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Design of an Integrated Smart Lighting Control System for Smart Homes Based on the KNX Protocol

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Abstract. This paper base on KNX bus tech, start from home life and office scene need, unite science innovation and human care, aim at different use scene, design full digital distribute control system for different place and people. Full digital distribute control system, to all kind light, air con, curtain and other electric device in area do auto and center control manage, realize energy monitor, not only can effective manage building electric device, give flexible use function and effect, also can keep and longer lamp and electric device use life, reach safe, save energy, human, smart effect, and can easy expand according to user need in future use.

Keywords: KNX, KNX control system, smart home, smart home system control algorithm, simulation tes

1. Introduction

Now China city grow fast, people life level up, people more hope live in friendly home office environment, but do this not easy. KNX system show advantage in this, KNX system change simple, can meet user need for comfort and safe keep upgrade, can keep give people easy, satisfy life environment. In this environment, this paper topic meaning is very clear, good for real research, theory and practice combine, research, test and use unite, more good for product user experience improve, also good for tech itself evolve [1]. KNX building smart home system, its use design also experience several stage, they are internet era, mobile internet era, IoT era. 1997 to 2009 is internet era, 2009 to 2012 is mobile internet era, 2013 to now is IoT era. Actually each era is many tech and trend accumulate, some new tech use and trend be found, with era node label [2].

2. KNX technology overview

KNX system have wide use space, its system set and config is easy operate, and flexibility very high, widely use in big scene. From normal room, to complex mix building, all can design install on topology.KNX standard is a global open control standard for home and building. It is accepted by Europe, China and USA standards. The standard covers TCP/IP, TP (twisted pair cable), RF (radio frequency) and other media to form a communication protocol tech.KNX building home system is widely used in many countries, it relate close to 3 factors. Weak current carrier way, tele-signal

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couple just on 24V system power [3].Then use domain plus line plus device 3-layer topology structure show network frame. Also, From structure figure look, not hard see it have high flexible feature, use space diverse, scene very wide and rich. KNX protocol is open and general, let all makers follow, KNX system structure show in Figure 1.

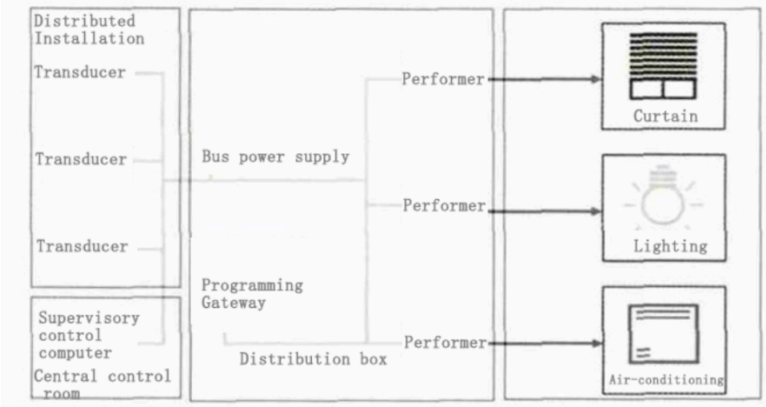

Figure 1. KNX system structure diagram

Refer to FAR model build relate function, bandwidth and model relative lag change number estimate method, use MATLAB program do coding. When p=6, d=1, bandwidth value h=0.376, APE value show smallest. FAR build model is FAR(6,1), improved model formula is:

$$X_t = a_1(X_{t-1})X_{t-1} + a_2(X_{t-2})X_{t-2} + ... + a_6(X_{t-6})X_{t-6} + \varepsilon_1 \quad (1)$$

Each device in KNX system have only one physical address, its function can set by program. Different device can connect and work together through bus, system no need change physical wire, just change program to adjust wholesystem function.

