Research for the Intelligent Carpet System and Smart Application Based on Sensor Technique

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Abstract. With Internet of things technology quickly development, sensing technology becomes extremely core frontend technology. This paper mainly focuses on studying pressure sensor's property and specification by comparison way, then developing the intelligent control technique between the pressure sensor and controller, finally combing the sensor and carpet based on the indoor application design. The paper puts forward an innovative intelligent carpet system. This distinctive design idea and application method must be of useful guidance significant and practical implication to coming smart life.

Introduction

Since IBM firstly providing new concept of Wisdom of the Earth, Internet of things (IOT) technology has become one key attention in the field. Scientists try to using various methods for developing new techniques so that realize the intellectualization on human life. In whole IOT system, sensor technique is indispensable part. It is as core technique for adopting frontend data

In term of pressure sensor technique, there are many sorts of sensors based on the material and electric component. No matter what is resistance type sensing technique or Holzer sensing technique, it is essential point to design the adaptive sensor to match applied environment and purpose. This is just key factor to promote the intrinsic value of sensor [1,2]. This paper mainly conducts studying for pressure sensing technique, afterwards analyzing pressure sensor functionality, property and specification, then designing the pressure sensor as key component in intelligent carpet system, meanwhile combining the auto-control technique by chip CPU, finally designing the applied indoor environment based on the networking things . That intelligent carpet system could be expandable applications in all indoor situations such as office building, hotel and house etc. It devotes an innovative significance for the smart work and life.

Intelligent Analysis and Comparison

Pressure Sensing Technique Analysis

Generally in human body, the hands of body bear most functionalities in routine work, study and daily life. Comparatively speaking, the feet of body take less function for labor and life except for the walking and standing etc. This paper makes use of natural property of feet and creates the bigger value for human smart life.

As far as pressure sensing technique, its main working mechanism is that results the sheet metal length and sectional area change in sensor conductor when external gravitation forced on the sensor surface [3]. Moreover its change obeys the following pressure sensing principal:

$$R = p L / S \tag{1}$$

Hereby, R is resistance value (Ω). p represents metal conductor resistance factor ($\Omega \cdot cm^2/m$). S shows sectional area of metal conductor (cm^2). And L conveys length of metal conductor (unit m). Obviously sensor resistance value is change with external pressure. When applied pressure on sheet metal, its length is enlarge, while its sectional area is decreased. Then the resistance becomes bigger.

Vice versa its resistance value is smaller. Regarding to this principle, it is only need to measure the resistance value, finally it deducts to get the pressure value on sensor. Thus achieves the goal for getting pressure data [4].

In general, there are many types of pressure sensor such as load type, capacitive acceleration type and voltage-resistance type (i.e. voltage type) etc pressure sensor. The former usually is used in manufacture industry and vehicle control on the road or bridge field. While acceleration type pressure sensor is for car production and hydraulic equipment etc aspect. As far as voltage-resistance type pressure sensor, it is applied in conventional stress situation.

There is extremely difference of sensor materials, structure, property, as well as purpose and so forth. This paper design principal is focusing on this main object, intelligent carpet system. Hence the pressure sensor responses human behavior as main object. That means measuring the gravity (or name as pressure forced on the sensor) scope from tewenty kilograms to one hundred kilograms usually. Meanwhile system applied environment is mostly indoor situations. The paper chooses half bridge type of pressure sensor as front-end data collector in system. This kind of sensor is of distinctive characteristics as following table 1.

Table 1. Pressure sensor characteristics.

Range [kg]	Voltage [V]	Temp. [℃]	Deviat. [%F.S]	Sensib[mv/v]	Out Vol [mV/V]	Non-line[%F.S]	Output [Ω]	isolation [MΩ]	Thick [cm]
50	5～10	-10～+50	0.2	0.9±0.1	±0.3	0.2	1000±50	≥2000 (100VDC)	1.5-2

Regarding the sensor characteristics, obviously there are some advantages. Firstly it is completely suitable for designing system; its measuring range locates in average gravity of human body, about 50 kilogram. Secondly the working temperature is just suitable for most indoor situations. Thirdly its sensibility achieves 0.9 (mv) that ensures sensor can collecting pressure data no matter who is adult or children. Then thanks to its output value (near 1 kΩ) and more high isolation resistance (2 kΩ), which assures the sensor component integrated with other auto-control unit without any electronic disturbing each other. Lastly this type sensor thickness is only 1.5 cm that becomes full feasibility combing sensor and carpet.

Micro Computer Technique Comparison

MCU chip mainly contains CPU, storage, I/O, and power etc. modules. Its major functionalities are doing calculation, logical analysis, data comparison. Meanwhile it sends the judgment result and control order to external units. Thus realizes different application target in various situations. Usually it bears operation, control, decision etc intelligent central administration purpose.

