TECHNICAL REPORT

Development of Irrigation Scheduler – Programmable Systems

Funded by

SERB, DEPARTMENT OF SCIENCE AND TECHNOLOGY (DST)

NEW DELHI, 110 016

Participating Agencies

ICAR- Indian Agricultural Research Institute (IARI), New Delhi

Centre for Development of Advanced Computing (CDAC), Mohali

CSIR-CMERI Centre of Excellence for Farm Machinery, Ludhiana

CSIR-CMERI CENTRE OF EXCELLENCE FOR FARM MACHINERY

OPP. GNE COLLEGE, GILL ROAD, LUDHIANA – 141 006

TECHNICAL REPORT

1. **Title of the project:**

   DEVELOPMENT OF IRRIGATION SCHEDULER – PROGRAMMABLE SYSTEMS

2. **Principal Investigator(s) and Co-Investigator(s):**

   Dr. Murtaza Hasan, Principal Scientist, IARI, New Delhi

   Dr. Dilip Kumar, Senior Design Engineer, CDAC, Mohali

   Dr. Pradeep Rajan, Principal Scientist, CoEFM, Ludhiana

3. **Implementing Institution(s) and other collaborating Institution(s):**

   ICAR- Indian Agricultural Research Institute (IARI), New Delhi

   Centre for Development of Advanced Computing (CDAC), Mohali

   CSIR-CMERI Centre of Excellence for Farm Machinery, Ludhiana

4. **Date of commencement:** 01.01.2010
5. **Planned date of completion:** 31.12.2012
6. **Actual date of completion:** 31.03.2014
7. **Objectives as stated in the project proposal:**

   - ✓ Design & development of irrigation scheduler programmable systems
   - ✓ To evaluate the performance of the developed scheduler in actual field conditions
   - ✓ Demonstration and field trials at farmers' fields

8. **Deviation made from original objectives if any, while implementing the project and reasons thereof:** No
9. **Experimental work giving full details of experimental set up, methods adopted, data collected supported by necessary table, charts, diagrams & photographs:**

   During the first phase, we have studied all the aspects viz., solenoids, motors, drip pipes, controllers, and the pressure pumps including suppliers related to Drip Irrigation System as suggested by Executive Director and prepared a brief report for the same, in second phase, we have developed the electronic gate opening circuit for single solenoid valve for multiple switching and also developed the driver circuit as per the specification of the solenoid valve installed at IARI (i.e., 24V AC, 1.7 Watt). At this moment, the driver circuit has been tested with the help of LEDs.

   In third phase, we have developed the electronic gate opening circuit for four solenoid valves for multiple switching and also developed the PCB for driver circuit. This electronic circuit tested on two solenoid valves 230 V AC and live demonstration was given to Executive Director, CDAC and PI, CoEFM. The demo model consisted of half inch pipe, a motor, two solenoid valves (230V AC), and the designed electronic circuit on a PCB. The gate opening and closing of two valves with multiple switching was demonstrated. The opening and closing time

including date, hour, minutes, AM/PM fed into the controller with the help of keypad and accordingly the valve opened and closed. In fourth phase, a prototype system has developed comprises of eight indicators for eight solenoid valves, LCD display, and keyboard matrix for data entry has been designed and fabricated. A live demo of the system at the CDAC premises, with two ¼" solenoid valves, layout of lateral pipes consists of emitters was given to Executive Director, CDAC Mohali on 29.12.2010.

A prototype system has been developed which controls pumps and flow of water from eight solenoid valves. The system has a LCD display, and a keypad matrix for data entry. The developed prototype was tested at the Lab level, IARI with solenoid valves with 24V supply. The prototype was also tested from the central irrigation control unit at IARI at farmer's field (Bhatia Farm located at Karnal) and found to be satisfactory in opening and closing the entire eight fields.

Experimental set up for testing the controller – It consisted of two main parts.

a. Irrigation Head Control Unit
b. Field Distribution Unit

Irrigation head control consisted of Pressurized water supply system, Filtration system, water metering unit, pressure gauge, various types of valves and Irrigation controller for automation. It is also known as the main control unit for pressurized drip fertigation system.

Fig 1: Irrigation Head Control Unit for Pressurized Drip Fertigation System

Field distribution unit consisted of different valves connected with different crops grown in open field, greenhouse and orchard, main line, sub-main line, lateral pipes and dripper of discharge varying from 2-10 liter per hour capacity. The solenoid valves are connected with the Irrigation controller for the automation of drip fertigation system. The solenoid valves can be operated with 24/220-230 volt or by live water supply through small tubes. The solenoid valves are connected with sub main and main line pipes of PVC or HDPE, located mainly in actual field and sometimes in the Irrigation control head. The HDPE lateral pipes of diameter varying from 12-20 mm are located in field beds in the numbers varying from 1 to 4 depending upon the types of crops. The last part of field distribution unit is known as drippers, which are attached with the lateral

pipes either externally or in-built with the lateral pipes. The dripper capacity varying from 2-10 liter per hour are mainly of two types in-line and on-line.