3. Research on control algorithms in home building control systems

Building and home control system involve many algorithm. This chapter discuss KNX and relate algorithm research with everyone. The algorithm include ARIMA model predict algorithm, PID control algorithm and other type algorithm.From math view, detect one process single or a group variable X, record it in a time period, get ordered number set is: X(t),...,X(aw). Deterministic and uncertain 2 sequence.

$$X_t = V_t + \xi_t t = \pm 1, \pm 2 \quad (2)$$

For predict model, in this equation (3), its coefficient φ. Use and do series estimate, build ARIMA(6,1,0) model, can predict calculate φ and δ value, use ARIMA predict model equation. It to front 12 week data do detail calculate, also can build a ARIMA predict model, this when execute command, more have operate space show in Figure 2.

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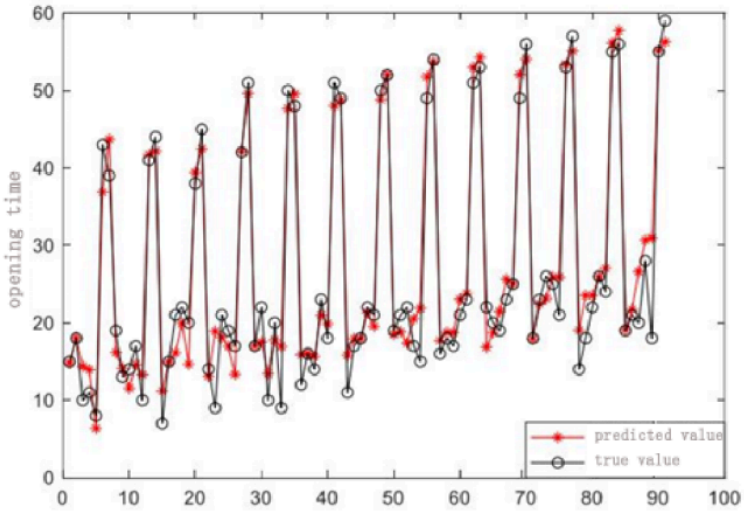

Figure 2. ARIMA sample prediction chart,time/day

In real life, try very hard to grasp some balance time probability distribution, relatively disagree. So we try use number as reference standard, in practice, take a step back measure. On sequence, number feature balance move happen some change, need first and second order moment, no change with time shift. Wide stable balance feature, use math language, can tell as follow formula.

$EY_t^2 < \infty, \forall \in T$,T is time series set.

$$w_1 = \phi_1 w_{t-1} + \phi_2 w_{t-2} + \phi_3 w_{t-3} + \phi_4 w_{t-4} + \phi_5 w_{t-5} + \phi_6 w_{t-6} + \sigma + u_t \tag{3}$$

$$y_{t,s} = y_{k,k+s+t}, V_{t,s}, k + s + t \in T \tag{4}$$

$Y_{t,s}$ is no relate to t and s, only relate to time gap t-s, meet these condition, is wide stable series. Write as:

$$y_{t,s} = y(t - s) \tag{5}$$

According to people life habit, smart system will auto recognize, form data store pool, then according to data, time node and other index, build model, reach a smart recognize, [4]judge and take action mechanism, and predict next time open time and smart response mechanism.

4. Analysis of the PID control algorithm

PID, from literal meaning is Proportional, Integral, Differential combine. PID algorithm is a control algorithm, good for scene where control object is fuzzy and not clear enough.PID controller, its parts, can made by proportional unit and differential structure unit [5].PID controller, have series unique advantage, like structure simple, stable performance good, operate very good, use flexibility very high. PID controller, simple structure frame, can by follow several parts compose.As shown in Figure 3.

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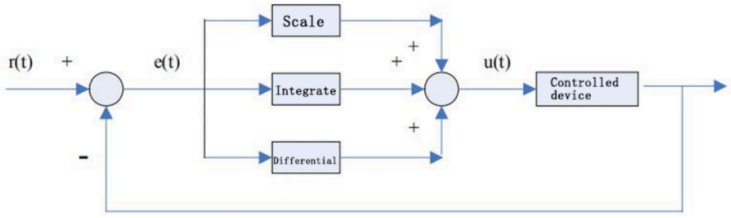

Figure 3. PID controller structure distribution andc omposition diagram

From formula 6 know r(t) is output value, e(t) is bias manage, u(t) is some control of output. Simple understand, PID controller is linear controller, it given value r(t) and real output value c(t) form control, form some bias.