At present, there are many sorts of MCU chip, such as 51 model chip, 52 model chip, Mega model chip and so on. Relatively speaking AT 89C51 model chip is simple and price is cheap. It needs to use simulator to conduct software and hardware debugging. Test is more complex [5]. While STC89C52 model is an advanced chip. Its characteristics are lower power consumption, high performance, 8KB programming flash memory etc. But the natives are limited I/O quantity and no strong expansibility [6]. Comparatively above, the Ardunio Mega 2560 model chip is of USB interface, 54 I/O lines in which 16 lines are as pulse width modulation output. Its 8KB ARAM, 4KB EPROM and 256 KB flash memory are more positives. Meanwhile it is compatible with Ardunio UNO expandable board. Based on the above comparison, the later is more suitable for the intelligent carpet system from cost performance view. This paper adopts this model chip as auto control unit.

Intelligent System Design

From above section analysis, this paper takes the half bridge 34 model pressure sensor as front-end gravitation data collector. Thanks to sensor 50 kg metric range, it is highly match for entire design object as well as applied environment.

From technique point of view, sensor gets the gravitation date which is analog message [7]. In order to processes these message by MCU, this system chooses HX711 module AD transfer for analog to digital data. Which most positive is containing 128 db gain amplifier, that is able to sensing the forced little pressure on carpet and promotes the system accuracy. The differential input circuit in AD transfer fully matches the output of half bridge sensor on the electronic characteristic.

As far as intelligent control unit, the paper adopts Mega 2560 module MCU. The purpose is to calculate and analyze the pressure data from sensor, meanwhile to decides the time delay setting based on the intelligent function. Therefore delivers relevant control signal to the lamp or electrical appliance and realizes the smart automatic control purpose.

The entire system module diagram is as following fig.1. The system is composed of pressure sensor unit (merging in carpet), AD transfer unit, MCU unit, and control relay unit.
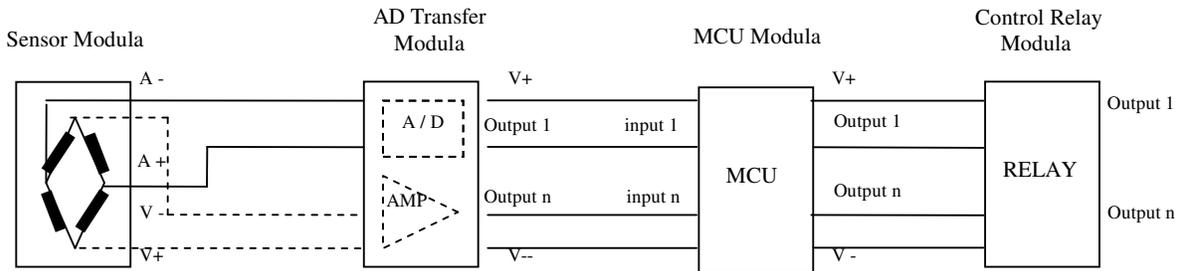

Figure 1. Intelligent System Module Diagram.

The whole working mechanism shows this procedure. Firstly the feet put on the sensor in carpet. Then the plantar pressure makes sheet metal section area change in sensor. Thus produces the resistance value change [8-9]. Sensor sends output signal to AD transfer, this unit transfers into digital signal and amplifies it. Later MCU computes this digital data, does comparison and logical analysis including time delay judgment, again stores this result and deliveries this data to control relay unit. Finally relay unit accordingly conducts switch turning on / off action for lamp or electrical appliance.

Intelligent System Application Method and Consideration

The Carpet Application Design

In order to considering the using convenience for people behavior, this paper puts the sensor in carpet. Moreover designs right down position in carpet as switching on position when entering this area [10]. By this method, both locates the carpet position function and matches human using habit. The concrete design construction and methods shows following fig.2.
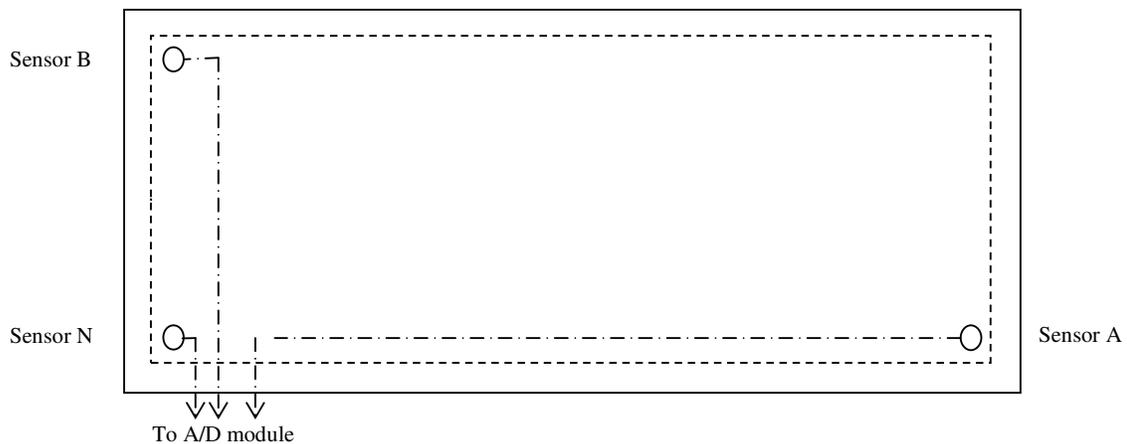

Figure 2. Sensing carpet distribution.

