Sigma Mixer Automation – SRS
AJM Industries, Pondicherry

Sep 01, 2022

Inspirisys solutions limited
First Floor, Dowlath Towers, New Door Nos. 57, 59, 61 & 63, Taylor's Road, Kilpauk, Chennai – 600 010

Author(s)	Ramachandran Chezhian Sakthimurugan	IoT Architect and Technical Lead	Inspirisys Solutions Limited
Reviewer	Ramanathan Arunachalam	VP – IoT Practice / Delivery	Inspirisys Solutions Limited
Approver(Client)			AJM Industries

Doc ID	AJM_SRS
Ver.#	1.0
Date	01-09-2022

DOCUMENT REVISION HISTORY

SL #	Date	Version #	Details of Change	Reason for Change	Reviewed by	Approved by
1	01-09-2022	1.0	Initial		Ramanathan Arunachalam	Ramanathan Arunachalam
2						
3						
4						
5						

TABLE OF CONTENTS

1 Introduction 4

2 Overall Description and Requirements 5

Sigma Mixer Machine 5

Sigma Mixer Machine – Process Flow & Requirements 5

Sigma Mixer Machine Process flow: 8

3 High Level Architecture 9

4 Data Capturing 9

5 Web Application 10

6 Machine Operating Environment 11

7 Design and Implementation Constraints 11

8 User Documentation and Training 11

9 Assumptions and Dependencies 11

10 External Interface Requirements 12

User Interfaces 12

Hardware Interfaces 12

Software Interfaces 13

Communications Interfaces 13

11 System Features 14

Description and Priority 14

12 Functional Requirements 14

Data acquisition 14

Data Phrasing and Manipulation 14

Data visualization 15

Reports and Summary 15

13 Non-Functional Requirements 15

Safety Requirements 15

Security Requirements 15

Recoverability 15

14 Data Requirements..... 16

15 Installation 16

16 Project Execution Requirements 17

Deliverables 17

17 Operating Environment..... 18

18 Technology Stack..... 19

19 Testing 19

1 Introduction

A.J.M. India Private Limited, Pondicherry is primary into the manufacturing of technical ceramics, plastic molded parts, metal components, and absorbent wicks. Kamivisa products are one among AJM's Product portfolio, producing absorbent wicks

Kamivisa likes to strengthen their system with emerging technologies and enable IoT based analysis on one of their key assets - Sigma Mixer Machine, which will help in improving the productivity and give quality insights.

InspiriSYS Solutions Limited (ISL) with expertise on Industry 4.0 and Digital Transformation space will join hands with Kamivisa as a Technology Partner, providing IoT solutions for shop floor automation (Sigma Mixer) to start with and work through further industrial automation including site integration, preventive maintenance, analytics, data insight etc.

This software requirement specification (SRS) document has been prepared based on various levels of functional and technical discussion with the customer and customer site due diligence visit. As agreed upon with the customer, this SRS document details the work to be carried out during Phase I.

Any changes or inclusions (apart from the scope detailed in subsequent sections below), are to be worked as a separate change request that will involve additional efforts.

2 Overall Description and Requirements

This section will detail about Sigma Mixer Machine and the requirements to automate as part of the Phase I work.

Sigma Mixer Machine

Sigma mixer machine mixes various raw materials to produce absorbent wicks, which is widely used as mosquito repellent. The mixer machine is currently operated and monitored manually, where safety protocols are limited. To improve and monitor overall productivity and safety features, there is an immediate requirement of mixer machine automation which will enhance operational efficiency.

Sigma Mixer Machine – Process Flow & Requirements

This section explains about sigma mixer process flow and requirement details to address. For easier understanding, picture references are also included here.

Figure (1) : Sigma Mixer Machine

Figure 1 shows the complete view of Sigma Mixer machine. The machine does a 5-minute cycle time for mixing. The various sections of the machine are indicated by number above with yellow round mark for easier understanding.