Fig 2: Field Distribution Unit for Greenhouse and Open Field

Fig.3 Scheduler connected to field solenoid valve (above) and irrigation & fertigation systems (below)

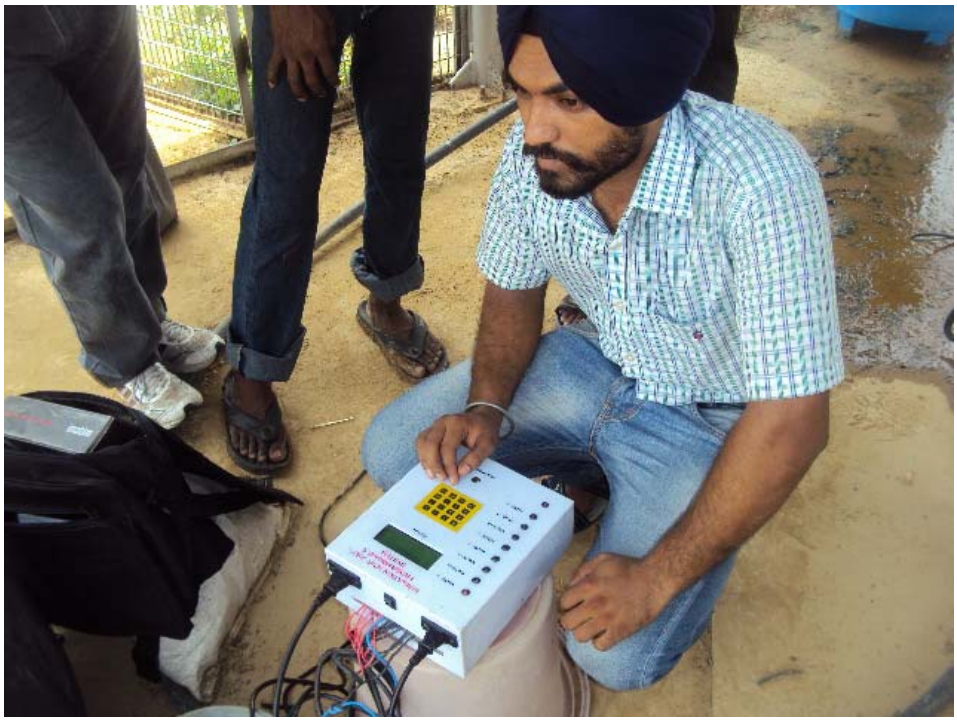

Fig.4 Scheduler programming (above) and Irrigated field (below)

Methods adopted for Field Testing of Irrigation Controller –

a. Single valve testing
b. Multiple valve testing
c. Crop based testing
d. Testing in open field, greenhouse and orchard
e. Time based testing
f. Length of plot/lateral testing

Data collected during field testing of the developed Irrigation Controller are as follows.

a. Time based testing data for the controller
b. Length of Plot testing data
c. Single/Multiple valve testing data

Table 1: Time duration and Length of plot testing for Irrigation Controller

Efficiency of Irrigation Controller	Running Time (Hr)	Length of Plot/ Bed (m)
100	0.5	5
100	1.0	10
100	2.0	15
100	4.0	20
100	6.0	25
100	8.0	30
100	10.0	40
100	12.0	45
100	14.0	50
100	16.0	55
100	18.0	60
100	20.0	65
100	22.0	70
100	24.0	75
100	30.0	80
100	35.0	85
100	40.0	90
100	45.0	95
100	48.0	100

Table 2: Single/Multiple Valve Testing for Irrigation Controller Operated Drip Irrigation Efficiency (%) at different Pressure Head (Pump Discharge Q = 5 lps and length of bed/plot = 25 meter)

Pressure Head (bar)	One valve	Two valves	Three valves	Four valves	Five valves	Six valves	Seven valves	Eight valves
1.00	30	28	25	22	20	18	15	10
1.50	60	55	40	30	25	20	12	8
2.00	95	90	80	60	52	40	33	25
2.50	100	100	100	90	85	65	50	30
3.00	100	100	100	95	80	60	52	35
3.50	100	100	100	100	100	95	90	80
4.00	100	100	100	100	100	100	100	90

Time based irrigation is done for a fixed duration in minutes for a given plot. Quantity based irrigation is done for a given plot in cubic meter and is cross checked by water meter installed in the system. In the non-conditional mode the irrigation quantity in cubic meter and irrigation interval in days has to be pre set for both time and quantity based irrigation scheduling. The minimum number of stations should be 8 to be connected to controller.