$$E(t) = r(t) - c(t) \tag{6}$$

Modern PID controller, it use some computer program to control, so also call PID control. Computer control system, itself use sample control. According to time node value, exist bias is normal. Compute control amount, show memory relate. So see, integral item and differential item exist in some formula, need do some real effect discrete handle.

$$u(k) = K_p e(k) + K_1 \sum_{j=0}^{k} e(j) + K_D[e(k) - e(k-1)] \tag{7}$$

A/D, D/A interface replace analog controller input output mechanism. PID control algorithm research also from traditional analog research shift to digital PID algorithm research. From traditional meaning, PID control algorithm mainly have 2 show form. First is PID control algorithm position form. Second is PID control algorithm increment form.

About PID increment control algorithm, increment PID control algorithm. It belong to some increment Au(k) of PID controller output control amount. Compare last control output amount, then can get.

$$Ou(k) = Pupae(k) + K, e(k)[\Delta e(k) - A(k-1)] \tag{8}$$

$$Se(k) = e(k) - e(k-1) \tag{9}$$

As algorithm keep upgrade, artificial intelligence mechanism also more and more bring into KNX building control system. And PID control algorithm and series artificial intelligence algorithm combine, more can push KNX system improve [6].Single algorithm sometimes cannot meet system need, so need combine many handle link.

5. Design of the room intelligent system control

Room smart system control design, finish shutter sunshade control design and indoor light control system design.Room sunshade system, its run device mainly outdoor roller shutter and indoor sunshade curtain. It have 4 switch, finish relate command. Program set parameter, touch screen, PAC hand operate finish. As Table 1 show.

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Table 1. Variable address allocation table

variable	Register address	variable	Register address
Indoor illuminance	%IW1	Outdoor illuminance	%MW227
Blinds unfolded(touch screen)	%MX80.3	Blinds unfolded(PAC)	%QX0.604
Blinds closed(touch screen)	%MX80.4	Blinds closed(PAC)	%QX0.605
Blinds stopped(touch screen)	%MX80.5	Blinds stopped(PAC)	%QX0.606
The sunshade curtain is unfolded(touch screen)	%MX81.1	The sunshade curtain is unfolded(PAC)	%QX0.607
The sunshade curtain is closed.(touch screen)	%MX81.2	The sunshade curtain is closed.(PAC)	%QX0.608
Shading curtain stopped(touch screen)	%MX81.3	Shading curtain stopped(PAC)	%QX0.609

Design mode mainly base on indoor outdoor brightness and infrared data. Infrared monitor mainly judge if indoor have people. If someone enter, use normal mode. If no one enter, start sleep mode. In common mode, outdoor brightness big than or equal 30000Lux, sunshade curtain and shutter can open; outdoor brightness small than or equal 300Lux, then close sunshade curtain and shutter. If indoor brightness small than or equal 100Lux, then open light system [7].

Fuzzy control algorithm analysis, its rule is:

$$A \rightarrow B,\ A \rightarrow B$$

Cadenza first put forward famous CRI algorithm in 1973, that is: change A→B. Through Dz change to relative fuzzy relation on XYZ. Use A* and Dz(A(x),B(y)) compound calculate get:

$$R_z(a,b) = (1-a) \bigvee (a \bigwedge b) \tag{10}$$

For some common compose rule, many people put forward some objection. Most main is, it no contain restore feature. When A=A*, B≠B*, it do relate restore analysis to CRI algorithm.

6. Conclusion

Building home system smart improve big city people work and life level. Now only one international standard use for home and building auto field. KNX tech and relate protocol standard, realize device info resource share, energy resource effective manage, living environment improve, property manage more order and effective. This paper deep analyze home building control develop status and market prospect at home and abroad, refer to smart building product develop at home and abroad, combine own real condition, in keep try and repeat test, get certain result.KNX control system as a system, exist a keep upgrade process, also mean function more advanced. Also new old algorithm keep add, conflict and run-in between various algorithm, flexible and unified, all need a coordinate maintain process, this more good for KNX system eco algorithm evolve and improve. Combine some exist hot tech knowledge, here discuss combine with various hot tech, help relate industry develop.

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