Section number 1 Indicates the loading hatch where raw powder material will be loaded into the vessel, through a rectangular window by filling the mixed chemical (which will be in the form of liquid) using a small barrel (figure 3). As per the process, loading hatch should be kept in a closed position when the mixer is on run -mode. But in many instances currently, operators leave the loading hatch in an open position while unloading the left out mixed material into the pot and the machine is still on run-mode.

Requirement(1): One of the important safety features, the mixer should be switched OFF when the loading hatch is opened. This is to make sure that the operator doing the removal of residing mixed material without any hazards

Requirement(2): Capture and record "loading hatch" status either in open or close

Requirement(3): Total time of loading hatch open/close status based on the selected date and time range.

Section number 2 shows the unloading hatch which will be at a closed position when mixer cycle is in progress and opened to collect the mixed material into the silver pot (Refer -to number 7 in figure 1). This unloading hatch open and close is handled using a pull and push lever (refer to figure 2) on the back side of the sigma mixer.

Requirement(4): Capture and record "unloading hatch" status either in open or close

Requirement(5): Total time of unloading hatch open/close status based on the selected date and time range

Figure (2) Unloading hatch lever

Figure (3) Mixture Barrel

Section number 3 Indicates the existing control panel where timer with display, buzzer, ON and OFF push switches are present along with LED indicator. There is no custom firmware available here to interrupt and add the additional signal to the existing controller.

Requirement(6): Auto power OFF when mixer cycle is complete.

Section number 4 Points 7.5HP – 4.5A motor. Mostly it operates with 80% of load. It is connected with gear box (refer to number 5 in figure 1). Gear box is connected with two ARMs (Refer to figure 4) sigma blades which will rotate both clockwise and anti-clockwise.

Figure (4) Two ARMs sigma blades

Requirement(7): Capture and record RPM of sigma blades.
Requirement(8): Min, Max, Average of RPM based on selected timestamp range

