NEW CONTROL SOFTWARE FOR CERBERUS 3D NANOINDENTATION SYSTEM

by

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(6^{th} June, 2013 – 20^{th} June, 2013)

INTRODUCTION:-

The objective of this phase was to compare the environments available for scientific and numerical computations and to explore the HTBasic Code.
The most popular environments for this purpose is Matlab, but due to project nature it was necessary to use an open source environment. The best open source alternative are :-

- GNU Octave
- FreeMat
- Scilab
- Pythonxy

The pros and cons of each environment were taken and then the final environment was decided after discussion with my supervisors. The comparision was made on the basis of following points:

- Ease of installation – ideally available for Win98/XP/Vista/Win7 using self-extracting installers.
- Well integrated with strong plugin support.
- Must be strong in computations.
- Easy to compile / run.
- User Interface.
- I/O – file, DAQ and GPIB support if possible.
- Documentation – well-written manuals and help files are essential.
- Support – good host site with evidence that there are plenty of other users.

The existing HTBasic code was analyzed during the but due to large size of the program its still a work in progress.

COMPARISION BETWEEN GNU OCTAVE, FREEMAT, SCILAB AND PYTHONXY:-

1. GNU Octave:
   GNU Octave is a high-level interpreted language, primarily intended for numerical computations. It provides capabilities for the numerical solution of linear and nonlinear problems, and for performing other numerical experiments. It also provides extensive graphics capabilities for data visualization and manipulation. Octave is normally used through its interactive command line interface, but it can also be used to write non-interactive programs. The Octave language is quite similar to Matlab so that most programs are easily portable.

2. FreeMat:
   FreeMat is a free environment for rapid engineering and scientific prototyping and

data processing. It is similar to MATLAB from Mathworks, and IDL from Research Systems, but is Open Source. FreeMat is available under the GPL license.

3. Scilab:

Scilab is free and open source software for numerical computation providing a powerful computing environment for engineering and scientific applications. Scilab is released as open source under the CeCILL license (GPL compatible), and is available for download free of charge. Scilab is available under GNU/Linux, Mac OS X and Windows XP/Vista/7/8.

Scilab includes hundreds of mathematical functions. It has a high level programming language allowing access to advanced data structures, 2-D and 3-D graphical functions.

4. Pythonxy:

Python(x,y) is a free scientific and engineering development software for numerical computations, data analysis and data visualization based on Python programming language, Qt graphical user interfaces and Spyder interactive scientific development environment.

After heavy discussion with my supervisors and analysis of information available on the internet, I have graded each environment on 8 factors on a scale of 10.

Environment	Installation	Plugins	Numerical computation	Ease to compile	UI	I/O	Documentation	Online support
Matlab	7	10	10	10	9	9	10	10
Octave	8	6	9	8	7	8	9	10
FreeMat	9	5	8	7	6	8	7	8
Pythonxy	8	10	9	10	9	9	10	10
Scilab	9	7	9	10	9	8	8	10

ANALYSIS OF OLD HTBasic CODE:

After the analysis of old HTBasic code, I was able to create a model of the program analyzed so far. “XPMASTER” is the main code. Following is a dissection of this code. The effect of each instruction is indicated in its front after ‘→’.

```
!*****************************************************************
!
!              XP MASTER PROGRAM
!
! This programming assumes the following devices are on the bus:
!
! Mod  10-31-97  move all config flags to Default and make a file for
!  passing COM /autost_flags/ info from AUTOST
!
! It is saved as "XPMASTER".
!
!*****************************************************************
! CONTROL KBD,1;1
! PRINTALL IS 10
!
!
OPTION BASE 1                          → sets the base index of array as 1 instead of 0
COM /Autost_flags/Pstate,Ieee_flag,Root$[25]      → variable declaration in scope/ block Autost_flags
Htbdir$="C:\HTE386"                    → default HTBasic directory. In Win7 it would be "C:\Program Files (x86)\HTBWin 10"
ASSIGN @Aflag TO Htbdir$&"\a_flags"    → creates a widget(I/o path) for I/o to copy standard flags and root directory
                                         from std. "a_flags" directory(not present in new HTBasic versions)
ENTER @Aflag;Pstate,Ieee_flag,Root$    → Input/copies data and assigns it to the variables Pstate, ieee_flags, Root$
ASSIGN @Aflag TO *                     → destroys/frees widget "Aflag"
MASS STORAGE IS Root$                  → sets the default directory same as "Root$"
  ! Check that master is not being rerun
ON ERROR GOTO 50                       → error
CALL Checrun                           → this CALL will result in trapable error(i.e. error which can
                                         be handled by HTBasic compiler) on first run since "Checrun" is not
                                         loaded in the memory. Hence determining rerun.
OFF ERROR                              → Execution of this statement will cause any subsequent error to be reported to
                                         the user and program execution will PAUSE.

LOAD Root$&"\XPMASTER",1               → Load the XPMASTER into memory and start executing from line 1

OFF ERROR
CLEAR ERROR                            →CLEAR ERROR resets ERRL, ERRLN, ERRM$ and ERRN to their default start-up values.


LOADSUB ALL FROM "CHECRUN"             → load all subroutines from CHECKRUN

!
  !COM block assignments
COM @Nano,INTEGER Sbyte,INTEGER Interrupt_mask
