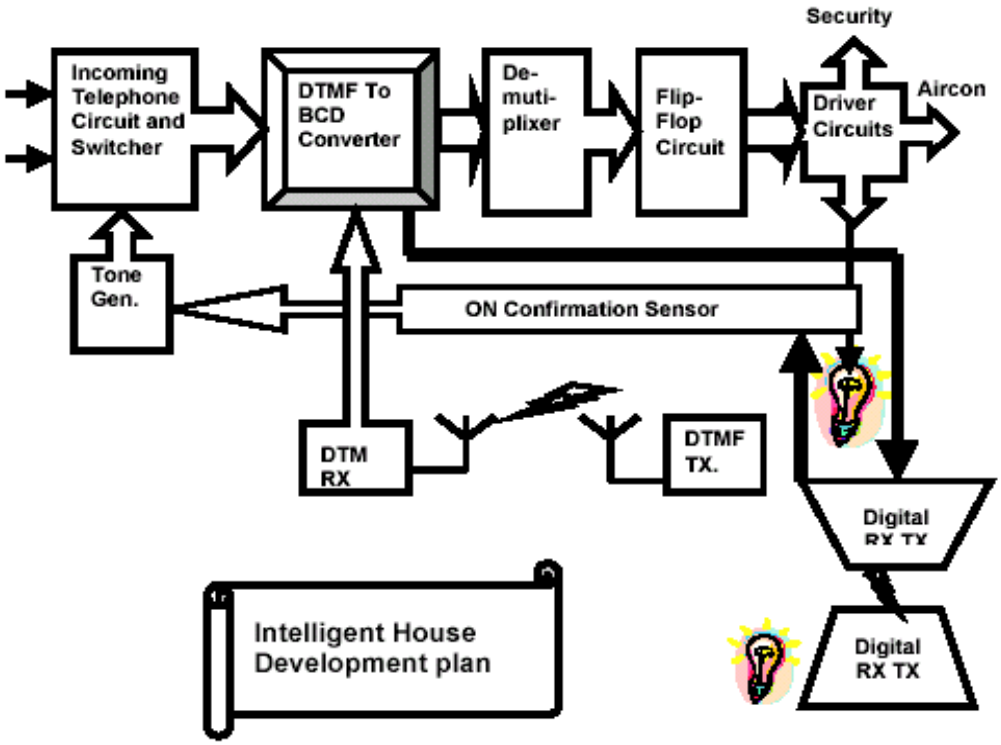

Fig. 2

Diagram Description:

Starting by receiving the tone by circuit isolation – to avoid effecting on the public network, the DTMF tones received will be analyzed from tones or frequencies to BCD output, where it will multiplexed to get more outputs, and fed to the flip flop circuit to maintain the status, this signal can be fed also to a digital transmitter / receiver to control wireless items. One of the important issues that the status of the controlled item should feedback the confirmation tone that item responded to the order, to comply with standard requirements.

CHAPTER 5 **:** CONCLUTION & RECOMENDATIONS FOR NEW DEVELOPMENT WORKS.

1. The network and server should not be included in the p.c. which need the pc to be on 24 hr but should use an alternative of micro controller which can be easily back up by a simple battery, while pc used to program the controller only and removed.
2. To study the firewall in home network and hacking activity in the home network as it may cause serious problems, imagine that somebody open your door by hacking your home network, in addition to the virus attacks which may come from the outside world.
3. This research did not use the new micro controller available in the market now, where I found there is good space for the future developers to work on this subject to work on the software and hardware to implement network and intelligent tasks using the same principle of DTMF.
4. The speed of the internet as the gate to the outside world is still very slow to carry all the smart house functions especially the video camera images where we cannot get live video from our house to other remote point.

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