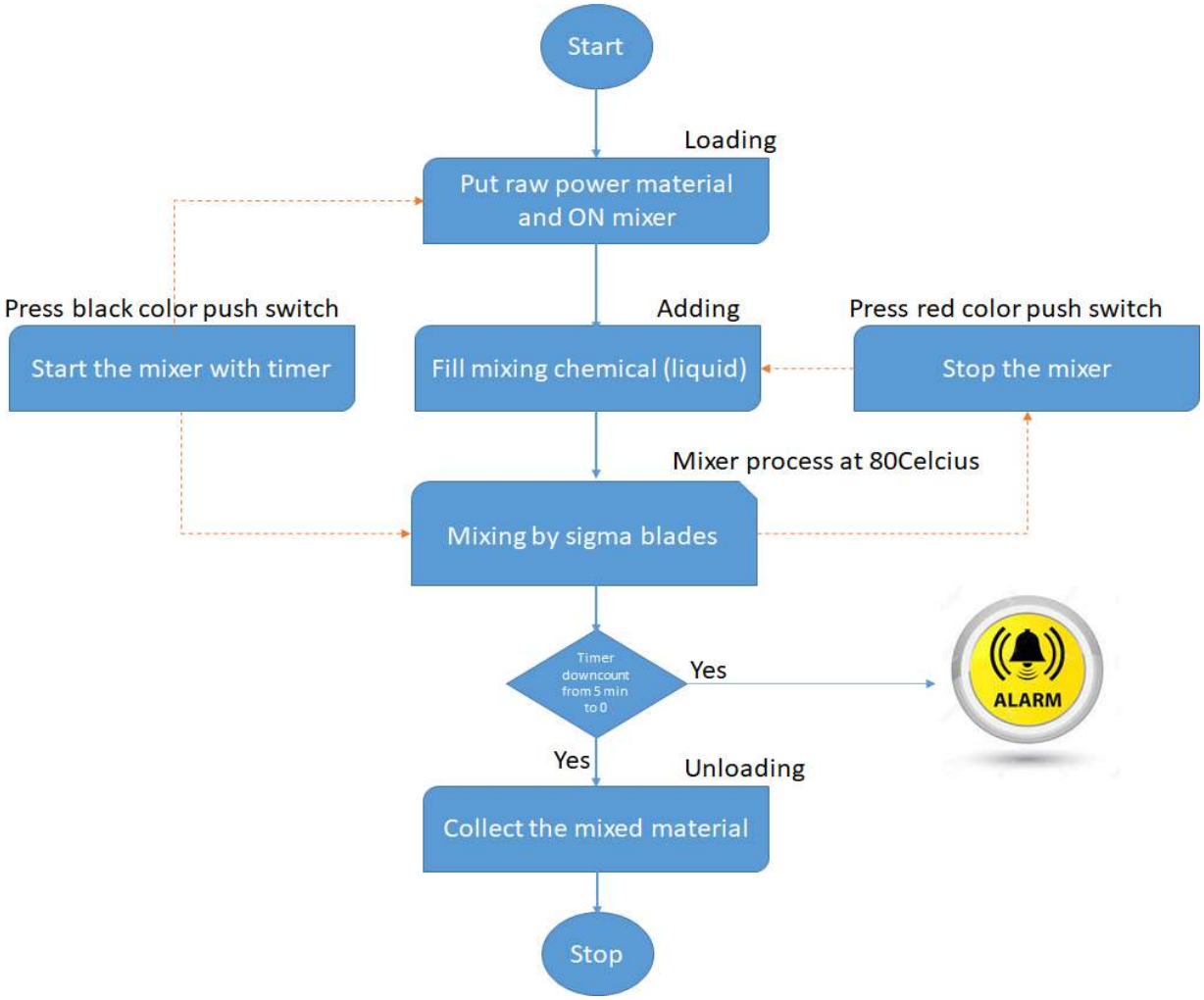
Section number 6 Indicates sigma blade shaft location where proximity sensor and RPM meter can be installed. As per the manual observation, one shaft RPM is 25 count, and another shaft RPM is 39 count for one complete mixing cycle.

Section number 7 Shows stainless steel pots which is used to collect mixed material.

Requirement(9): Derive the total number of completed cycles & running time of each cycle in HH:MM based on the selected date and time ranges
Requirement(10): Derive total time(HH:MM) in operation and idle status with respect to the selected date and time range.
Requirement(11): Capture sigma mixer consuming electrical energy units and plot the energy pattern based on the selected date and time range

Sigma Mixer Machine Process flow:

Figure (5) Mixer process flow diagram



3 High Level Architecture

The below figure illustrates the proposed architecture of the IoT solution to address on the above mentioned requirements.