The developed irrigation scheduler is capable of doing ***non-conditional, time based irrigation scheduling***.

TECHNICAL SPECIFICATIONS

Software Features

Irrigation Program : Number of valves up to 8, sequential or grouped

Control : Single Pump

Irrigation Method : Time

Day Access : Odd/even, weekly up to 30 days

Hardware Features

CPU : 8 Bit Microcontroller running at 11.0592 MHz

Keypad : 16 Keys keypad to set date, time, valve number, timings

Data Memory	: 64 Kbytes EEPROM
Display	: 20 Character x 4 Line high contrast backlit LCD
RTC	: Non Volatile Real Time Clock Calendar, with battery backup
Output	: 24 VAC – up to 8
Power Requirements	: 230 ±10% VAC
Dimensions	: 25 cm(L) x 25 cm (W) x 7.5cm (H)

Design Features

Wall mount option

12V, 4A Power Supply via external 230V AC Power Adaptor

Indigenous irrigation controller developed and tested for automation of drip Fertigation system for different horticultural crops grown in open fields, greenhouses and orchards. It would help in automation and wide spread popularization of drip fertigation among farmers. The developed irrigation controller is technically very simple and cost effective. The developed irrigation controller can be used at the farmer's field for automation of drip irrigation system.

a. Development of Irrigation controller prototype for eight solenoid valves operated in the field for automation of drip Fertigation system.

b. Irrigation controller prototype equipped with pumping information and general failure indicator through LED sensor.

c. Continuous duration testing ranging from 1hour to 48 hour done for Irrigation scheduler prototype at CPCT, IARI field for open field, greenhouse and orchard grown horticultural crops and the developed prototype was found to be successfully working.

d. Plot length testing for drip lateral connected with developed Irrigation controller prototype done at CPCT, IARI for open field tomato and brinjal for bed length ranging from 20 meter to 100 meter. The developed irrigation controller was found to successfully operate the dripper for bed length up to 100 meter.

TECHNICAL REPORT

10. Detailed analysis of results indicating contributions made towards increasing the state of knowledge in the subject:

Indigenous irrigation controller developed and tested for automation of drip Fertigation system for different horticultural crops grown in open fields, greenhouses and orchards. It would help in automation and wide spread popularization of drip fertigation among farmers. The developed irrigation controller is technically very simple and cost effective. The developed irrigation controller can be used at the farmer's field for automation of drip irrigation system.

11. Conclusions summarizing the achievements and indication of scope for future work:

a Development of Irrigation controller prototype for eight solenoid valves operated in the field for automation of drip Fertigation system.
b Irrigation controller prototype equipped with pumping information and general failure indicator through LED sensor.
c Continuous duration testing ranging from 1hour to 48 hour done for Irrigation scheduler prototype at CPCT, IARI field for open field, greenhouse and orchard grown horticultural crops and the developed prototype was found to be successfully working.
d Plot length testing for drip lateral connected with developed Irrigation controller prototype done at CPCT, IARI for open field tomato and brinjal for bed length ranging from 20 meter to 100 meter. The developed irrigation controller was found to successfully operate the dripper for bed length up to 100 meter.
e The future task is to make a more powerful dynamic Fertigation controller linked with various sensors and weather monitoring station

Achievements

- ✓ Technology package prepared
- ✓ Technology has been transferred to one industries

Technology Transfer

M/s Raftaar Professional Engineering Company
Shed No.10, STEP,
Near GNE College, Gill Road,
Ludhiana-141 006, Punjab

12. S&T benefits accrued:

I. List of Research publications

S No	Authors	Title of paper	Name of the Journal	Volume	Pages	Year
1.	M.Hasan, Balraj Singh, Naved Sabir, Sanjay Kumar, Dilip Kumar, Pradeep Rajan, V.R.Dahake	Design and development of indigenous irrigation controller for the automation of drip fertigation system	Proceedings of the V-World Aqua Congress	II	400-406	2011
2.	Dilip Kumar, Harpreet Singh, M.Hasan, V.R.Dahake, Pradeep Rajan	Design and Development of Indigenous Irrigation Scheduler for Drip Irrigation System	International Journal of Instrumentation Technology (IJIT) https://doi.org/10.1504/IJIT.2013.053282	I(2)	114-123	2012

II. Manpower trained on the project

a) Research Scientists or Research Associates: 02 Research Associate

b) No. of Ph.D. produced: Nil

c) Other Technical Personnel trained: 04 nos.

III. Patents taken, if any: No