COM /Nano/A$[30],INTEGER Ld_slot,D_slot,M_slot,Vm_slot,Mp_slot,Hpib_slot
COM /Table/Loe,Xloefact,Yloefact,Xdrfact,Ydrfact,Zdrfact
COM /Table_ext/Xmaxacc,Xminacc,Xmaxvel,Xminvel,Xmaxmove,Xmin_error,Ymaxacc,Yminacc,Ymaxvel,Yminvel,Ymaxmove,Ymin_error,Syshiflag
COM /Ztable/Zmaxacc,Zminacc,Zmaxvel,Zminvel,Zmaxmove,Zmin_error
COM /Table_io/Command$[256],Answer$[256],INTEGER Weddr,Raddr
COM /Data_io/Mess(16)
COM /Ring/Read(16)
COM /Data_io2/@Lock_in,Lockin,Forc_cacl,Disp_cacl
COM /Data_io3/ INTEGER Scrach
COM /Dyn_io/Lanswer$[256],Lcommand$[256]
COM /Menu/Choice$[100][75],Value$[100][45],Title$[10][75],INTEGER Choice(10,3),Pchoice,Level,Mvtab(10,20,2),Gmenu,Lmenu
COM /Bsdm/TS[80],Vrd[50][15],Sn$[20][10],Sc[20],No,Nv,Ns
COM /Cal_data/ REAL Cal_data(200,3)!increase size of cal array S_mod  rbp
COM /D_cal_exact/ REAL V(3)
COM /Out_put/Plotter,Printer,@Plotter,@Printer,Destin
COM /Position/Shape(999,3),Nr_of_Indents,Snum,Firstfile
COM /Run_para/Search,Load_range$(6)[2],Ta,Tr,Drift,Diamond
COM /Pio_pri/Sf[20],Var(50)
COM /Address/Datafiles$[25],Subprogs$[25],Floppy$[25],Caldata$[25],Shapel$[25],Indent$[25],Specinvest$[25],Macro$[25],Hpstat$[25],Hdisc$[25]
COM /Dta_data/Diadata(10,100),Radius
  ! following com addition for calc menus
COM /Mthmen/File_no$(999)[3],Calcprog$[8],Prefix1$[20],Prefix2$[20],Base_file$[8],INTEGER Nr_of_files,Wrongprog
COM /Version/Dsover,Hbver,Dacver,Headver$[1],Printerver$[5],Cartflg,Hlp,Scratchin,Lockinin,Nanover,Hbdin,Ubdin,Bb_ver,App_pointsys config flags RBP
COM /Version2/Off23,Dispver,Ls_flag,Ad1in,Dcmsu,Sp5,Sp6,Sp7,Sp8,Sp9,Sp10
COM /Loadvr/Lvr0,Lvr1,Lvr2,Lvr3
COM /Clock/Log_max,Log_min,Log_1hps,P_max,P_min!clock limits
      !Log_ limits spec. to old mech. & MAKEIND   P_  Pacer Period limits
COM /Mentxt/Menutxt$(5)[75] !pass com for menu messages
COM /Tablepol/Xpol$[4],Ypol$[4],Zpol$[4]!polarities for drive axes
COM /Tabtyp/Tabtyp$[3],Ex1$[1],Ex2$[1],Spr1,Spr2
COM /Scratch/Xg_cal,Yg_cal,Xf_cal,Yf_cal,Xs_cal,Ys_cal,Zmax,Zmin
COM /Disp_lim/Dlin_lim,Dscl_lim,Rp_lim,Ed_lim
COM /Systat/Sys_flag
COM /Mod_data/Modcal(2000,3)!new com for modulation cal
COM /Sp_cal/Spdata(4,40)
COM /Out_ctrl/Printer_add,Bit_bucket,Dump_io
COM /Xyz/Nxyz,Xyzdat(3,600)
COM /App_parm/Apwt,Min_apdd,Min_apdb,Min_apdi,Max_aprt,Absmin_drt(3),Absmax_drt(3)
COM /Test/ INTEGER Test_rel
COM /Xptst/No_shapelib,No_explib,No_indlib,Exp$[1],Repeat_stream,Exp_util_flag
COM /Spec/Numsp,Spec$[25][150],Specpos(999)
COM /Xpstuff/Valdata$[14],Valexp$[10],Valhed$[16],Valhead$[10]
```