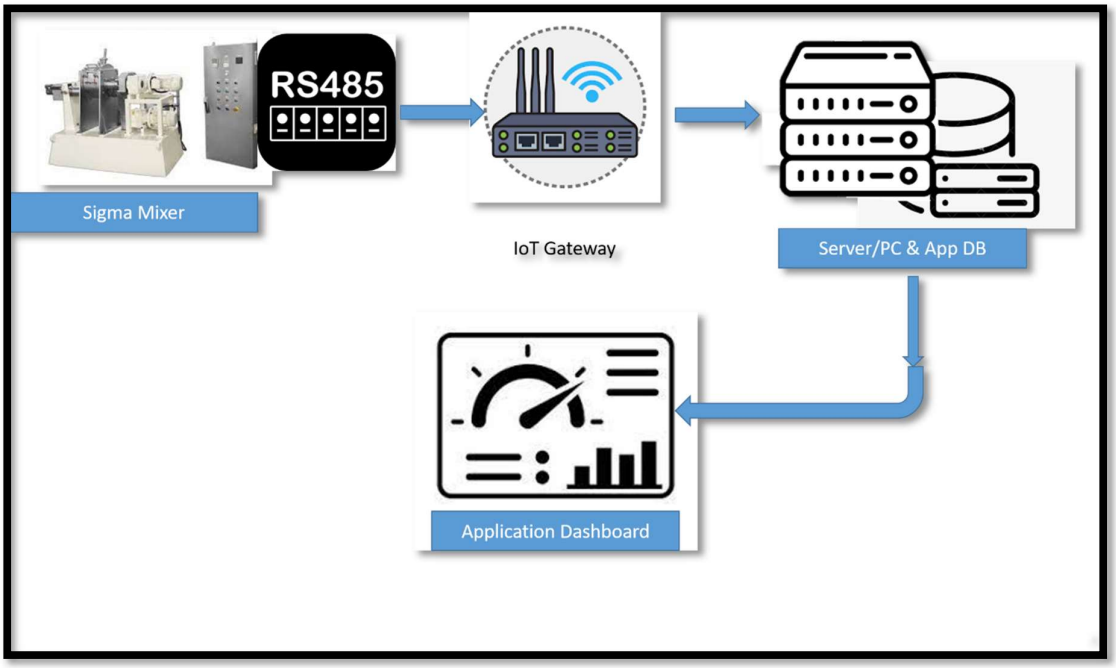


Figure (6) IoT data flow diagram

4 Data Capturing

This section details the data to be captured from the machine, to address the requirements.

- ✓ **Sigma Mixer ON/OFF status**
  - Display the current status of sigma mixer operation condition. Sigma mixer ON by green color indication and OFF by red color indication
  - ON signal will be captured via DI – IO card and send the data to sever via IoT gateway

- ✓ **Sigma Blade shaft1 RPM count**
  - Capturing RPM count by placing proximity sensor and RPM meter
  - Mechanical fixture is required
  - Min,Max and Average of RPM based on the selected date and time range

- ✓ **Sigma Blade shaft2 RPM count**
  - Capturing RPM count by placing proximity sensor and RPM meter
  - Mechanical fixture is required
  - Min,Max and Average of RPM based on selected date and time range

- ✓ **Loading hatch open/close status**
  - Option1: Capturing Latch Switches status via IO card.
  - Option 2: Capturing via proximity sensor
  - Total time of loading hatch open/close status based on selected date and time range

- ✓ **Unloading hatch open/close status**
  - Capturing via proximity sensor
  - Total time of unloading hatch open/close status based on the selected date and time range

- ✓ **Energy consumption pattern**
  - Fixing the energy meter to capture energy consumption
  - Energy meter communicates with the gateway via RS485
  - Plot the energy pattern with respect to time

- ✓ **Total mixer count**
  - Display the total number of mixer counts based on the selected timestamp range
  -
- ✓ **Total time of sigma mixer operation and idle condition**

- ✓ **Reports downloads**
  - Historical data can be viewed and exported into .CSV or image.

5 Web Application

A web-based application will be developed by ISL and hosted in AJM on-premises server, which will include monitoring dashboards, analytics info, and report generation. All the sensors and digital input (DI) will connect to the gateway via RS485 and IO card. Gateway will send data to the server via existing WiFi connectivity.

5.1 User Classes and Characteristics

IoT web application can be accessed only by authorized stakeholders. As per the requirement, 10 types of user have to be created based on roles to access the web app.

6 Machine Operating Environment

The mixer system is in shop floor area. Mixer has motor, limit switch, timer and buzzer. The operating temperature of the area will be around 40°C. Operator can set the timer in minutes. For an instance (5 min), the buzzer will be horned for cycle completion. There is no existing embedded firmware to communicate or integrate with the sensors. Additional sensors, hardware, gateway, and firmware are required to enable data capture. Mechanical fixtures will be required.

(Note: AJM should provide a tinker or welder to fix the additional mechanical fixture to install proximity sensors and meters)

7 Design and Implementation Constraints

Expected dedicated server for Sigma mixer Automation for an instance 16 GB Ram, I5 processor, 512 GB Storage. Lesser configuration may affect the processing speed of the application. Still try to leverage the existing server and deploy lightweight modules for better performance.