- The sensor sets in the 10 cm from edges, it is convenient both for installation and leading wires.
- Setting the A position as turning on lighting device function when enter this area. (of course the sensor A being of turning off function when stepped on this position again) .
- Arranging left up corner B position as switching on lighting device function when entering other room.
- At left down N position, it fixes as switching on some electrical appliances function such as moisture extractor, fan, and air purifier etc.
- If the carpet needs control multi line lamps, the relevant sensors set in the right edge, each sensor is separated by 30cm. In the same way, left edge is for multi line electrical appliances.
- As smart one of functionality, sets sensor A and B as interconnection,. When people go to other room, he only needs to step on the B position, switching on the lighting in other room, after 60 seconds, the A switch automatic turning off lighting (this time period is flexible to adjust by smart software) .
- Designing the time length of forced on sensor is 10 seconds as available people action to avoid mis-operation. (the time data also be flexible setting)

  With the help of above method design, the system realizes intelligent automatic control functions.

The Application Environment Consideration

This part mainly focuses on the situation application method. The relevant diagram shows as following Fig.3.

  The carpet sets at the entrance of gate for easily using by people. While system control box fixes in the generic cabling box in indoor and which is embedded into wall of room. This control box contains AD unit, MCU unit and relay unit. Its relevant working voltage is constant 5-10 v supplied by nickel cadmium battery or adapter by alternating current 220 v. The output lines from relay connect to switcher of lighting or appliance with parallel connection method.
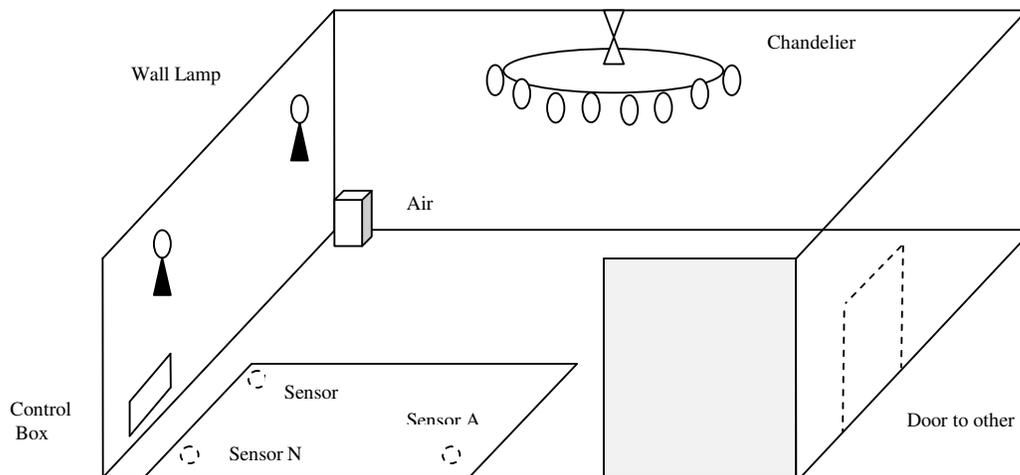

Figure 3. Intelligent system situation design.

  Based on this diagram, sensor A controls wall lamps and a chandelier in this room. Sensor B is for other room lighting (seeing the right side door in Fig.3). Sensor N sets to control air purifier (also for other appliances if need).

  This paper provides the system flexibility based on the practical situation. One sensor A can controls one lamp or more lamps which needs adding according output quantity of relay and linking output to relevant lamp switchers. In the same way, sensor N can control multi appliance devices. In order to enhance the smart functions, system can set any two sensors as interconnection. It realizes this inter-control function by MCU software without any extra cost. If the intelligent carpet system is used in the situation where there are many rooms such as meeting room, visitor room, lab room, working area, dining room, and rest room etc. It is fully feasibility setting the carpet at each entrance

of areas. Of course it is suitable for various situations in personal house as well based on the different purpose.

By the paper discussion, this system research and design not only integrates the sensing technique, AD technique, automatic control technique as well as relevant software technique but also closely combines the system and actual situation. It extremely enhances the entire system functionality, feasibility and flexibility.

Conclusion

This paper focuses on the research for pressure sensor. At this base, firstly puts forward an innovative design which making use of feet, releasing hands, and initiating smart life new mode. Secondly by sensor collecting data ability, the paper is intent to analyze pressure sensor characteristic and develop intelligent logical functionality in MCU, then creates a new carpet system with logical thinking. Lastly by the aid of software function design, it realizes interconnection, intelligent control and automatic applications between smart system and lighting appliances. Meanwhile the paper's research thought, method and solution are of grand theory reference value and actual application significance.

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