Variable Declarations and assignments.

```
COM /Counters/Uxcor,Uycor,Uscor
COM /Currcals/F_cal(3),D_cal(3),Sp_cal(3),Df_cal(3),Dd_cal(3),Dsp_cal(3)[5/2/00 bsl
COM /Nanopc/@L_dvm,@D_dvm,Dadr,Ladr,Tadr,Madr,Dreg[20,3],Lreg[20,3][bsl 3/22/00
COM /Cal_coeff/F_coeff[3,3],D_coeff[3,3],Sp_coeff[4,3],Df_ratio[3],Dd_ratio[3],Dsp_ratio[3],Fr_ratio[4,3],Dr_ratio[8,3],Dr_intr[8,3][bsl 5/2/00
COM /Curr_tst/Tst_type$[17],Tst_seq$[12,10,1)[10],Tst_type,C_set$[1]
COM /Defaults/Def_param$[25][7]
COM /Pccards/Dflag,Lflag,Mflag
COM /High_load_lo/Hicomm$[256],Hians$[256],INTEGER Highload,Hiln,Hiadr,Cont_flag
COM /Def_vn/Dvn$[30][10]
COM /Liprans/Liprans
COM /Exptype/Exp_type$[6][17]
COM /Doffset/Doffset$[2],Doffset,Range$[2],Dspare1$[8],Dspare2$[8],Dspare3$[8]
   ladd 3/27/97 rbp
COM /Offset/ INTEGER Orow,Ocol,REAL Offcal[3,255]
Orow=3
Ocol=255
COM /Xyscals/ INTEGER Xrow,Yrow,REAL Xcol,Ycol,Xyzrow,Xyzcol,Xstiff[2,3325],Ystiff[2,3325],Xyscal[4,5000]
Xrow=2
Yrow=2
Xcol=3325
Ycol=3325
Xyzrow=4
Xyzcol=5000
COM /Atod1/Ad1adr,Ad1chnl,Ad1range,Ad1period,Ad1avg
COM /Nanopc2/D_card_id,L_card_id,Z_card_id
COM /Nanoull/Zadr
COM /Disp_lim_dr/Dlis_lim_0,Dlis_lim_1
COM /Limtbw/Xp_lim,Xm_lim,Yp_lim,Ym_lim[1/28/98 RBP
COM /Log_dim/Manvar,Mandat
Manvar=20
Mandat=5000
COM /Ind_data/Logged_data(20,5000) BUFFER,Ctrl_seq$[12,10,6][10],Zero_displ
   !note manvar,mandat are dims of Logged_data
COM /Zero_targ/Zero_targ,Spare1,Spare2,Spare3,Spare4,Spare5
COM /Thread_adr/Dbadr,Dyadr,Lxadr,Lyadr,Xyac,Xytaks
COM /Xyaddress/Xcalidata$[25],Ycalidata$[25][bsl 5/2/00
COM /Xysp_cal/Xspdata(4,40),Yspdata(4,40)
COM /Datio_3d/@Xlock_in,@Ylock_in
COM /Xyac/Xlockinin,Xlockin,Xdisp_oscl,Xforc_oscl,Ylockinin,Ylockin,Ydisp_oscl,Yforc_oscl
  !
   !
   !Setup CRT
   !
   CONFIGURE DUMP TO "HP-PCL"                    → Specifies the graphic printer language for DUMP. DUMP copies the contents
                                                   of the display to a printing device.
  PLOTTER IS CRT,"INTERNAL";COLOR MAP            → Specifies the graphics output device and language. CRT in this case with last
                                                   used CRT driver.
   PRINTER IS 1                                  → Specifies the system printing device.

  CLEAR SCREEN                                   → clears the alpha display
  GCLEAR                                         → Clears the graphics screen
  LOAD KEY Root$&"\skeys.nan"!Load custom softkeys → Load the Softkeys, i.e. A softkey is a function key whose function can be
                                                   changed under software control.
   CONTROL 1,12;0       !Turn on key labels      → Sends CONTROL information to an interface, I/O path, or widget attribute(s).
                                                   CONTROL destination, register;value
  ! CONTROL 2,2;1            !Set softkey menu to user1
  !
   ! now setup defaults
   !
  LOADSUB ALL FROM "Default"!for default setup routine → loads CSUB (compiled subroutine) "DEFSUB" into the memory.
  CALL Default
   !
  Dflag=0                                        → displacement flag to search displacement card.
  ON ERROR GOTO Derr                             → on error in next line follow this branch.
  I=READIO(8080,Dadr+0)                          → Inputs a byte or word from an I/O Port.
  IF I<>D_card_id THEN GOTO Derr                 → matches the input id with the id of disp. card

   Dflag=1  !found displacement card             → set Dflag to 1 in case it matches.
Derr: OFF ERROR
   CLEAR ERROR
   Lflag=0
   ON ERROR GOTO Lerr
   I=READIO(8080,Ladr+0)
   IF I<>L_card_id THEN GOTO Lerr
   Lflag=1  !found load card
Lerr: OFF ERROR
   CLEAR ERROR
   Mflag=0
   ON ERROR GOTO Merr
   I=READIO(8080,Madr+1)
   Mflag=1  !found motor card
Merr: OFF ERROR
   CLEAR ERROR
   !
  Sys_flag=Lflag AND Dflag AND Mflag
```

Similar procedure for Load card and Motor card

RESULT & DISCUSSION:-

1. After deep evaluation of the available options due to its slight advantage over Matlab and increasing use in the scientific community, Pythonxy is selected as the final environment.
2. Following points about the "XPMASTER" code were identified:
   a. We must check whether it is "rerun" of the "XPMASTER" to do calibration.
   b. Identify the printer status initially, and make it available throughout the program.
   c. Select the appropriate drivers for the printer; in this case it is "HP-PC".
   d. Perform the appropriate test to ensure that appropriate displacement card, load card and motor card are present.

NEXT OBJECTIVE:-

The objectives of the next phase in the project are as follows-

- ✓ To fully explore the htbasic code and create the interaction model between different subroutines.
- ✓ To study the raw binary data from the Cerberus system and write a python code to convert it into the desired txt format.