Also, there is no backup server to enable high availability, hence AJM needs to make sure continuous power supply to the server by dedicated UPS.

8 User Documentation and Training

Application user manual document and training will be provided to the key stakeholders, after the production implementation which will also cover high level trouble shooting details.

9 Assumptions and Dependencies

- ✓ Dependencies from AJM - For power isolation/provision of ladder/Existing wiring connection support/Mechanical support like welding, cutout, sensor, and limit switch installation.
- ✓ ISL will support identifying the location for sensor/limit switch and meter installation
- ✓ Required power supply to be provided from AJM
- ✓ If the server crashes data cannot be retrieved in case of a local server, hence it is recommended to take a server snapshot in a regular periodic interval by AJM

- ✓ Stable Internet connection & Remote access must be provided by AJM during implementation and support.
- ✓ Dedicated AJM SPOC is required until project completion, ensuring coordination to meet up timelines and prompt responses on questions/clarifications requested within two business days, which otherwise will impact the project schedule.

10 External Interface Requirements

This section will detail the various interfaces that will be part of the proposed IoT solution

User Interfaces

Figure (7) Mixer process flow diagram

Figure 7 is showing the IoT web application color theme and layout of the screens. End user to enter the credentials to access and navigate the screens. It will contain consolidated data insights and historical patterns.

Hardware Interfaces

Sensors, limit switches, RPM meters, and energy meters will connect with the IoT gateway by wired connection via RS 485 Protocol and DI IO card. Energy meter installation on the control panel requires mechanical work to fix and rewiring may also happen for mixer energy consumption. Either Din rail mounting or mechanical clamp for the IoT gateway fixing with power adaptor. Power sockets will be required for various meters (Note: AJM to provide electrician for the power supply provisioning)

Software Interfaces

The data upstreaming to application services will be done via MQTT and REST API calls.

As per the requirement, there are no existing systems or application interfaces required for the IoT application. The application will interface with MongoDB for the database. Dedicated VPN connection will have to be enabled by AJM for on-premises network access.

Communications Interfaces

Sensors and IoT gateway communicate to the local server via plant network connectivity (Existing AJM Wi-Fi connectivity). Set Wi-Fi credential details in IoT gateway firmware to pick the AJM network automatically when the power goes down or the device gets rebooted. AJM will have to provide a continuous power supply to the gateway for high data availability.

11 System Features

Description and Priority

Si.No	Description	Priority
1	Sigma Mixer ON/OFF status	High
2	Mixer cycle time	High
3	Sigma mixture shaft1 RPM real time data	High
4	Sigma mixture shaft2 RPM real time data	High
5	Loading Hatch open/close switch status	High
6	Unloading Hatch open/close switch status	High
7	Mixer machine energy consumption	High

The above mentioned are essential data points to be captured for analysis, which will help to improve the mixer productivity and performance improvement.

12 Functional Requirements

This section will detail the functional requirements to be addressed as part of the proposed IoT solution.

Data acquisition

Various sensor data will be captured and sent to the gateway via RS485 and DI IO card. Event trigger and polling methods can be used for data acquisition. All the sensors and meters are connected to the gateway via a standard communication cable. Hence reliable physical connection is required for longer life. Data availability depends on wired connection and sensors, meters response.

Data Phrasing and Manipulation

IoT gateway performs the data phrasing and manipulation to consolidate all the sources data. Based on the data receiving mechanism like event trigger or polling method, received data will be formed as JSON and pushed into the application server. Data manipulation may be required based on sensors; meters register data type.

Data visualization

The captured data will be displayed in real time as visualization dashboards in the web application and will be able to view the historical data as well. Trend graphs will show the data pattern for the selected timestamp range. Sensors and meter data values will show the current value of the mixer in a value card widget. A consolidated dashboard will also be available to indicate the overall mixer status with KPIs.

Reports and Summary

Users can export the data pattern into the .CSV or image format for further data analysis.

13 Non-Functional Requirements

Safety Requirements

Mixer machine power to be isolated and safety lock to be provided in isolator. It is recommended to use the industrial grade of sensors, hardware, and gateway to improve safety integrity level (SIL)

Security Requirements

Enable multilayer security in the IoT solution. The application can be accessed via only through AJM VPN connectivity. A user account is required to access the application. Strong Wi-Fi credentials are required to avoid local environment hacking.

Recoverability

- Hardware will be replaced based on the warranty period
- Application issues will be sorted out via remote access up to 3 months from the date of implementation (only on the scope agreed in this document)

14 Data Requirements

Sl No	Data Element Name	Data Type	Default Value & DisplayFormat	Comments
1	Mixer Status ON/OFF	Boolean	ON/OFF	
2	Mixer Shaft1 RPM	Float	Eg.100.0 RPM	
3	Mixer Shaft1 RPM	Float	Eg.100.0 RPM	
4	Loading Hatch Open/Close	Boolean	Open/Close	
5	Unloading Hatch Open/Close	Boolean	Open/Close	
6	Mixer machine Energy Consumption	Float	Eg.120 Kwh	
7	Cycle Count	Integer	1,2,3	

15 Installation

This section describes various installations involved as part of the proposed IoT solution,

1) Hardware Installation:
    - Proximity sensor
    - Limit switches
    - CT
    - RPM meter
    - Energy Meter
    - Panel
2) IoT gateway configuration
3) Software Installation
    - Frontend Framework and Packages Installation
    - Backend Software Installation
    - Database installation and configuration
    - Edge Device Interfacing

16 Project Execution Requirements

This section will detail the deliverables as part of the proposed IoT solution for Mixer Machine Automation

Deliverables

- Edge Firmware deployment for Data acquisition
- Formation of Data exchange JSON via RS485
- InspiriSYS IoT solution and DB deployment
- Enable Dashboard access
- Web Application Screens
    - Login Page
    - Consolidated Dashboard
    - Historical Data Analysis
    - Trend graph
    - Reports Download option
    - Excel Reports (based on Machine ID, Date & Time)
    - Mixer machine status report
    - Mixer machine process report
    - Energy consumption report by machine

17 Operating Environment

This section details the hardware, software, and server requirements for the proposed IoT Solution

Software:

- Frontend Module – Screen Visualization
- Backend Module – MQTT broker, Message queue, and routing
- Edge Development – Sensor data acquisition
- DB Operation – Cron Module

Hardware:

- Proximity sensor – 4 No.
- RPM meter – 2 No.
- Energy meter-1 No.
- Limit Switch-2 No.
- CT -3 No.

Server configuration: (AJM already has this server)

- Microsoft Windows 10 pro
- Ram 8GB
- Hard disk 250 GB
- I3 Processor

18 Technology Stack

The technology stack is listed below:

- User Interface
  - HTML5
  - ReactJs
  - Bootstrap
  - FontAwesome
  - Primemg
  - ChartsJS, Apex Charts, Plotly Charts
- Backend
  - NodeJS
  - Pm2
  - ExcelJS
  - Axios
- REST API
- API authentication – JWT tokens
- VBS

19 Testing

This section will describe the various testing to be performed for the proposed IoT Solution

Unit testing will be performed on the following modules

- Hardware and sensors connectivity & data values
- IoT Gateway configuration, downstream and upstream reliable

communication, WIFI signal strength

- Application services status and data logging functionality
- Screens navigations and widgets alignment
- Auto populate on the trend graph
- MQTT Topic subscription and publication
- Data storing and retrieval
- Responsible screen test
- User login test

End to End flow and performance test

- Testing metrics on both hardware and software data flow
- 10 concurrent user performance testing
- Screen loading on larger data size

UAT support will be provided.